Africa
Energy Parks

D7.1
SDG Report

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This deliverable was developed based on collective efforts from all partners of the AfricaEnergyParks consortium.

Abbreviations	
AEP	Africa Energy Parks
CEC	CREMA Executive Committee
CREMA	Community Resource Management Area
ICS	Improved Cookstove
MCA	Multicriteria Assessment
PUE	Productive Use of Energy
REEP	Renewable Energy Parks
SDG	Sustainable Development Goals
SOJAKODA	Soma Jang Kong and Dabori
S-LCA	Social Life Cycle Assessment
VSLA	Village Savings and Loans Association

Glossary

Community Resource Management Area (CREMA): A community-based natural resource management approach used in Ghana, integrating wildlife conservation, benefit-sharing, and development.

Externality: Unintended consequences or pre-existing local conditions that may affect third parties not directly involved in a transaction or production.

Impact Sub-categories: Specific areas within a broader category used to assess detailed impacts in a study, such as those within the Social-Life Cycle Assessment

Life Cycle Assessment (LCA): A methodology used to evaluate the environmental impacts of products and services throughout their life cycle.

Localization of SDG Indicators: The process of adapting Sustainable Development Goal (SDG) indicators to reflect local contexts and characteristics, ensuring they are relevant to specific national and district development plans.

Microgrid A small-scale, localized energy system that can operate independently or in conjunction with the main electricity grid. It typically includes renewable sources like solar, wind, or hydro, and may serve a single village or community.

Multicriteria Assessment (MCA): A decision-making framework used to evaluate and compare alternatives based on multiple criteria or factors, integrating both quantitative and qualitative data.

Off-grid Communities: Communities that are not connected to the national electricity grid and rely on alternative sources of energy.

Participatory Process: A method that involves stakeholders in decision-making to ensure their perspectives and needs are considered.

Productive and Economic Uses: The use of energy for activities that contribute to economic growth and productivity, such as agriculture, manufacturing, and services.'

Qualitative Responses: Non-numeric data collected from stakeholders, such as opinions, experiences, and observations.

Ranking Rules: Mathematical methods used to prioritize options based on their performance across multiple criteria.

Social Hotspots: Areas or issues within a community that present significant social challenges or risks.

Social, Economic, and Environmental Dimensions: The three pillars of sustainability, encompassing social equity, economic viability, and environmental protection.

Social-Life Cycle Assessment (S-LCA): A methodology used to assess the social impacts of products and services throughout their life cycle.

Stakeholder Analysis Tool: A tool used to identify and analyze stakeholders, understanding their influence, interests, and potential contributions to a project.

Stakeholders: Individuals or groups with an interest or stake in a project, including community members, state institutions, private sector entities, non-governmental organizations, and research institutions.

UNEP/SETAC Guidelines: Guidelines developed by the United Nations Environment Programme (UNEP) and the Society of Environmental Toxicology and Chemistry (SETAC) for conducting Social-Life Cycle Assessments.

Executive Summary

Work Package (WP) 7 aims to assess relevant parameters for measuring the social, economic, and environmental performance of the planned and technical solutions under the Renewable Energy Parks (REEP). Among the deliverables under this WP is the Sustainable Development Goals (SDG) Report, which is mapped to Task 7.1. The SDG Report highlights the social performance of the REEP during the development phase to ensure the adoption of the most sustainable system solutions. To further this objective, community members in the SOJAKODA Community Resource Management Area (CREMA) and other stakeholders were engaged through a multicriteria assessment to document their needs and priorities in relation to the design and implementation of solutions under REEP.

Using the Social-Life Cycle Assessment methodology, data was collected through semi-structured interviews, questionnaires, focus group discussions, and observations to assess the societal needs of diverse stakeholders with interests in the Africa Energy Park (AEP). The results of this assessment were mapped to social and economic indicators within the Sustainable Development Goals (SDGs) framework. Subsequently, the SDGs were prioritized by the stakeholders based on their needs and preferences.

The multicriteria assessment revealed that community members in the CREMA communities had limited knowledge of the AEP and the technical solutions to be deployed, posing a significant challenge to the sustainability of the planned and developed technical solutions from REEP. The study identified SDG 1 (No Poverty), SDG 7 (Affordable and Clean Energy), SDG 16 (Peace, Justice, and Strong Institutions), and SDG 8 (Decent Work and Economic Growth) as the prioritized social and economic SDGs. The study also highlighted essential linkages and synergies across all prioritized SDG indicators, requiring a nexus approach as envisaged in AEP to achieve durable and sustainable development.

While the CREMA landscape has attributes to support the AEP, there are also social hotspots. Social hotspots identified in the SOJAKODA CREMA landscape included farmer-herder and human-wildlife conflicts, as well as the perceived neglect of satellite communities regarding the distribution of the planned and developed technical solutions. These social hotspots present significant risks to the success of the AEP.

The establishment of small and medium-scale businesses could contribute to job creation in CREMA communities. However, the assessment found weak linkages between the AEP and the landscape's ecotourism potential, as well as markets for processed foods, which could otherwise create employment opportunities for community members. The concentration of the planned and developed technical solutions in the four CREMA communities can limit job opportunities in the landscape. Consequently, economic disparities are likely to persist in the landscape, reflecting a broader issue within the national development agenda.

In this study, we advocated for the active participation of CREMA in the management of the planned and developed solutions. However, existing governance structures and instruments need to be retooled and improved to ensure effective participation. The risks and externalities identified in this study do not suggest poor design of the AEP but rather serve as useful pointers to the issues that should be considered during the full implementation of the AEP to ensure positive outcomes. Findings from the SDG can support decision-making in other parts of Africa where similar projects are being developed to facilitate sustainability and durable development.

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1. Introduction

Task 7.1 aims to engage with the local community and stakeholders to clarify their needs and priorities related to the design of the Renewable Energy Parks (REEP) and thereby enable a more sustainable development locally of the REEP. Results from the community and stakeholder engagement are captured in this SDG Report.

Renewable energy microgrids hold considerable prospects for Ghana's energy sector, economic growth, and green transition. Rural communities' access to reliable and affordable electricity from renewable energy sources, especially solar, has witnessed significant progress and investments. However, many off-grid communities still exist. In Ghana, 60% of the rural population has no connection to the national electricity grid, and these isolated communities cannot meet their energy needs for productive and economic uses (Kipkoech et al., 2024).Though Ghana has achieved electrification coverage of about 86%, five million citizens have no access to electricity (Saddari et al., 2025).

In addressing this disparity, the Africa Energy Parks (AEP) project was developed to improve access to productive use of clean and affordable energy in selected communities of Soma, Jang, Kong, and Dabori - fringing the Mole National Park. The four project communities are part of the SOJAKODA Community Resource Management Area (CREMA). A CREMA is a community-based natural resource management approach being used in Ghana for natural resource management.

This study investigates the criteria and priorities of different stakeholders in the CREMA communities regarding the planned and developed technologies, as well as the social externalities related to the design and implementation of the REEP. In this study, externality is defined as unintended consequences or pre-existing local conditions that may affect third parties not directly involved in a transaction or production. We focused on social and economic externalities associated with AEP (Ramalho et al., 2025). The study was conducted through a multicriteria assessment of diverse stakeholders' preferences using the Social Life Cycle Assessment (S-LCA) as the framework. These preferences were mapped to the relevant SDG indicators, and the SDGs were prioritized, resulting in the SDG Report. It is the expectation of AEP that the findings from the SDG report would support decision-making in other parts of Africa where similar projects are being developed and deployed to facilitate durable and sustainable development.

1.1 The CREMA Concept

The CREMA mechanism is an innovative tool for natural resource management and landscape-level planning in predominantly rural communities. CREMA integrates wildlife conservation, benefit-sharing, and development to benefit resource-rich communities, the government, and the environment (Asare, 2013; Foli et al., 2018). Landscapes are spatially heterogeneous geographic areas characterized by diverse interacting patches or ecosystems, including those modified or created by humans (Wu & Hobbs, 2002). Before the CREMA mechanism, the Forestry Commission of Ghana and its divisions adopted a control and restrictive approach to wildlife management. This approach resulted in unsatisfactory outcomes, as wildlife

populations dwindled, leading to significant economic, biodiversity, and cultural consequences for the State and fringe communities. Additionally, the State's vested economic management rights over wildlife failed to create the necessary incentives for communities to support wildlife conservation. Through Ghana's Policy for Collaborative Community-Based Wildlife Management (2000), the CREMA concept was developed. CREMA draws its mandate from the Wildlife Resources Management Act, 2024 (Act 1115).(World Bank, 2024). The CREMA concept acknowledges the rights of communities and supports the devolution of natural resource management authority to local communities (Bayala, 2024). From wildlife conservation, the CREMA has evolved and now being used as a vehicle for REDD+ (Reducing emission from deforestation and forest degradation) implementation (Dugasseh et al., 2024).

The establishment of CREMAs has facilitated community-led collaborative approaches to wildlife management and helped minimize unsustainable practices. However, weak governance structures, elite capture, poor financing mechanisms, conflicts over land and tree rights, and disincentivizing benefit-sharing mechanisms have affected the performance of CREMAs in Ghana. Currently, there are about 59 CREMAs across Ghana, including the SOJAKODA CREMA, which is being used as a replication site for the Horizon Project, "REPOWER" (REEP).

1.2 The Africa Energy Parks Project

The Africa Energy aims to support African countries in achieving SDG 7 and climate change mitigation and adaptation targets under the Paris Agreement through the establishment of Renewable Energy Parks (REEP). AEP specifically seeks to provide CREMA communities fringing the Mole National Park with access to affordable and renewable energy to facilitate social and economic activities, as well as environmental stewardship. The project uses the water-energy-food-ecosystem (WEFE) nexus to create a hub for renewable energy production, food processing, and water for agricultural activities. AEP will also promote the development of productive use of energy (PUE) machines and improved cookstoves.

The project will replicate and test in practice the microgrid system (solar photovoltaics, battery energy storage system, and biomass combined heat and power) developed under the Horizon Project "REPOWER" in the SOJAKODA CREMA. With CREMA communities gaining access to energy, the project will facilitate the development of technologies and activities for the productive use of energy (PUE) under a circular economy approach. This circular approach includes using waste generated from agriculture and food processing as feedstock for the BCHP plant and cookstoves. It is expected that lessons learned from the SOJAKODA CREMA replication site will help scale up communities' access to renewable energy sources through best practices. While the effort to provide CREMA communities with clean and affordable energy can contribute to the SDGs and improve living conditions, there are potential externalities that can erode these benefits. Early identification of the externalities can minimize them and contribute to building resilience in the Mole Ecological Landscape. The inability of AEP to address these externalities would be dire for the landscape, which hosts significant biodiversity populations but faces an ecosystem tipping point.

To address these challenges (including planned and developed technical solutions and externalities) in AEP, a detailed social sustainability analysis of the REEP was conducted, leading to the generation of the SDG report. Among other things, the SDG report provides guidelines for replicating the REEP. Implicit in this is the improvement of the livelihood and socioeconomic well-being of CREMA community members. Specifically, the SDG report assesses and measures the social performance of the REEP in the development process to ensure the most sustainable system solutions are used, based on a multicriteria analysis of SDG indicators among diverse stakeholders. By leveraging participatory interactions with local communities and multicriteria assessments, the report will document societal needs for sustainable development. Results from the multicriteria assessment will be used in the conceptual development and early-stage design of the REEP to ensure the social sustainability of the technical solutions.

1.3 Multicriteria Assessment

A multicriteria analysis (MCA) is a decision-making framework used to evaluate and compare alternatives based on multiple criteria or factors (Munda, 2023). MCA provides a framework for aggregating both quantitative and qualitative data across individual criteria, generating indicators of overall performance for different options. This method is especially valuable when making decisions that involve trade-offs between conflicting objectives or criteria with varying levels of importance.
(Dean, 2020; Mendoza & Macoun, 1999).

The MCA serves as an effective methodological and operational framework for conducting ex ante impact assessments of policy options or comparing policy alternatives. The MCA process is interdisciplinary and multidisciplinary, participatory, and transparent, enabling the integration of both technical impact dimensions and social perspectives (Dean, 2020; Munda, 2023). MCA establishes preferences between options by referencing an explicit set of objectives identified by the decision-making body. Mathematical aggregation and ranking rules ensure consistency between the underlying assumptions and the results obtained (GOG.UK, 2024; Mendoza & Macoun, 1999).

MCA methods can serve as powerful framework for sustainability-related analysis, given their interdisciplinary and multidisciplinary approach (Munda, 2023). In this SDG report, we adapted MCA approach within a sustainability context, drawing from the social and economic SDG indicators, to assess the AEP in CREMA communities. Specifically, we relied broadly on qualitative responses from stakeholders to conduct a sustainability assessment of the planned and developed technical solutions using the relevant SDG indicators. It is replete in literature of how stakeholders perspectives in MCA processes are critical for engendering inclusion and participation and the sustainability of projects that contribute to the SDGs (GOG.UK, 2024). We provide further detailed information about the MCA process in the Material and Methods section.

1.4 Linkages between Sustainable Development Goals (SDG) and Social Life Cycle Assessment (LCA)

The 17 Sustainable Development Goals (SDGs) of the United Nations are a global initiative aimed at advancing development and fostering a more

sustainable future through collective action by 2030.(Herrera Almanza & Corona, 2020; Sorooshian, 2024). The SDGs can be grouped into social, economic, and environmental dimensions to reflects the priorities of stakeholders and beneficiaries (Roche et al., 2025). The use of the SDG framework in this study lies in its global relevance, interdisciplinary nature, and policy impact. Yet, Yamaguchi et al. (2023), suggest that research on the SDGs is in its developmental stages, and many aspects of the SDGs remain underexplored. There is also the lack of guidance on how to assess the contribution of product supply chains to the SDGs from a life cycle perspective (Weidema et al., 2018). A typical example is a microgrid system.

Life cycle assessment (LCA) has been identified as a potential tool to evaluate product value chains in relation to the SDGs (Herrera Almanza & Corona, 2020). Specifically, for the social dimension of sustainability, the Social Life Cycle Assessment (S-LCA) is considered an appropriate methodology (Roche et al., 2025). S-LCA evaluates the social impacts of goods and services across value chains to identify hotspots with high social risks (Corona et al., 2017). Notably, the impact subcategories of S-LCA are linked to all 17 SDGs, except for SDG 13 (Climate Action) and SDG 15 (Life on Land) (UNEP, 2020). Building on these insights, this study employs an integrated S-LCA framework aligned with the SDGs to assess societal needs and the social sustainability of AEP in CREMA communities. See Table 1 for the relationship between the SDGs and S-LCA impact sub-categories.

Table 1 Relationship Between the SDGs and S-LCA Impact Sub-Categories

Categorization	**SDGs**	**S-LCA Impact Sub-Categories**
Social	Reduce Poverty (1)	Fair salary and poverty alleviation
	End Hunger (2)	Access to material resources
	Good Health (3)	Health and safety, human health issues, safe healthy living; health issues for children as well as consumers
	Quality Education (4)	Access to immaterial resources and education provided to the local community
	Gender Equality (5)	Equal opportunity; discrimination; and sexual harassment
	Justice and Strong Institution (16)	Legal system corruption; prevention and mitigation of armed conflicts; delocalization and migration; access to immaterial resources: and secure living conditions
	17. Partnership for the Goals (17)	Public commitment to sustainability issues
Economic	Affordable and Clean Energy (7)	Access to material resources
	Decent Work and Economic Growth (8)	Freedom of association; child and forced labor; working hours; social benefits/security; local employment and fair salary; contributions to economic development; and employment relationship.

	Industry, Innovation and Infrastructure (9)	Access to material resources and technology development
	Reduced Inequality (10)	Indigenous rights; delocalization and migration; equal opportunity; and wealth distribution
	Sustainable Cites and Communities (11)	Cultural heritage: community engagement; capacity building
	Responsible Consumption and Production (12)	Fair competition; supplier relationships; social responsibility promotion; respect for intellectual property rights: feedback mechanism; transparency; consumer privacy; end of life responsibility; and children concerns regarding marketing practices; and ethical treatment of animals.
Environment (Planet)	Clean Water and Sanitation (6)	Access to material resources
	Climate Action (13)	Non-applicable
	Life on Land (15)	Non-applicable

(UNEP, 2020)

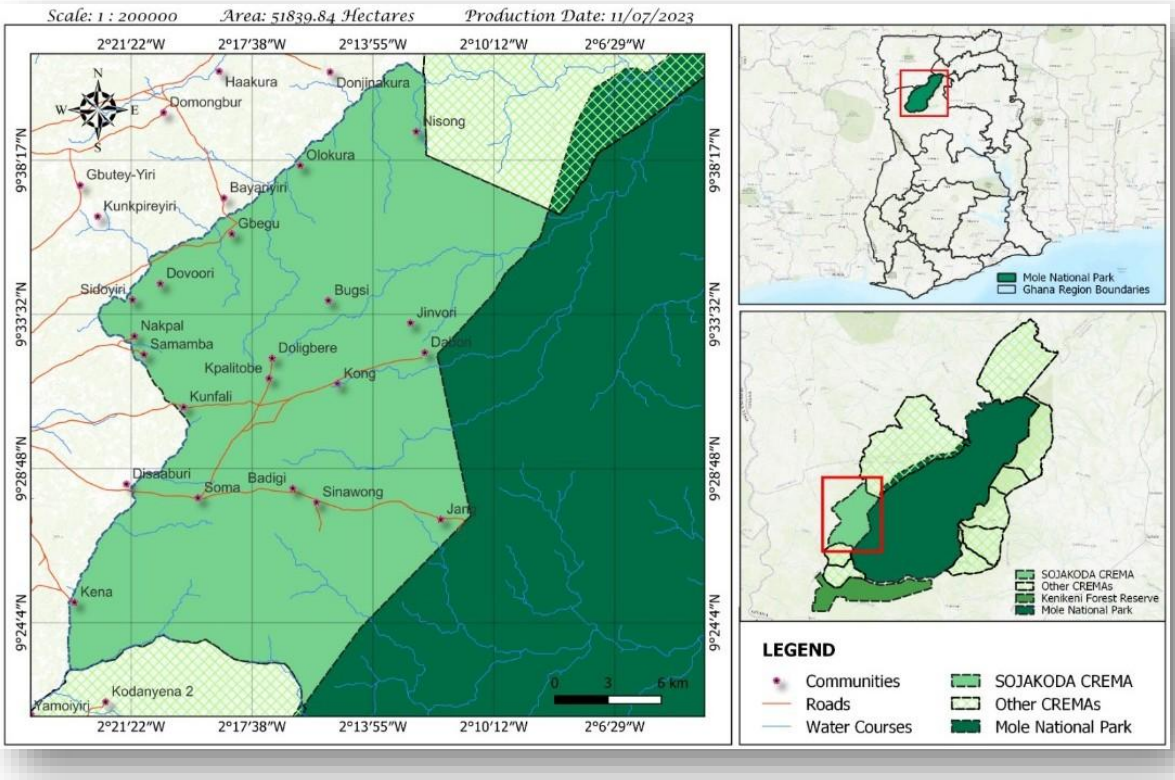
2. Materials and Methods

2.1 Study Area

2.1.1 The SOJAKODA CREMA

The 52,000-hectare SOJAKODA CREMA was established in 2022, encompassing the Soma, Jang, Kong, and Dabori communities in the Sawla-Tuna-Kalba District of Ghana. Dabori and Jang share a border with Mole National Park, while Soma and Kong are located approximately 12 km and 5 km away from the park, respectively. In the landscape, farming, fuelwood and charcoal production, and livestock rearing are the major economic activities (see Figure 1 for the map of the SOJAKODA CREMA). The SOJAKODA CREMA was established to promote community participation in the governance of natural resources within the Mole Ecological Landscape. Its creation followed extensive engagement and sensitization efforts by the Wildlife Service Division of the Forestry Commission and other partners with the four communities that form the CREMA. As part of the management strategy, CREMAs serve as buffer zones for the protection of Mole National Park. These buffer zones, which are outside Mole National Park, are managed by the communities as ecological corridors for environmental, economic, social, and cultural benefits.

Figure 1 Map of the SOJAKODA CREMA

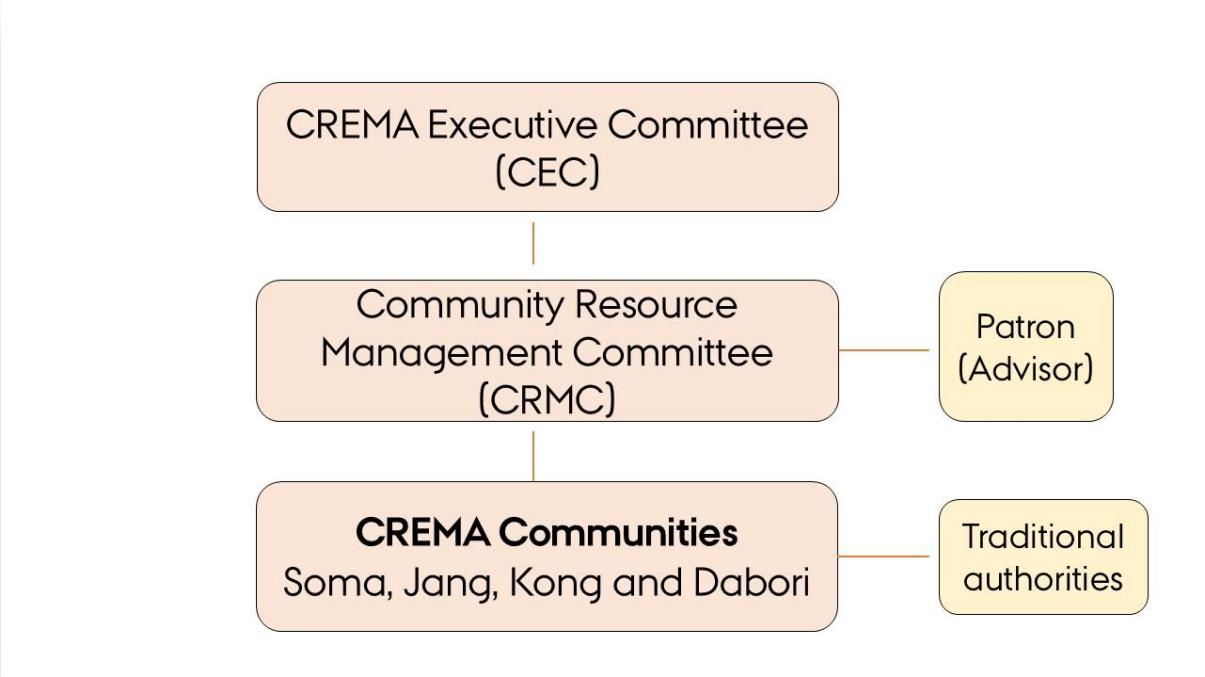


Source: Forestry Commission

Through the support of the Forestry Commission, a constitution and by-laws have been created for the CREMA, aimed at promoting effective natural resource

governance. The SOKAKODA CREMA is yet to receive certificate of devolution from the Ministry of Lands and Natural Resources. Within the organizational structure of the SOJAKODA CREMA, the highest decision-making body is the 19-member CREMA Executive Committee (CEC). Refer to Figure 2 for the CREMA organogram. The CEC includes four representatives each from the Soma, Jang, Kong, and Dabori communities, as well as one representative each from Mole National Park, Partners in Participatory Development (PAPADEV), and the Sawla-Tuna-Kalba District Assembly. Additionally, the CREMA has a Patron, whose role is solely advisory.

Figure 2 Organigram of the SOJAKODA CREMA



2.2 Localization of Relevant SDGs

The SDGs are national and global level targets and often does not reflect local contexts and characteristics (Li et al., 2024). To address this limitation in the study, we localized some of the relevant SDG indicators based on the social, economic, and environmental dimensions captured in national and district development plans, such as the National Medium-Term Development Policy Framework 2022-2025 and the Sawla-Tuna-Kalba District Assembly Medium Term Development Plan. Localization of the SDG indicators provided a bottom-up approach for the multicriteria assessment of stakeholders' needs and externalities associated with the developed solutions. The localized SDG indicators were mapped to the impact sub-categories of the S-LCA for this study.

2.3 Stakeholders Identification and Selection

A stakeholder analysis tool (see Appendix 1) was used to identify key stakeholders for the multicriteria assessment. This tool helped us understand the power dynamics and level of authority (control and power), the potential contributions (both technical and non-technical), and the social impacts of the planned and developed

technical solutions for each stakeholder. The identified stakeholders were categorized into five groups: community, state institutions, the private sector, and non-governmental organizations and research institutions. See Table 2 for the list of stakeholders. We compared the list in Table 1 with the S-LCA stakeholder groups outlined in the UNEP/SETAC guidelines and subsequently focused on local communities, value chain actors, workers, and consumers for the study.

Table 2 List of Stakeholders

Stakeholder	Category	S-LCA Category
Traditional authorities	Community	Local community Consumers Value chain actors
CREMA executives		
Village Savings and Loan Associations (VSLA) members[1]		
Farmers (women and men)		
Men group[2]		
Youth groups[3]		
Hunters		
Herders		
Artisans (e.g., corn mill operators)		
District Assembly Members	Government	Consumers Value chain actors
Forestry Commission (Wildlife Staff)		
Operator of Tuna High School Microgrid	Research	Non-applicable
PUE Expert	Private	Value chain actors
Solar Energy Expert		
Commodity Value Chain Expert[4]		
Landscape Governance Expert[4]	NGO	
Gender Expert[4]		

The stakeholder categories were selected based on their relevance to the developed solution and the potential social and economic benefits they could derive. The remaining stakeholder categories were excluded due to the insignificant socio-economic impacts the developed solutions would have on them. For the assessment, stakeholders were selected from each stakeholder category using random sampling and snowballing techniques.

2.4 Data Collection

The data collection process utilized several assessment tools, including semi-structured interviews, questionnaires, focus group discussions, and observations. Site-specific data were collected from the four communities within the SOJAKODA CREMA. The site-specific data collection approach was used to gather current, high-resolution data on stakeholder needs, SDG externalities, and social hotspots associated with the REEP project. On average, each stakeholder spent approximately

[1] Kanyitisumo, Nukpane Fonga 1, Soozaabol, Yogbol
[2] Big six, Aduonadi, Nuukpannefonga
[3] Big six Attàa group
[4] These experts have extensive experience working in CREMA communities in Northern Ghana.

20 minutes participating in the data collection exercise. A total of 78 respondents participated: 22 in semi-structured interviews, 8 in the questionnaire survey, and 44 in focus group discussions (see Appendix 2 for the list of tools used for each stakeholder). In preparation for the data collection, PAPADEV, a partner in the AEP project, organized the CREMA communities, while the Forestry Commission carefully reviewed the stakeholder list for the exercise. Additionally, a joint data collection activity was conducted in the communities with NTNU and MASS, who were working on Task 1.2 and Task 4.1, respectively. To ensure accuracy and avoid duplication, a review of the technical reports prepared by consortium partners was conducted.

Semi-Structured Interviews

The semi-structured interviews involved 22 stakeholders, including farmers, CREMA executives, men, women and youth leaders, vulnerable groups, public servants, artisans, and experts. Stakeholders were interviewed regarding their needs and priorities, as well as social externalities. Specifically, the interviews focused on planned and developed technical solutions, PUE machines, clean energy, poverty reduction, food security, governance, collaborative natural resource management, and environmental stewardship. This exercise generated mostly qualitative data to explore and interpret the needs and priorities of stakeholders and externalities that can impact the planned and developed technical solutions. We also conducted five interview sessions with stakeholders via telephone, as they were not physically present in the landscape. Three local languages - Vagala, Wali, and Twi - were used for the semi-structured interviews and translated into English. See Appendix 3 for the questions used in the semi-structured interviews.

Picture - Interviews with community members in Jang (1) and Dabori (2)

Questionnaire Administration

The survey questionnaire was integrated into a mobile-compatible offline version of SurveyXact, designed by Ramboll, and used for data collection in the CREMA communities. Using a mobile phone, statements were read from the questionnaire, and stakeholders were asked to respond to the statements to the best of their ability. The statements focused on PUE machines, inclusion and participation, benefits from the REEP, stakeholders' contributions, and preferences. A total of 8 stakeholders participated in the survey, including officers from the Wildlife Services Division of the Forestry Commission, CREMA, Assembly members, and governance and value chain specialists. The language used for the survey was English. The questionnaire used is provided in Appendix 4.

Focus Group Discussions

We conducted six focus groups across the four CREMA communities, involving a total of 44 participants. The aim was to leverage group dynamics to gain insights into the needs and priorities of stakeholders, as well as to assess the social and economic externalities of the developed solution. Two focus group discussions were held for each of the following groups: men, women, youth, and CREMA executives. The discussions were conducted separately for men, women, youth, and CREMA executives to ensure focused and relevant dialogue. The separate interview approach was adopted because, men, women and the youth have distinct, separate roles within the household and at the community level. This kind of categorization made it relevant to conduct interview discussions for each individual group separate from the other.
Key issues discussed included job opportunities, economic activities, energy governance, poaching, fuelwood and charcoal production, environmental stewardship, cookstoves, and PUE machines.

Picture Focus group of community members in Jang (1) and Soma (2)

2.5 Data Analysis

We transcribed semi-structured interviews and focus groups discussions conducted in English using Otter.ai 2.0, while interviews in Valga and Waali were transcribed manually. Following from Kiger and Varpio (2000), we employed thematic analysis to identify, analyze, and present patterns from the transcribed interviews. These patterns were coded and thematically categorized under social and economic externalities. Responses from the questionnaire were analyzed using the SurveyXact analytics tool

embedded in the software. In the prioritization of the SDG, we followed the steps outlined in Mendoza and Macoun (1999) for ranking and interpretation of points accumulations.

3 Results

This section presents the results from the multicriteria assessment of the planned and developed technical solutions and social and economic externalities associated with the AEP project. Here we present the results from the questionnaire, semi-structured interviews, observations and focus group discussions with key stakeholders within and outside the SOJAKODA CREMA.

3.1 Questionnaire

All respondents in the survey indicated their willingness to diversify their energy sources, and 88% are not satisfied with their current energy source.

Are you willing to change your energy source?	Percent	Respondents
Yes	100.0%	**8**
No	0.0%	**0**
Total	**100.0%**	**8**

However, reliability and cost are the major factors that would influence their choice of energy sources. Half of the respondents would like to spend GHS 10-20 monthly on energy supplied by the microgrid and cooltainer, but 63% would prefer to pay the same amount for the irrigation system. Regarding payment methods for the services provided by the developed technologies, majority of respondents would pay by cash, followed by mobile money, and through credit/installments. Capacity building, managerial roles, and co-creation processes in the design of the microgrid were highlighted as areas for driving community participation in AEP. While all respondents were satisfied with the site for the microgrid, 38% were not satisfied with the siting of the cooltainer. More than 80% of respondents believed that microgrid, cooltainer, and solar pump would be beneficial to them in terms of additional income and increasing the shelf life of agricultural produce.

Anticipated impact of microgrid on job creation	Percent	Respondents
No impact	0.0%	**0**
Beneficial	87.5%	**7**
Harmful	12.5%	**1**
Not sure	0.0%	**0**
Total	**100.0%**	**8**

In terms of governance instruments needed to ensure effective management of the developed solutions, respondents prioritized drafting by-laws, conflict management, and benefit-sharing mechanisms. Additionally, 62.5% of respondents were comfortable with a joint ownership arrangement for the developed solution. See Appendix 5 for the full results and analysis of the questionnaire.

3.2 Semi-Structured Interviews and Focus Group Discussions

3.2.1 Needs and Priorities of Stakeholders

In this section, we broadly highlight the priorities and needs of stakeholders in relation to the developed solution, as outlined in Table 3. Additionally, we provide deeper insights into these statements in the subsequent sections.

Table 3 Stakeholder Expectations of Planned and Developed Technologies

Criteria (Solutions)	Stakeholder Category	Expectations	Lead Voice
Microgrid system (PV Solartainer + BESS + BCHP)	Local Community	There is an urgent need to diversify energy sources due to widespread dissatisfaction with the current energy sources and options (1)[5].	The youth in the four CREMA communities expressed strongly their dissatisfaction during the interview and focus group discussions over the fact that their communities are not connected to the national grid. Men and women respondents also expressed their frustrations over their inability to start businesses or improve educational outcomes of their children due to the absence of electricity in their communities.
	Local Community Consumers	The cost of electricity should be affordable and reliable (2).	All community members, and in particular the corn mill operator in Jang were of the view that the cost of electricity should be affordable to community members.
		Community members prefer to pay in cash for electricity supplied by the microgrid (3).	Men respondents in the Jang community expressed their willingness to pay for services through cash since it is readily accessible.
		Electricity sourced from the microgrid should lead to a reduction in household energy costs (4).	The statement was strongly associated with the Gender Expert and corn mill operator during the interview sessions highlighted the expectation of reduced energy cost with the introduction of renewable energy.
	Local Community	The community members' capacity for repairs and maintenance of the microgrid system should be built to ensure optimal performance (5).	The youth, women, and CREMA executives indicated their willingness to participate in training activities to build their capacity for operating and maintaining the microgrid system. Traditional leaders in Soma also support the capacity building of community members for the optimal performance of the developed solutions.
		Community would prefer to sell their crop residue to feed the BCHP (6).	Farmers (men) in Jang conceived the idea of using farm residue as fuel for the microgrid.
		The management team of the microgrid should include CREMA executives and the District Assembly (7).	CREMA Executive, Landscape Governance and Gender Experts made comments to suggest that the involvement of CREMA executives and members of the District Assembly would facilitate good governance and sound managerial practices.
		There is a strong willingness among community members to contribute labour towards the construction of the microgrid (8).	Comments from the youth, both men and women respondents, in all four CREMA communities indicate that they can provide the labor for mounting the developed solutions.

[5] Statement number

Criteria (Solutions)	Stakeholder Category	Expectations	Lead Voice
	Value chain actors	Each component of the system (PV solar, BESS, BCHP, etc.) should be capable of generating electricity independently as well as collectively (9).	The microgrid operator in Tuna suggested that each energy producing component of the microgrid system should be capable of generating energy independently. This would ensure the continuous supply of power when component has a fault.
		Access to adequate biomass with the required dryness should be secured (10).	In the interview with the microgrid operator he numerated the challenges of accessing well-dried biomass to feed the BCHP.
		There is a need for the development of regulations and management plans for the microgrid (11)	The Landscape Governance Expert and CREMA executives strongly advocated for the development of governance instruments such as by-laws to guide the management of the microgrid.
Improved cookstoves (ICS)	Local Community Consumers	ICS design should integrate elements of traditional cookstoves and accommodate traditional cooking practices. E.g., preparing "tuo zaafi"[6] (12)	The women respondents interviewed remarked that the design of the ICS should incorporate elements that reflect their traditional cooking practices. The women interviewed specify that certain foods are suitable to cook in certain pots, to maintain the cultural value attached to the dish.
		ICS should support large-scale commercial food processing activities e.g. roasting gari will require bigger ICS (13).	Food processors in the landscape suggested the development large ICS to cater for large food processing and institutional cooking.
		Random sampling techniques are recommended in the distribution of ICS (14).	Women respondents in Jang and Kong proposed a random approach to the distribution of Improved Cooking Stoves (ICS) to ensure fairness.
		ICS should reduce the intensity of fumes that cause discomfort during cooking (15)	Comments relating to the unhealthy cooking environment were mainly made by women respondents in all four CREMA communities during the focus discussion sessions.
		The use of ICS should reduce the amount of fuelwood and charcoal used for cooking in households (16)	This observation is linked to the anticipation among women respondents that the efficiency of the ICS would reduce the amount of fuel required for both domestic and commercial food processing.

[6] A delicacy common to the CREMA landscape and is prepared by cooking and stirring a combination of maize or millet flour and water till it is a smooth, slightly firm mixture is attained.

Criteria (Solutions)	Stakeholder Category	Expectations	Lead Voice
		The use of ICS will reduce time spent on fuelwood collection (17).	Women pointed out that the fuelwood is scarce in the nearby forest/bushes, which means they would have to spend more hours fetching fuelwood, walking long distances. Reducing the use of fuelwood will help them use their time in other productive work in the household.
		There would be reduced risk of being attacked by animals in the forest, such as snake bite or being attacked by wild animals, and rape incidences (18).	Women face potential risks, including animal attacks and injuries from working in the bushes. Additionally, they are vulnerable to sexual violence, with reported cases of rape in nearby communities.
		The processing center should have ICSs that can be rented for a period (19).	Women respondents in Jang provided this suggestion as a way of getting many women to use ICS.
Cooltainer	Local Community	Smaller sized cooltainers are preferred due to it convenience and privacy it provides (20).	Women and young respondents in CREMA communities suggest that smaller-sized cooltainers are preferred, as they would provide the opportunity to take better care of the cooltainers.
		The cooltainer is needed for the storage of frozen foods and vegetables from farms to reduce food losses and increase shelf life (21).	Women and a few men respondents in all four CREMA communities expect the cooltainers to help them store food and fish items.
Solar powered irrigation system	Local Community	The demonstration sites for the dry season gardening need to be secured (fenced) to prevent cattle from destroying the crops (22).	Respondents, primarily farmers, consistently highlighted the main challenges related to herder-farmer conflicts as a key issue affecting the security of the demonstration farms. This sentiment was repeatedly expressed during interviews and group discussions with farmers across all four CREMA communities.
		Food items to be cultivated on the demonstration farm include vegetables, cassava, groundnuts, onions, and watermelons (23)	Vegetables were suggested by women farmers while cassava, groundnuts and onions were suggested by men farmers. A CREMA executive in Kong suggested watermelon.
		A drip or sprinkler irrigation system would be suitable for the demonstration farms (24)	Farmers in all CREMA communities suggested that a drip or sprinkler irrigation system is preferred as it would reduce the workload and have greater coverage of land under cultivation.
		Production from the demonstration farms should be enough for	Both men and women farmers expect the demonstration farms to be highly productive to support both domestic and commercial purposes.

Criteria (Solutions)	Stakeholder Category	Expectations	Lead Voice
		subsistence and commercial purposes (25).	
		Planting materials and agrochemicals would be needed to control pests (26).	Farmers in Kong suggested that farmers should be provided with planting materials and agrochemicals to support farming activities in the demonstration farms.
		Plots should be allocated to the various groups in the communities so that most people can participate in the dry season gardening (27)	This statement resonates with migrant farmers and women respondents in Dabori and Jang, as the allocation of plots in the demonstration farm to groups within the CREMA communities would ensure participation and equity in benefit sharing.
		Support women to increase access to land for the dry season gardening as income-generating activities (28).	Women farmers and a few men respondents in Dabori suggested that equitable distribution of land would ensure inclusive participation.
		The water source for the irrigation scheme should be transformed into a multiple water use system to serve both agriculture and domestic purposes (29).	The Assembly Member for one of the CREMA communities suggested that the water source for the irrigation scheme should be modified into a multiple-use system so that animals can also benefit, especially in the dry season.
	Value chain actors	Provide market linkages for agricultural produce (30).	Farmers and women respondents, during interviews and focus group discussions, strongly advocated for aggregators to offtake produce from the demonstration farms to reduce food losses.
PUE Machines[7]	Local Community Workers	Machines should be easy to repair and operate (31).	CREMA executives and the youth groups requested basic but efficient PUEs, so they can be easily maintained and repaired.
		The processing center should have spare parts so that broken ones can easily be fixed (32).	The PUE specialist and a cornmill operator in Jang strongly advocated for the need for spare parts to be readily available to ensure continuous operations of the PUEs.
		The noise from the PUE should be minimal so it may not distract or create a nuisance to the wildlife population (33).	This statement is associated with the wife of a Wildlife Guard in the Jang Camp who was concerned about the potential impact of the noise generated by the PUEs when in operation.
		The processing center should be in a position to employ the youth in the community (34).	The youth focused the interview sessions on how they could be employed to work at the processing center. Adult women respondents also hoped that job opportunities would be created for their children and husbands

[7] Corn mill, cassava grater, cracking machine, processing machine, combine harvester, groundnut processing machine and gari processing machine

Criteria (Solutions)	Stakeholder Category	Expectations	Lead Voice
		Women in the community could also be trained on how to use and maintain the machines (35)	The CREMA respondents highlighted the importance of training women on the use of machines and other equipment. When the youth are trained, there are chances that they can move out of the community in search of opportunities elsewhere. When the trained manpower leaves the community, those left behind, in most cases elderly men and women, cannot manage to maintain the machines.

3.3 Insights into the Priorities and Needs of Stakeholders

During interviews and focus group discussions with stakeholders, it was observed that most stakeholders had limited knowledge of the AEP and the technologies to be deployed in the four CREMA communities. However, the launch of the project in Jang provided stakeholders with an opportunity to have more information about the initiative. Many stakeholders expressed that they would be more supportive of the project if they were better engaged and educated about it. Due to this knowledge gap, CREMA community members opined they are currently unable to provide the support needed to ensure the project's success. Nonetheless, CREMA community members have clear priorities, needs, and expectations from the project.

Regarding the location of the microgrid and processing center, stakeholders from the Jang community expressed satisfaction due to its proximity to the community. However, engagements with traditional leaders in Soma revealed that they would have preferred the facilities to be in their community, as Soma is almost equidistant to most nearby communities. An elder from Soma commented, "*We have no objections to placing the machines in Jang, but Soma's central location would make the processing facilities more accessible to the surrounding communities. We fully support the project and hope that similar machines will also be installed in Soma in the future*"

There is unanimous agreement among stakeholders that the new technologies to be introduced in the CREMAs will provide reliable electricity, simplify cooking and food processing, reduce food waste, and help produce hygienic products. Women were excited about the PUE machines, which are expected to reduce labor and the time spent processing food under unhealthy conditions. Nonetheless, they expressed disappointment over the lack of pictorial representations of the PUEs. During a focus group discussion in Kong, one woman rhetorically asked, *"If we don't know what the machines look like, how can we confidently say we can operate them?"* Women also raised concerns about the implications if most women are not beneficiaries of the improved cookstoves (ICS). In both men's and women's focus group discussions, stakeholders proposed using a random sampling technique based on numbered cards for the distribution of AEP benefits. This they hope will take away any form of biases in benefit sharing. There was a consensus that widows and physically challenged individuals should be given priority in the distribution of the ICS.

The majority of stakeholders interviewed believe that electricity supplied through the microgrid should be affordable so consumers can pay. In an interview with a CREMA executive, he stated, "*Every community member who receives electricity from the solar plant or services from the food processing facility must pay for the services so the machines can be maintained*." This view is shared by all other stakeholders, including consortium partners who participated in the interviews.

Stakeholders interviewed prioritized training as a prerequisite to ensure that the developed solutions are maintained and operated at an optimal level. They expressed their displeasure over previous solar lighting projects in their communities where their participation was limited. A CREMA executive said, "*The people (solar contractors) came and installed the streetlights without training us on how to fix them when they break down… currently, it is only one streetlight that is working*." Community members

with educational and technical skills (artisans) were identified in all four communities, and these individuals have expressed their desire to undergo further training to operate the microgrid and allied technologies that would be installed by the project. In focus group discussions, women also expressed their willingness to undergo similar training in preparation for managerial or technical roles in the processing center. The non-functional solar infrastructure and processing machines were a major concern for community stakeholders. They specifically expressed the desire to have the solar streetlight in Jang fixed and the shea butter processing machine in Soma installed.

One of the priorities of stakeholders in the CREMAs is to reduce the cost of processing food (transportation) or operating a small-scale business (fuel consumption). The cost of diesel is the reason why corn mill operators in the four CREMA communities are willing to switch from diesel to solar. A corn mill operator in Jang said, "*I use 3 gallons of diesel for my cornmill every day and therefore if I can still do the same amount of work using solar at a lesser cost, my incomes will increase*". On the issue of the food processing facility competing with businesses such as the corn miller operator, the operator responded, "*too much meat does not spoil the broth*".

When it comes to hiring workers, community members in Jang prefer to recruit individuals from within the Jang community itself. Meanwhile, members of the Soma and Dabori communities have expressed a strong interest in securing employment opportunities at the processing center. They aspire to gain stable and gainful employment, which would contribute to their economic well-being. Community members with relevant experience are willing to provide technical guidance and share managerial insights gained from their work in the landscape.

A critical concern for community members is the availability of ready markets for their agricultural produce, particularly as they are excited about increasing the production of agricultural commodities. They also expect to receive competitive prices for their processed agricultural products. An expert working in the Mole Ecological Landscape highlighted that in projects like the AEP, a private entity should ideally be part of the consortium to aggregate, and offtake all processed produce. Such an arrangement would ensure community members of ready markets and competitive pricing for their produce.

During focus group discussions and interviews, community stakeholders requested a tractor to assist with farming activities and a combined harvester for rice harvesting. Additionally, community members suggested promoting rice cultivation and the rearing of ruminants as ways to increase incomes and improve livelihoods of CREMA communities.

3.4 Assessment of Social and Economic Externalities

This section documents responses from stakeholders covering social (SGDs 1-5; 16-17) and economic (7-12) externalities for prioritization of SDG indicators. Statements from diverse stakeholders were mapped to the SDG indicators that were commonly associated with the responses from stakeholders related to SDGs 1; 2; 7; 8; 9 and the least mentioned were 4; 6; 10; 12; 16 and 17.

The selected site for the developed solutions, woodlots, and the demonstration farm for dry season gardening did not displace or resettle any CREMA members. Landlords voluntarily released the lands for the project. The project successfully secured the lease agreement for the site for microgrid and allied technologies, facilitated by the Ministry of Energy. According to a consortium partner, documenting the lease agreement in the name of the Ministry of Energy is standard practice in most solar projects they are involved in, and it also reduces potential land conflicts. One concern was the possibility of migrant farmers losing the right to continue farming on the land earmarked for the AEP activities. However, a consortium partner and traditional leader in the landscape, indicated that there is a low possibility of farmers losing their land since there are few migrant farmers and all AEP activities would be on communally owned land.

Frequent herder-farmer and human-wildlife conflicts are a major concern for most stakeholders in the landscape. Traditional authorities and the Forestry Commission have often tried to address these conflicts, but crop farmers remain dissatisfied. When farmers complain, officers visit the farm to assess the level of destruction, but no action is taken. Farmers interviewed reported that their farms are often raided by cattle and elephants, but they do not receive adequate compensation. A CREMA executive during a focus group discussion in Jang stated, "*They (Forestry Commission) tell you; you have no right to kill an elephant, but does the elephant have the right to destroy crops? Is it fair?"* Contrary to the assertion of lack of compensation, a herder in Kong reported paying 10,000 GHS (€613.00) as compensation for his cattle destroying yam sets. A young farmer expressed his frustration over his inability to cultivate cassava and yams anymore due to the frequent raiding of his farms. He also narrated how his colleagues had abandoned farming and migrated to seek greener pastures in the big cities. He further suggested that these conflicts could affect the success of the project and reduce the benefits that would accrue to community members.

In most of the interviews and focus group discussions, it was revealed that the absence of economic opportunities in the landscape has contributed to poaching activities. Another economic activity detrimental to the flora and ecosystem services in the landscape is commercial fuelwood and charcoal production. An Assembly Member narrated how he led a team to confiscate more than 1,800 bags of charcoal in an area between Jang and Dabori. An interview with an expert working in the landscape suggested that poaching has reduced in CREMA communities within the Mole Ecological Landscape compared to non-CREMA communities. Nonetheless, he opined that charcoal production is on the increase in both CREMA and non-CREMA communities. However, all stakeholders engaged during the assessment were hopeful that the AEP project would provide job opportunities to minimize poaching and commercial charcoal production in the SOJAKODA CREMA. Regarding the reduction in charcoal production, a woman CREMA executive in Kong stated, "*In the tree planting project where the women were paid, the level of charcoal production reduced*." CREMA communities indicated their willingness to leverage microgrids to purchase corn mills and fridges to start their income-generating enterprises.

Community stakeholders highlighted the prospect of people from nearby communities relocating to Jang to access electricity and establish small-scale businesses. While community stakeholders are not currently worried about the potential relocation of

people from nearby communities, they emphasized that it would negatively impact the limited social amenities in Jang.

The absence of electricity is affecting learning and academic performance in the CREMA communities, per the deductions from the interviews. This situation is reflected in the number of people with formal education in CREMA communities. Stakeholders were enthusiastic that the project would improve the learning and educational outcomes of their children and offer them the opportunity to use electronic devices. According to the youth and women in the CREMAs, they are aware of the training opportunities offered by the AEP and believe it would build their technical competence and brighten their prospects for employment opportunities.

During the interviews, women specifically expressed the numerous challenges they face when accessing fuelwood for cooking meals for their families. A woman interviewed in Kong indicated that they would have to go very far into the forest to fetch fuelwood, mainly for domestic purposes. They narrated instances where, during the collection of fuelwood, they get injured, bitten by snakes, attacked and raped by herders, or go missing in the forest. The situation is further compounded by the fumes and smoke entering their eyes, causing them to sometimes go temporarily blind, excessive cough and chest pains, and phlegm coming from their noses. Deductions from the interviews, focus group discussions, and questionnaires imply that women in the CREMA are key to ensuring energy security in the home and for productive uses. Women in the CREMA believe that the ICS would help them cook in a hygienic and healthy environment and prevent soot from discoloring their cooking utensils. A few men and youth indicated their willingness to assist in the kitchen when their wives have access to an ICS, despite cultural norms that typically discourage men from helping in the kitchen. Besides the ICS, the women believe that the location of the PUE processing center would reduce the cost of processing food, increase storage life, and reduce working hours and physical effort.

There are many social groupings in these communities, including the Village Savings and Loans Associations (VSLAs), farmers, men, and youth associations. According to members of these groups, they work to improve their living conditions, thereby contributing to the SDGs. Community stakeholders opined that some of the associations e.g., the VSLAs are weak due to poor structures but have been leveraged to implement projects with mixed outcomes.

Table 4 Social and Economic Externalities

Criteria	Stakeholder	Statement	Lead Voice
Social	Local community Value chain actors	The land allocated for the developed technologies, demonstration farm and woodlot may result in some community members losing the right to continue farming on the same piece of land (36).	Farmers in Dabori and Kong were concerned about losing their farmland, which may be part of the areas designated for the demonstration farms and the woodlot.
		Jang being connected to the electricity grid would facilitate the movement of people from surrounding areas to Jang (37).	This concern was raised by mainly young respondents in Jang, who suggested that access to electricity in their community would incentivize their peers from other communities to relocate to Jang to benefit from the developed solutions.
	Value chain actors	The CREMA should actively be involved should have rights in the deployment of the planned and developed solution. Registering land titles for the designated project area under the Ministry of Energy can limit community ownership and may conflict with the CREMA concept (38).	The Landscape Governance Expert was of the view that the CREMA can play a meaningful role in ensuring the sustainability of the technical solution if the CREMA can exercise management rights over them.
		The proximity of the football field to the processing center can be a source of contaminants (dust) during food processing (39).	This is an observation made by researchers during data collection activities in the Jang.
	Value chain actors	Potential noise from operating the PUEs could distract academic activities in Jang Primary School (40).	This is an observation made by researchers during data collection activities in the Jang.
	Local community	The developed technologies and PUEs can be used as teaching and learning materials for students and schools within the area (41).	This statement is associated with both men and women respondents in Jang, who view the developed solutions as opportunities for acquiring practical knowledge either for themselves or their children.
	Local community Value chain actors	Harvesting fuelwood by women in CREMA carries several risks, including snake bites, sexual assault, and physical injuries (42).	Women respondents in the interviews and focus group discussions repeatedly echoed the risks associated with harvesting fuelwood in the forest.
		There was no relocation of settlements in the landscape to pave the way for AEP (43).	All respondents indicated that no settlement or family in the landscape has been relocated because of the implementation of AEP.
		CREMA communities would benefit from capacity building in non-technical areas such as financial management (44).	This statement is linked to the Gender Specialist and women respondents, who foresee capacity building in non-technical areas.

Criteria	Stakeholder	Statement	Lead Voice
		Connection of Jang to the electricity grid would facilitate learning and improve educational outcomes among students (45).	Both women and men respondents especially parents believe that access to electricity in the community would enhance educational outcomes among their children.
	Local community	Husbands would be interested in helping their wives with culinary activities due to the ease that comes with using the improved cookstoves (46).	Men respondents indicated their willingness to help with meal preparation at home if the ICS makes cooking more comfortable, even though traditionally, women are the ones who cook in homes within CREMA communities.
		The demonstration farms and dry season gardening intervention has the potential to exacerbate the herder-farmer conflict (50).	Gender specialist and women respondents the in CREMA made comments to support this statement during the interviews and focus group discussions.
	Value chain actors	The community engagement processes, and project activities of AEP would help revive dormant social groups to contribute to the SDGs e.g., VSLAs (48).	CREMA executives, Landscape Governance Expert, and the gender specialist were of the view that activities of the AEP would revive dormant groups such as the VSLAs in the CREMA communities.
	Local community	AEP would build governance structures in CREMA communities to draw community support and participation in CREMA activities (49).	This statement is associated with CREMA executives, Landscape Governance Expert, and staff of the Forestry Commission who are of the view that AEP would support the improvement of community governance structures in the CREMA for sustainable conservation.
		The dry season gardening intervention has the potential to exacerbate the herder-farmer conflict (50).	This statement was repeatedly made by farmers during interviews and focus group discussions.
		The focus of intervention in the four communities, which are of the same ethnic group, can be perceived as discriminatory (51).	An Assembly Member in the CREMA made this statement to encourage AEP to reach out to satellite communities within CREMA communities. This would eliminate the perceived discrimination.
		Electricity in Jang would facilitate access to information and promote entertainment, religious and other nightlife activities (52).	The youth in Jang highlighted how access to electricity would improve access to information and promote other social activities such as entertainment.
	Value chain actors	The publicity given to the SOJAKODA CREMA through AEP would result in the flow of financial and technical support and research to improve livelihoods (53).	This statement is associated with Landscape Governance and Commodity Value Chain Specialists, suggesting that there would be support coming from outside the CREMA to facilitate conservation and livelihood improvement activities.
		AEP and Shea Savanna Emission Reduction Program linkages would create better opportunities and impacts in the landscape (54).	A Forestry Commission staff member, along with the landscape governance expert, highlighted the connections between the two projects, focused on building landscape

Criteria	Stakeholder	Statement	Lead Voice
			resilience, reducing poverty, and lowering emissions, being implemented simultaneously within the landscapes.
		Opportunity for SOJAKODA CREMA to deepen relationships with academia, the private sector, and NGOs for collaboration (55).	A staff of the Forestry Commission and Landscape Governance Expert suggested that AEP has the potential to build a stronger relationship with partners outside the CREMA due to the mileage AEP would give to the SOJAKODA CREMA.
Economic	Local community, Consumers Value chain actors	Infrastructure development will be prioritized within the community. e.g. reshaping the main road to Jang (56).	According to all respondents interviewed in Jang, the road improvements have significantly enhanced accessibility and transportation to and from the community.
		AEP would facilitate the repairs of broken down solar powered streetlights in CREMA communities (57).	The youth and the Solar Energy Expert were of the view that since AEP work evolves around renewable energy, it would be helpful if AEP can repair the broken down solar powered streetlights in the Jang and other CREMA communities.
		AEP would create the environment for the establishment of small sized enterprises within the natural resource products e.g., dawadawa and tamarind value chains (58)	The commodity value chains specialist indicated the potential of natural product value chains that can be developed organically alongside the AEP focused agricultural produce.
	Local community	Some entrepreneurs in the food value chain, e.g., corn millers would be crowded out of business due to the establishment of the processing center (59).	The corn miller in Jang expressed concern about losing his clients to the processing centre when it is operational.
	Value chain actors	There is an opportunity for CREMA to leverage its role in biodiversity conservation and the promotion of clean energy technologies to enhance the value of its produce through certification programs e.g., organic certification (60).	The commodity value chain specialist indicated opportunities available to the CREMA due to its unique position of promoting biodiversity conservation and clean energy utilization.
	Value chain actors Consumers	Taxes paid from the processing centre would contribute to the revenue of the Sawla-Tuna-Kalba District Assembly (61)	An Assembly member within the CREMA indicated that the Sawla-Tuna-Kalba district stands to benefit from taxes that would be paid by the processing facility.
		The unique design of AEP can be incorporated into the tourism map of the Mole National Park to attract tourists (62).	There is the opportunity for AEP developed solutions to be listed as a tourist site due to its contribution towards sustainability.

3.5 SDG Prioritization

In this section, we identify SDG indicators associated with statements made by stakeholders for the planned and developed technical solutions (Table 3) and identified social and economic externalities in the landscape (Table 4). We present identified SDG indicators in Table 5. Subsequently, the number of indicators for each SDG was determined in Table 6.

Table 5 Identified SDG Indicators

SDG	Indicator	Statement No.
	1.2.2 Proportion of men, women, and children of all ages living in poverty in all its dimensions according to national definitions. 1.4.1 Proportion of population living in households with access to basic services. 1.4.2 Proportion of total adult population with secure tenure rights to land….by sex and by type of tenure.	1; 2; 4; 25; 28; 30; 38; 39; 43; 44; 54; 55; 58
	2.2.2 Prevalence of malnutrition among children under 5 years of age, by type (wasting and overweight). 2.3.2 Average income of small-scale food producers, by sex and indigenous status.	13; 21; 22; 23; 26; 27; 36; 47; 54; 58
	3.4.1 Mortality rate attributed to cardiovascular disease, cancer, diabetes, or chronic respiratory disease. 3.9.2 Mortality rate is attributed to unsafe water, unsafe sanitation, and lack of hygiene.	15; 26; 29; 33
	4.1.1 Proportion of children and young people: …… (b) at the end of primary; achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex. 4.3.1 Participation rate of youth and adults in formal and non-formal education and training …… by sex. 4.4.1 Proportion of youth and adults with information and communications technology (ICT) skills, by type of skill. 4.a.1 Proportion of schools with access to: (a) electricity; …… (g) basic handwashing facilities.	5; 40; 41; 44; 45
	5.a.1 (a) Proportion of total agricultural population with ownership or secure rights over agricultural land, by sex; and (b) share of women among owners or rights-bearers of agricultural land, by type of tenure.	18; 28; 35
	6.5.1 Degree of integrated water resources management.	24

SDG	Indicator	Statement No.
	16.1.2 Conflict-related deaths …… and cause. 16.3.1 Proportion of victims of violence … conflict resolution mechanisms. 16.7.2 Proportion of population who believe decision-making is inclusive and responsive, by sex, age……group. 16.10:2 Ensure public access to information and protect fundamental freedoms.	7; 18; 37; 38; 39; 42; 49; 52; 53; 54
	17.1.2 Proportion of domestic budget funded by domestic taxes.	55; 61
	7.1.1 Proportion of population with access to electricity. 7.1.2 Proportion of population with primary reliance on clean fuels and technology. 7.2.1 Renewable energy share in the total final energy consumption.	1; 3; 4; 10; 11; 16; 17; 20; 35; 37; 57
	8.3.1 Proportion of informal employment in non-agriculture employment, by sex. 8.5.1 Average hourly earnings of women and male employees, by occupation, age and persons with disabilities. 8.5.2 Unemployment rate, by sex, age and persons with disabilities. 8.9.1 Tourism direct GDP as a proportion of total GDP and in growth rate.	6; 8; 30; 34; 41; 58; 59; 62
	9.3.1 Proportion of small-scale industries in total industry value added. 9.b.1 Proportion of medium and high-tech industry value added in total value added. 9.4.1 CO_2 emission per unit of value added. 9.1.1 Proportion of the rural population who live within 2km of an all-season road.	9; 12; 31; 32; 56; 59; 60
	10.3.1 Proportion of the population reporting having personally felt discriminated against or harassed … human rights law. 10.1.1 Growth rates of household expenditure or income per capita among the bottom 40 per cent of the population and the total population.	2; 14; 19; 46; 51
	11.6.2 Annual mean levels of fine particulate matter	39

In determining the performance of each SDG indicator in relation to the planned and developed technical solutions, we constructed a performance matrix from the results to aid in decision-making. The performance matrix was constructed by ranking the number of indicators through the regular ranking approach. In this approach, we assigned each SDG relevant to the planned and developed solutions and externalities a rank, based on the perceived importance of the indicator to stakeholders. The ranking was based on a 9-point scale and the points accrued for each SDG were interpreted using Mendoza and Macoun (1999). The rank for each SDG is the sum of all indicators (points) under the SDG. See Table 6 for the performance matrix to support decision making in the AEP.

Table 6 Performance Matrix of the Planned and Developed Solutions and Externalities Versus SDG Indicators

SDG	Indicators							Point Accumulation	Classification[8]
	Planned and Developed Solutions					Externalities			
	Microgrid system[9]	ICS	Cooltainer	Irrigation System	PUEs	Social	Economic		
	***	-	-	***	*	******	-	13	Extremely Important
	*****	*	*	-	-	***	*	11	Very Important
	*	*	-	-	-	********	-	10	More Important
	-	*	*	***	-	***	**	10	More Important
	**	-	*	*	*	*	**	8	Important

[8] Adopted from Mendoza and Macoun (1999)
[9] PV Solartainer + BESS + BCHP

	*	*	-	-	**	-	****	8	Important
	*	-	-	-	-	****	-	5	Moderately important
	**	**	-	-	-	*	-	5	Moderately important
	-	*	-	*	*	*	-	4	Less to moderately Important
	-	*	-	*	-	*	-	3	Less Important
	-	-	-	-	-	-	*	2	Weak to Moderately Important
	-	-	-	-	-	-	*	1	Weakly Important

	-	-	-	*	-	-	-	1	Weakly Important
	-	-	-	-	-	-	-	-	Non-Applicable
Total	14	8	3	10	5	26	9	**81**	

The total number of indicators (*) under each SDG is a demonstration of how stakeholders prioritize social and economic SDGs. Generally, stakeholders prioritized SDGs 1; 7; 16 and 8, which is based on the number of indicators associated with the SDG. Regarding the developed solutions, the microgrid system had the highest number of indicators (14 indicators), with the least being the PUEs and cooltainer. On externalities, SDG indicators relating to social conditions in the landscape were highly prioritized (25 indicators) as against 9 for economic externalities.

In using the multicriteria assessment, the local community category of stakeholders (farmers, VSLA members, traditional authorities, men, and youth groups) prioritized SDGs 1; 2; 7 and 8. Within the same stakeholder category, CREMA executives, women in the VSLAs, and farmers prioritized; SDG 16; 4 and 6, respectively. Consumers prioritized SDGs 7 and 1. The value chain actor's category prioritized SDG 7 and 8. However, the community governance specialist focused more on SDG 16, the gender specialist on SDG 5 and 10. An outlier in this stakeholder category is the prioritization of SDG 17 by an Assembly Member. In response to the prioritization of the developed solutions, the multicriteria assessment indicated that the local community category of stakeholders was much interested in the solar powered irrigation system and the microgrid. Notwithstanding women in this stakeholder category also prioritized the ICS over the PUEs and cooltainer.

Based on the number of assigned indicators in Table 6, we used visualization tool treemap, to display the SDGs in a set of rectangles where each rectangle's size is proportional to the number of indicators as prioritized by stakeholders. See Figure 3 for the treemap.

Figure 3 SDG Indicators Treemap for Developed Solutions and Externalities.

The largest rectangle shows the SDG with the highest number of prioritized indicators and, while the smallest rectangle shows the SDG with the least number of prioritized indicators as deducted from the semi-structured interviews, questionnaire and focus group discussions.

4 Interpretation and Discussion

This study assesses the social performance of the REEP in the development process to ensure the most sustainable and, implicitly, most durable system solutions possible are used in other geographical locations based on a multicriterial analysis. This section of the report discusses the findings within a broader literature.

4.1 Implications of Social and Economic Externalities

The multicriteria assessment using the SDGs has raised awareness and interest in AEP activities that promote social sustainability among diverse stakeholders in CREMA communities. This increased awareness creates an enabling environment for broad-based stakeholder participation and engagement in the project. Additionally, the assessment has provided an opportunity to identify stakeholder priorities and explore collaboratively, how these priorities can be aligned with the SDGs for sustainable transitions involving diverse stakeholders (Lyra & Lehtimäki, 2023). The study showed that the most prioritized social indicators by stakeholders were related to SDG 1, followed by SDGs 16; 2; and 4. For the economic indicators, SDGs 7; 8; and 9 were prioritized. These indicators were prioritized mostly by community stakeholders, as they formed the majority of participants in the multicriteria assessment. Stakeholders did not prioritize any indicators under 12, which may be attributed to local priorities, the agroecological landscape of the CREMA, and limited knowledge of the goals. The prioritization of indicators related to SDG 1 by CREMA communities resonates with the perception that developing countries, particularly Ghana, derive greater benefits when efforts are focused on social and economic advancements (Annan-Aggrey & Arku, 2024).

The results from the study demonstrated the multidimensional and interconnected nature of the SDG indicators as they relate to AEP implementation. It also highlighted how broad the impact of AEP could be through deliberate linkages across all prioritized indicators, emphasizing the need for a nexus approach to achieving sustainable development. AEP's adoption of the energy-water-food-ecosystem nexus shows the project's commitment to ensuring durable sustainability within the CREMA landscape. We found from the multicriteria assessment that the water component of the nexus was not adequately considered by stakeholders, likely due to the nature and focus of the AEP. However, there were significant synergies and connections between the water and food components of the nexus, indicating stakeholder interests and willingness to invest and support activities within the two components. Akrofi (2024), opined that the nexus approach provides one of the best prescriptions for facilitating sustainable development, using the SDGs. Therefore, the AEP, tailoring its interventions around the energy-water-food-ecosystem nexus and prioritized SDG indicators by stakeholders, would significantly contribute to achieving social sustainability within the SOJAKODA CREMA.

The prioritization of most indicators under SDG 1 by stakeholders underscores the importance of poverty reduction in the landscape. This is particularly significant given that unemployment emerged as the most pressing social issue affecting CREMA community members. The situation is further compounded by limited economic opportunities for the youthful population. Economic opportunities play significant roles in achieving sustainable development as documented in studies by Akrofi (2024); Annan-Aggrey and Arku (2024); Passos Neto et al. (2023). In

evaluating the impact of SDG 1, Leal Filho et al. (2021) found out that stakeholders from 34 countries considered SDG 1 a threat to the achievement of SDG 2 ‘Zero Hunger’, SDG 3 ‘Good Health and Well-being’, SDG 4 ‘Quality Education’ and SDG 6 ‘Clean Water and Sanitation’. It is within this context that Tladi (2022) described SDG 1 as a leitmotif and central to achieving all the other SDGs. The evidence from the multicriteria assessment related to the prioritized SDGs could serve as a basis for AEP to tailor interventions that reflect the needs of stakeholders in the SOJAKOKOA CREMA, ensuring that no one is 'left behind'

Collectively, fewer indicators i.e. 81 were prioritized by stakeholders despite the localization of relevant SDGs by the study. This finding supports the argument that the SDG framework is not sufficiently informed by local experiences in order to be effectively applied (Nagati et al., 2022). However, Akrofi (2024) found a strong association between localized SDGs targets and improved socio-economic outcomes, particularly in areas of healthcare access, education, gender equality, and economic opportunities in Ghana. Notwithstanding and per the findings of this study, we agree with Reuter (2023) that the SDG framework should adopt a more inclusive approach by effectively engaging with local communities to generate positive outcomes. It is important to note that an excessive focus on localizing the SDGs to specific community contexts, without adequate consideration of broader national or global frameworks, can be counterproductive and lead to unsustainable outcomes. Therefore, striking a balance between localized implementation and broader national or global SDG frameworks can yield better outcomes.

The high proportion of indicators prioritized under SDG 1 could also mean a developmental imbalance in respect to the other SDGs (Li et al., 2024). The lower prioritization of indicators could be attributed to the amount of information stakeholders, particularly CREMA communities, had on AEP. This assertion is supported by an earlier study by a consortium partner (Ministry of Energy), which suggested that there was a *'relatively low level of comprehension of clean energy concepts, indicating a significant knowledge gap'*. Therefore, the same can be argued for the small number of prioritized indicators under other SDGs. However, we recognize that the number of indicators under each SDG varies, and thus the number of indicators does not necessarily establish that the SDG is not prioritized.

4.2 Social Hotspot and Risks

The multicriteria assessment of diverse stakeholders revealed social and economic risks that can impact the sustainability of the AEP and its outcomes. These risks, described as social hotspots, are found across the four CREMA communities. Social hotspots are specific locations or activities where significant social issues, vulnerabilities, or risks are concentrated or likely to occur (Martín-Gamboa et al., 2024; UNEP, 2020).

The farmer-herder and human-wildlife conflicts in the CREMA present significant social hotspots and risks to the AEP, particularly for the demonstration farms and agricultural produce intended for the processing facility. Addressing these challenges is beyond the scope of the AEP. However, AEP interventions could include steps to secure areas designated for agricultural activities. There are opportunities for the AEP to collaborate with existing initiatives within the landscape, such as the Environmental

Protection Agency's efforts with the Forestry Commission and CREMAs, to address these conflicts. To de-escalate conflicts in CREMA communities and ensure that the expected benefits from AEP accrue to stakeholders, we suggest establishing a Feedback and Grievance Reporting Mechanism (FGRM). The FGRM would serve as both a platform for stakeholders to channel their concerns and have them addressed by selected representatives from all interest groups involved in the AEP. Alternatively, the CREMA's conflict resolution mechanism could also be used to prevent and resolve community level project conflicts.

One of the technological solutions that generated significant discussion was the solar-powered irrigation schemes. We recommend modifying the system into a multi-water use system (MUS), which would provide more benefits than the original plan of water for dry season gardening. The MUS would address the competing water needs for domestic purposes and animal watering to a certain extent. The benefits of MUS include improving water quality, health and nutrition, gender empowerment, and effective water governance (Stellbauer et al., 2025).

The concentration of activities in Jang, could generate apathy and lack of support for project activities by the other 3 communities. This apathy can also be extended to satellite communities bordering the CREMA. Satellite communities can be described as fringe stakeholders - marginalized and non-collaborative stakeholders whose voices are not easy to account for (Lyra & Lehtimäki, 2023). Although AEP is being implemented in Soma, Jang, Kong, and Dabori, it is important for the project to find innovative ways to engage satellite communities. This would dispel the misconception among satellite communities that AEP favors a particular group while discriminating against others. In addressing these concerns, AEP activities would be implemented in 10 multi-ethnic communities across the landscape. Additionally, the satellite community of Badigi would be connected to the microgrid and woodlot. Similarly, effective engagement with the fuelwood/charcoal and herder communities would help garner support and minimize the impact of their activities, which are detrimental to the project's outcomes. Broadly, stakeholder engagement and information education communication activities should consider the literacy rate of CREMA community members for effectiveness. We support the suggestion made by PAPADEV (2024) that "*the project must create a highly contextualized, visually oriented, and culturally sensitive methodology for describing the advantages and operation of the microgrid system because traditional technical communication approaches will not be adequate*". A further step in the engagement process at the district level would be a deliberate effort to integrate AEP into the Sawla-Tuna-Kalba District (STK) Assembly Medium Term Development Plans.

CREMA has supported natural resource governance in the landscape by building governance structures and instruments. Although the SOJAKODA CREMA was recently established, it has made significant progress in galvanizing community support for environmental sustainability and stewardship. The CREMA has been a conduit for women's participation and supports efforts to address unsustainable land use practices. The SOJAKODA CREMA is strategically positioned to play a significant role in the management of AEP, as it includes traditional leadership, representatives of local government and NGOs, as well as community members. However, the CREMA has not received certification of devolution because it has not completed all

the required steps. It is not financially independent and has weak governance structures. Additionally, CREMA has yet to develop a management plan for the geographical area it covers. AEP presents an opportunity for the SOJAKODA CREMA to incorporate clean renewable energy into its management plan and other governance instruments for sustainable development.

The CREMA appears to be the only governance structure that directly links traditional authority with state institutions in the landscape. However, the SOJAKODA CREMA has not been successful in creating awareness among community members that they are part of the CREMA. Yet stakeholders in STK are widely known to actively participate in processes that address community needs (Mohammed et al., 2023). The CREMA will need to rally community members to identify more with the CREMA and support its activities. Despite these challenges, CREMA's active participation in managing the planned and developed technical solutions can facilitate sustainably practices in the landscape. This involvement could also bring financial benefits to support CREMA's activities. Similar management models are being practiced in the Wechiau and Murugu-Mognori CREMAs in northern Ghana, where CREMA executives manage shea processing facilities. Exchange visits to these CREMAs would facilitate peer-to-peer learning experiences, providing valuable insights into how CREMAs can play an effective role in the management of the AEP. Reuter (2023) asserts that "*Innovative and effective solutions for local actors are other local actors who have successfully implemented one or several of the SDGs, particularly peers who experience similar local conditions and constraints*". In as much as we advocate for the active participation of CREMA in the management of the developed solutions, the governance structures and instruments of SOJAKODA CREMA need to be retooled and improved.

Limited livelihood opportunities in the CREMA are considered the main reason for unsustainable land use practices in the landscape. To address this, the Sawla-Tuna Kalba District established the District Local Economic Development Team to explore areas for job creation (STK, 2020). The efforts of the STK Assembly align with the AEP's job creation agenda. The successful creation of 10 small and medium-scale businesses would contribute to the district's economic development strategy and have the potential to employ the youth who form the majority of the population. Consequently, jobs would be created in Jang, where the microgrid and processing center are located, with priority given to community members in Jang for recruitment. This approach would rally support for the project, build trust, and minimize potential tensions in Jang. However, it leaves the other CREMA communities with limited job opportunities. To this end, more deliberate engagement with the Sawla-Tuna-Kalba District Assembly and commodity companies would enhance the effectiveness of AEP in addressing poverty through the productive use of energy. Additionally, mapping AEP's outcomes to the district's Medium-Term Plans and activities can improve the coverage of benefits and impacts on CREMA communities.

The Mole Ecological Landscape is a hub for tourism in Ghana. However, there appears to be no connection between the REEP solutions and ecotourism potential of the landscape. Hailiang et al. (2023) suggests that investment in renewable energy solutions lead to significant rise in the tourism activities while Qamruzzaman (2025) found out that an increase in tourism activity is associated with a rise in the utilization

of clean energy sources. A deliberate blend and investment in renewable energy sources, combined with the ecotourism potential of the landscape, would create significant employment opportunities for CREMA communities.

The concentration of planned and developed technical solutions in Jang may limit access to job opportunities, particularly for people outside the community. AEP. Consequently, we believe there would be increased unemployment and economic disparity in the four CREMA communities, reflecting a common feature in the national development approach. AEP can facilitate the development of value chains for other common natural resource products, such as 'dawadawa' and tamarind, and establish market linkages for these products to create job opportunities for CREMA members. The unique role of SOJAKODA CREMA in biodiversity conservation and the promotion of clean energy technologies offers tremendous opportunities to enhance the value of its produce and natural resource products through certification programs. Certification of selected natural resource products would improve the income that actors in the value chain receive. There were concerns among entrepreneurs, such as corn mill operators, about losing their jobs. However, an innovative approach to addressing this challenge in AEP implementation would not crowd out these entrepreneurs but rather create many job opportunities for community members to obtain decent jobs.

While the social hotspots and externalities identified in this study do not indicate poor design, they serve as useful pointers to be considered during the implementation of the AEP. Table 7 highlights key areas that consortium partners should consider when carrying out project activities.

Table 7 Recommended Actions for Identified Challenges and Opportunities

Challenge and Opportunities	Recommended Actions	Responsible Consortium Partner
Facilitate processes for the adoption of best management practices for the technical solutions.	• Draft management plans and by-laws for the management of the planned and developed technical solutions. • Adopt a slide scale or tiered approach to the payment of energy consumed. • Ensure equitable distribution of benefits and access to developed technical solutions.	FC and PAPADEV
Improve natural resource and energy governance	• Facilitate the development of the SOJAKODA CREMA management plan. • Integrate sustainable and affordable clean energy in the CREMA management plan. • Build the capacity of CREMA executive and communities in sustainable resource management and entrepreneurship. • Build strong linkages between the AEP outcomes and the landscape's ecotourism potentials.	FC
Provision of adequate biomass with the required dryness should be secured	• Develop short-term strategy for the supply of biomass since it would take a longer time for the woodlot to mature. • Develop long term plans for the supply of biomass with the required dryness. • Incorporate dryer in the BCHP system.	MASS MARSH
Clean energy for large-scale commercial food processing	• Develop large ICS to cater for large food processing and institutional cooking. • Give priorities to vulnerable households in the distribution of ICS.	EGA
Grievances and conflict management	• Establish a Feedback and Grievance Reporting Mechanism to serve as platform for stakeholders to channel their concerns and have them addressed.	AU and NTNU

Challenge and Opportunities	Recommended Actions	Responsible Consortium Partner
Reduction of farmer-herder conflicts	• Secure sites for the dry season gardening to prevent cattle from destroying planted materials. • Continue engagement and dialogue with farmers, herders and traditional authorities on ways to reduce farmer-herder conflicts.	PAPADEV
Improvement in community stakeholder engagements and knowledge of the AEPs, including the planned and developed technical solutions.	• Create animated videos and illustrations of PUE and microgrid components. • Create a highly contextualized, visually oriented, and culturally sensitive information education. communication materials to improve community understanding of the AEP. • Assign roles to community members and facilitate co-creation processes in AEP activities.	INNOVA
Existing non-functional solar infrastructure and processing machine in the landscape.	• Fix non-functional solar infrastructure and shea processing machines and provide training for the repairs.	DEN, MASS and FC
Access to markets and competitive pricing	• Engage companies to offtake processed products from the processing center. • Establish an AEP Women's Association to undertake marketing of produce.	PAPADEV
Certification activities.	• Initiative steps to obtain certification (organic or Fairtrade) for selected products under the AEP.	FC
Multiple Water Use System	• Examine the feasibility in redesigning the solar powered water system into MUS to address the competing water needs.	DENG
Peer to Peer Learning	• Conduct exchange visits to well-established CREMAs and other community managed projects for peer-to-peer learning experiences.	PAPDEV

A deliberate effort to address these challenges and leverage opportunities identified in Table 7 would promote sustainable development across the landscape, delivering significant benefits to CREMA members and enhancing landscape resilience through access to affordable, clean energy.

5 Conclusion

The multicriteria assessment of diverse stakeholders on REEPs developed solutions has provided deeper insights and understanding of stakeholder priorities and needs as they relate to social SDGs. Results from the multicriteria assessment would be used in the conceptual development and early-stage design of the REEP to ensure social sustainability and to provide guidelines for replication in other African countries.

The adoption of the multicriteria assessment using SDG indicators, along with methodological approaches such as S-LCA, helped evaluate the social sustainability of the AEP, which is being implemented with the energy-water-food-ecosystem nexus framework. While this made the process complex, it also helped to distill and isolate key areas of stakeholders' interests and priorities in alignment with the SDGs. The multicriteria assessment revealed that, based on stakeholder prioritization, the energy-water-food-ecosystem nexus framework for AEP contributed more to the energy and food components than to the water and ecosystem components. Given that this study focused on the social sustainability of the AEP, the ecosystem aspect of the nexus was not considered. This will be addressed in Task 7.2 under the Life Cycle Assessment.

In the study, we found strong interest and high expectations among CREMA communities regarding the AEP, particularly its potential to provide a reliable energy source and enhance economic well-being through the planned and developed technical solutions. Stakeholders prioritized indicators linked to SDGs 1 (No Poverty), 7 (Affordable and Clean Energy), 8 (Decent Work and Economic Growth), and 16 (Peace, Justice, and Strong Institutions), reflecting the recognition of the interconnectedness between poverty alleviation, energy access, institutional strength, and sustainable economic development. AEP should not only focus on SDG goals and targets but also on durable, sustainable solutions for communities. Therefore, incorporating the needs and priorities of stakeholders in REEP design, with a special focus on SDGs 1 and 8, would meet stakeholder expectations and drive inclusive participation in AEP activities. However, this may not necessarily result in durable sustainability due to weak governance practices.

We found that there is limited knowledge of the AEP and the planned and developed technical solutions in the four CREMA communities. This lack of awareness could hinder the communities' ability to co-create and take ownership of the AEP, which is essential for achieving social sustainability. Additionally, concerns have been raised about the over-concentration of AEP activities and potential jobs in Jang, at the expense of other CREMA communities. To address these concerns, engagement with fringe stakeholders needs to be improved and intensified to dispel the misconception that they are being discriminated against. Gaining the buy-in of satellite communities would not only contribute to achieving the SDGs but also improve the coverage and number of beneficiaries. Furthermore, the frequent conflicts between farmers, as well

as human-wildlife conflicts, pose significant challenges for the proposed demonstration farms, food security, and the supply of raw materials to feed the food processing center. This underscores the need for an innovative approach to effectively address these challenges.

The SDG report utilized participatory processes and a multicriteria assessment to evaluate and highlight the social performance of the AEP. By applying SDG indicators, the societal needs of stakeholders were identified and documented. These identified societal needs and externalities would facilitate the development of the most sustainable system solutions for the REEP, ensuring the social sustainability of the technical solutions. The risks and externalities identified in this study do not suggest a poor design of the AEP but rather serve as useful pointers to the issues that should be considered during the full implementation of the AEP to ensure positive outcomes. The findings on the social and economic externalities within the CREMA landscape provide critical insights for the execution of Tasks 7.2, 7.3, and 7.4, which focus on investigating the environmental, economic, and total sustainability of the AEP, respectively. Additionally, these findings complement other related tasks in the AEP, specifically Tasks 1.1, 1.2, 3.1, and 5.1. Beyond the AEP, the methodologies employed for the SDG report, along with the key findings of this study, can be utilized to develop a framework and template for microgrid renewable energy projects in Africa and other parts of the world.

Reference

Akrofi, M. M. (2024). SDGs localization and socio-economic development outcomes in Ghana. *Sustainability Nexus Forum*, *32*(1), 19. https://doi.org/10.1007/s00550-024-00559-5

Annan-Aggrey, E., & Arku, G. (2024). SDG dilemma in local policymaking in Ghana: when ambition and reality collide. *Canadian Journal of African Studies / Revue canadienne des études africaines*, *58*(2), 397-420. https://doi.org/10.1080/00083968.2023.2299822

Asare, R. A. (2013). Community Resource management as a strategy to manage African forest resources.

Corona, B., Bozhilova-Kisheva, K. P., Olsen, S. I., & San Miguel, G. (2017). Social Life Cycle Assessment of a concentrated solar power plant in Spain: A methodological proposal. *Journal of Industrial Ecology*, *21*(6), 1566-1577. https://doi.org/https://doi.org/10.1111/jiec.12541

Dean, M. (2020). Chapter Six - Multi-criteria analysis. In N. Mouter (Ed.), *Advances in Transport Policy and Planning* (Vol. 6, pp. 165-224). Academic Press. https://doi.org/https://doi.org/10.1016/bs.atpp.2020.07.001

Dugasseh, F. A., Adams, M. A., & Zandersen, M. (2024). Actor perceptions of the governance framework and non-carbon Benefits from the Ghana Cocoa Forest REDD+ Program: An Extended Q-Study of the Juabuso-Bia Hotspot Intervention Area. *Environmental Management*. https://doi.org/10.1007/s00267-024-01978-2

Foli, S., Ros-Tonen, M. A. F., Reed, J., & Sunderland, T. (2018). Natural resource management schemes as entry points for integrated landscape approaches: Evidence from Ghana and Burkina Faso. In *Environmental Management* (Vol. 62, pp. 82-97).

GOG.UK. (2024). *An introductory guide to multi-criteria decision analysis (MCDA)*. https://analysisfunction.civilservice.gov.uk/policy-store/an-introductory-guide-to-mcda/

Hailiang, Z., Chau, K. Y., & Waqas, M. (2023). Does green finance and renewable energy promote tourism for sustainable development: Empirical evidence from China. *Renewable Energy*, *207*, 660-671. https://doi.org/https://doi.org/10.1016/j.renene.2023.03.032

Herrera Almanza, A. M., & Corona, B. (2020). Using Social Life Cycle Assessment to analyze the contribution of products to the Sustainable Development Goals: a case study in the textile sector. *The International Journal of Life Cycle Assessment*, *25*(9), 1833-1845. https://doi.org/10.1007/s11367-020-01789-7

Kipkoech, R., Takase, M., Ahogle, A. M. A., & Ocholla, G. (2024). Opportunities and challenges in Ghana's renewable energy sector. *Discover Applied Sciences*, *6*(10), 530. https://doi.org/10.1007/s42452-024-06148-x

Leal Filho, W., Lovren, V. O., Will, M. et al. (2021). Poverty: A central barrier to the implementation of the UN Sustainable Development Goals. *Environmental Science & Policy*, *125*, 96-104. https://doi.org/https://doi.org/10.1016/j.envsci.2021.08.020

Li, S., Sun, Z., Guo, H. et al. (2024). Localizing urban SDGs indicators for an integrated assessment of urban sustainability: a case study of Hainan province. *International Journal of Digital Earth*, *17*(1), 2336059. https://doi.org/10.1080/17538947.2024.2336059

Lyra, M. G., & Lehtimäki, H. (2023). In the margins of stakeholder engagement: Fringe stakeholders' inclusion in sustainability transition Initiatives. In J. Kujala, A. Heikkinen, & A. Blomberg (Eds.), *Stakeholder Engagement in a Sustainable Circular Economy : Theoretical and Practical Perspectives* (pp. 393-425). Springer International Publishing. https://doi.org/10.1007/978-3-031-31937-2_12

Martín-Gamboa, M., Mancini, L., Eynard, U. et al. (2024). Social life cycle hotspot analysis of future hydrogen use in the EU. *The International Journal of Life Cycle Assessment*. https://doi.org/10.1007/s11367-024-02335-5

Mendoza, G. A., & Macoun, P. (1999). *Guidelines for applying multi-criteria analysis to the assessment of criteria and indicators*. CIFOR. https://www.cifor-icraf.org/publications/pdf_files/Books/toolbox9.pdf

Mohammed, A. S., Fuseini, M. N., & Baba, K. C. (2023). Grassroots stakeholders' perception of participation in the Medium-Term Development Plan of District Assemblies in Ghana: The case of Sawla-Tuna-Kalba District. *Heliyon*, *9*(8), e19178. https://doi.org/https://doi.org/10.1016/j.heliyon.2023.e19178

Munda, G. (2023). Social multi-criteria evaluation of policy options. In M. F. Norese, M. A. De Vicente y Oliva, & I. Abi-Zeid (Eds.), *Multicriteria Decision Aiding Interventions: Applications for Analysts* (pp. 217-233). Springer International Publishing. https://doi.org/10.1007/978-3-031-28465-6_8

Nagati, O., Gad, H., & El-Didi, A. (2022). Localizing the SDGs Through the Formal-Informal Interface: The Case of Ard al-Liwa, Cairo. In S. Croese & S. Parnell (Eds.), *Localizing the SDGs in African Cities* (pp. 47-65). Springer International Publishing. https://doi.org/10.1007/978-3-030-95979-1_4

Passos Neto, G. d. M., Alencar, L. H., & Valdes-Vasquez, R. (2023). Multiple-Criteria Methods for Assessing Social Sustainability in the Built Environment: A Systematic Review. *Sustainability*, *15*(23), 16231. https://www.mdpi.com/2071-1050/15/23/16231

Qamruzzaman, M. (2025). Unlocking the nexus: Tourism, clean energy, innovation, and environmental sustainability in the top 20 tourist nations. *Sustainability Analytics and Modeling*, *5*, 100037. https://doi.org/https://doi.org/10.1016/j.samod.2024.100037

Ramalho, E., Lima, F., López-Maciel, M. et al. (2025). Understanding wind energy economic externalities impacts: A systematic literature review. *Renewable and Sustainable Energy Reviews*, *209*, 115120. https://doi.org/https://doi.org/10.1016/j.rser.2024.115120

Reuter, T. A. (2023). SDG localization: Finding the middle ground to top-down and bottom-up approaches with the help of digital networking. *Sustainability: Science, Practice and Policy*, *19*(1), 2207372. https://doi.org/10.1080/15487733.2023.2207372

Roche, L., Holzapfel, P., & Finkbeiner, M. (2025). Primary data share indicator for social life cycle assessment. *Journal of Cleaner Production*, 145051. https://doi.org/https://doi.org/10.1016/j.jclepro.2025.145051

Saddari, N., Agyemang Derkyi, N. S., Peprah, F. et al. (2025). Techno-economic and environmental assessment of grid and solar photovoltaic microgrid supply options for isolated off-grid rural communities toward sustainable and affordable electricity in Nkoranza South, Bono East, Ghana. *Results in Engineering*, *25*, 103915. https://doi.org/https://doi.org/10.1016/j.rineng.2025.103915

Sorooshian, S. (2024). The sustainable development goals of the United Nations: A comparative midterm research review. *Journal of Cleaner Production*, *453*, 142272. https://doi.org/https://doi.org/10.1016/j.jclepro.2024.142272

Stellbauer, M., Jepson, W., Lefore, N., & Thomson, P. (2025). Advancing multiple-use water services for development in low- and middle-income countries. *WIREs Water*, *12*(1), e70008. https://doi.org/https://doi.org/10.1002/wat2.70008

Tladi, D. (2022). SDG 1: End poverty in all its forms everywhere. In J. Ebbesson & E. Hey (Eds.), *The Cambridge Handbook of the Sustainable Development Goals and International Law* (pp. 50-71). Cambridge University Press. https://doi.org/DOI: 10.1017/9781108769631.003

UNEP. (2020). *Guidelines for socal life cycle assessment of products and organization 2020*. https://www.lifecycleinitiative.org/wp-content/uploads/2021/01/Guidelines-for-Social-Life-Cycle-Assessment-of-Products-and-Organizations-2020-22.1.21sml.pdf

Weidema, B., Goedkoop, M., & Mieras, E. (2018). *Making the SDGs relevant to business.* .

World Bank. (2024). *Ghana: CREMA financial sustainability analysis report*. https://documents1.worldbank.org/curated/en/099062624103016750/pdf/P175989149fb5c091baca1542856aa4f50.pdf

Wu, J., & Hobbs, R. (2002). Key issues and research priorities in landscape ecology: An idiosyncratic synthesis. *Landscape Ecology*, *17*(4), 355-365. https://doi.org/10.1023/A:1020561630963

Yamaguchi, N. U., Bernardino, E. G., Ferreira, M. E. C. et al. (2023). Sustainable development goals: a bibliometric analysis of literature reviews. *Environmental Science and Pollution Research*, *30*(3), 5502-5515. https://doi.org/10.1007/s11356-022-24379-6

Appendices

Appendix 1 Stakeholder Identification and Analysis Tool

Stakeholder	Category (State, Private, NGO, Community)	Level	Level of Authority	Location	Position on Project	Contribution to Project	Expectations of Stakeholder
			Control and Power Score: 1-5	Within (W) Outside (O)	Support (S), Neutral (N) Resister (R)	Technical, Non-Technical and Others Indicate T or NT or O	

Appendix 2 List of Tools for Data Collection

Stakeholder	Data Collection Tool Used
Traditional authorities	Semi-Structured Interview
CREMA executives	Semi-Structured Interview; Questionnaire
Village Savings and Loan Associations (VSLA) members	Focus Group Discussions; Semi-Structured Interview
Farmers (women and men)	Focus Group Discussions; Semi-Structured Interview
Men's group[10]	Focus Group Discussions; Semi-Structured Interview
Youth groups[11]	Focus Group Discussions; Semi-Structured Interview
Hunters	Semi-Structured Interview
Herders	Semi-Structured Interview
Artisans (e.g., corn mill operators)	Semi-Structured Interview
District Assembly Members	Semi-Structured Interview; Questionnaire
Forestry Commission (Wildlife Staff)	Semi-Structured Interview; Questionnaire
Operator of Tuna High School Microgrid	Semi-Structured Interview
PUE Expert	Semi-Structured Interview;
Solar Energy Expert	Semi-Structured Interview
Commodity Value Chain Expert[12]	Semi-Structured Interview; Questionnaire
Landscape Governance Expert[4]	Semi-Structured Interview; Questionnaire
Gender Expert[4]	Semi-Structured Interview

[10] Big six, Aduonadi, Nuukpannefonga
[11] Big six Attàa group
[12] These experts have extensive experience working in Mole Ecological Landscape and CREMA communities in Northern Ghana.

Appendix 3 Semi-Structured Interview for Assessing Societal Needs of Developed REEP Solutions

External Stakeholders

Social Externalities Mapped to SDGs 1-5 and 16-17

Goals 1&2 Poverty and Hunger

1. How can renewable energy policies and interventions e.g., installation of microgrid system[13] help to reduce poverty in CREMA communities?
2. How can a community managed microgrid system be designed to create jobs and stimulate economic activities in CREMA communities?
3. What is the level of solar energy adoption in agriculture to improve incomes of CREMA communities?
4. How can the productive use of energy in CREMA communities reduce food insecurity and malnutrition?
5. What new value chains can be developed from the (i) microgrid system (ii) cooltainer (iii) solar pump (iv) cookstoves to help reduce poverty among CREMA members?
6. What are the social risks and opportunities associated with reducing poverty and hunger in the CREMAs?

Goal 16 Peace Justice and Strong Institution

7. What can be done to strengthen governance practices in the CREMA to effectively manage the (i) microgrid system (ii) cooltainer (iii) solar pump?
8. What are the weaknesses and strengths of current policy and institutional frameworks to provide off-grid communities with solar energy?
9. What are your thoughts on a CREMA Energy Fund meant to cover the cost of operation (i) microgrid system (ii) cooltainer (iii) solar pump
10. Where do you suggest funding should come from?

Goal 17 Partnership

11. How will the solar energy infrastructure in CREMA contribute to multiple SDGs?
12. What are some of the lessons learned from public-private partnerships in the promotion of renewable energy in rural communities?
13. What role can the District Assembly, NGOs, and external partners play in building the capacity of CREMA communities in terms of managing the microgrid system and other deployed technologies?
14. What are the social risks associated with improving partnership between the community and external stakeholders in the provision of clean energy?

Economic Externalities Mapped to SDGs 7-12

Goal 7 Affordable and Clean Energy

15. What are the challenges regarding the use of microgrid systems for productive uses in off-grid communities?

[13] Photovoltaic + Battery Energy Storage System+ Biomass Combined Heat and Power

16. What are the national/district targets and interventions on solar energy which are aimed at contributing to SDG 7?
17. What will be the implications for extending electricity from the national grid to CREMA communities, which are already benefiting from microgrid systems?
18. What are the social risks and opportunities associated with providing clean and affordable energy to CREMA communities?

Goal 8 & 9 Decent Work and Economic Growth and Industry, Innovation and Infrastructure

19. How can the productive use of energy facilitate the development of sustainable enterprises and value chains in CREMA communities?
20. How should solar energy projects be designed and implemented to create jobs (particularly for the youth, women and vulnerable groups) to stimulate economic activities?

Goal 10 Reduced Inequality

21. How can the various groups in CREMA communities be effectively engaged to ensure that benefits from the microgrid and allied technologies address the needs of members?
22. How can the benefits from the microgrid be distributed equitably across the different socioeconomic groupings in the CREMA?
23. What measures can make solar energy accessible and affordable, particularly for rural and underserved communities in line with SDG 1 and SDG 10?

Goal 12 Sustainable Consumption and Production Patterns

24. What could be the best way to dispose of hazardous materials from the installation of the microgrid?
25. What are strategies for the safe disposal, recycling, or refurbishment of solar equipment to prevent e-waste buildup in the community?
26. How can the ethical sourcing of raw materials for renewable energy systems be promoted?

Community Stakeholders

Goal 1&2 Poverty and Hunger

1. How can the clean energy technologies deployed help to reduce multi-dimensional poverty in CREMA communities?
2. How should the benefits from clean energy technologies be shared among community members?
3. In what ways can the clean energy technologies in CREMA communities improve the quality of life of members (e.g., food security, health, education, or economic opportunities)?
4. How can the productive use of energy in CREMA communities reduce food insecurity and malnutrition?
5. What new economic activities or value chains do you envisage could be introduced to CREMA communities with the deployment of clean energy technologies?

6. What are the social risks associated with reducing poverty and hunger facilitated by clean energy technologies?

Goal 4 & 5 Quality of Education and Gender Equality

7. What will be the motivation for CREMA members, particularly women and young girls to participate in training programs aimed at building local capacity for the clean energy technologies?
8. Which skill sets related to the sustainable management of clean energy technologies would you like to be trained in?

Goal 16 Peace Justice and Strong Institution

9. What do you suggest is an effective approach to adapt in managing the clean energy technologies deployed?
10. Which people or group of people do you suggest can successfully manage the microgrid system?
11. How can accountability and fair distribution of benefits from the clean energy technologies deployed be achieved?
12. What cultural or social factors can influence the acceptance and use of solar energy in CREMA communities?
13. How can CREMA communities handle technical challenges (e.g., equipment breakdowns, system upgrades) associated with the deployed clean energy technologies?

Goal 17 Partnership

14. What is the motivation or level of preparedness of CREMA communities to collaborate with external stakeholders?
15. What are the available plug-ins for foisting collaboration between CREMA communities and external stakeholders?

Economic Externalities

Goal 7 Clean Energy

16. What are your current energy needs?
17. What challenges do you face in obtaining affordable and reliable energy?
18. What concerns do you have with the clean energy technologies deployed and how can it be addressed?
19. What local skills or expertise exist in CREMA communities that can be leveraged in the deployment of clean energy technologies?
20. How can CREMA communities innovatively finance the maintenance and operational cost associated with the deployed technologies?
21. If a CREMA Energy Fund is to be set up for future investment in clean energy technologies, where do you suggest the financial inflows should come from?
22. What challenges will communities encounter in maintaining the microgrid system and allied technologies?
23. What will be the implications for the deployed technologies if electricity from the national grid is extended to CREMA communities already accessing energy from the microgrid system?
24. What are the social risks associated with providing clean and affordable energy to CREMA communities?

Goal 8 & 9 Decent Work and Economic Growth and Industry, Innovation and Infrastructure

25. What challenges do you face in obtaining affordable and reliable energy and how can the challenges be addressed?
26. How can the deployment of clean technologies assist in the establishment or improvement of enterprises and value chains within CREMA communities?
27. How should clean energy technologies be designed to create decent local jobs for particularly for the youth, women and vulnerable groups?
28. What kind of support do you need to participate in training activities with the aim of managing and maintaining the microgrid system?
29. What funding options are available to young entrepreneurs and artisans for acquiring machinery and tools to utilize clean energy sources for productive uses?

Goal 10 Reduced Inequality

30. What are the ways to effectively involve communities and in particular, marginalized groups in the deployment and management of clean energy technologies?
31. How can benefits from the AEP project be distributed fairly among CREMA community members?

Appendix 4 Questionnaire for Assessing the Societal Needs of CREMA Communities for Social Sustainability

Objective
To assess the societal needs of community actors to facilitate sustainable development in the use of clean energy.

Part 1 Socio-demographic characteristics

1. ID ……... Community ……
2. Age …… Gender ……
3. Educational Level……... Occupation ……

Part 2 AEP Project

1. Have you participated in any meeting or durbar regarding the AEP project in the last three months? Yes …….. No ……...
2. Which aspect of the AEP project will you contribute to?
   Labour ……... Technical support ……. Management ……
   Donate land ……... Supply local material (specify) ……...
3. Which communities should be prioritized after Jang in the AEP project?
   ……..... .....
4. Do you have any concerns with the site for the? (Split)
   Microgrid Yes …….. No ……...
   Cooltainer Yes …….. No ……...
   Solar pump Yes …….. No ……...

Part 3 Energy

1. How satisfied are you with your current sources of energy?
   Satisfied …….. Not Satisfied ……...
2. Are you prepared to change or diversify your energy source?
   Yes …….. No ……...
3. Which of the following options can influence your choice of a new energy source? Cost …….. Environmental consideration …….. Health ……... Convenience …….. Reliability ……...
4. How much are you willing to pay monthly, for the use of services provided by? (split and provide range) Microgrid GHS..... Cooltainer GHS…….
   Solar pump GHS ……
5. How do you intend to pay for services provided? Mobile money .....
   Cash ..... Barter ..... Credit/installment ……
   VSLAs.....

Part 4 Governance

1. Which type of community involvement would you like to see in the AEP project?
   The design of the technologies e.g., microgrid and cookstoves
   …..

Capacity building e.g., technical and soft skills ….....
Co-ownership of technologies deployed e.g., microgrid system ….....
Decision on site selections for the technologies to be deployed ….....
Environmental and social impact monitoring.....
Feedback mechanisms and grievance mechanisms
Others (specify)
.....

2. Which participation do you think could be critical for managing the microgrid and other technologies sustainably?
   STK District Assembly.....Traditional rulers.....
   VSLAs.....CREMA executives
   .....VSLAs.....Religious leaders.....
   NGOs.....Others
3. Which of the following ownership arrangements would you prefer?
   Limited liability company ….... Community ownership ….....
   District Assembly ….... Joint ownership ….... Other (specify) ….....
4. Identify the appropriate governance instruments that can help regulate and ensure sustainable use of the microgrid and other technologies. By-laws.....
   Operation and maintenance protocols.....Conflict management guidelines..... Management plans .....Transparency and anti-corruption guidelines..... Benefit sharing and grievance reporting guidelines..... Financial plans.....

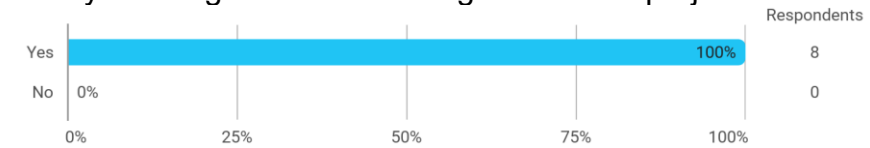
Part 5 Impacts

1. What are the anticipated impacts of the microgrid on
   Job creation No Impact …... Beneficial ….Harmful …... Not Sure…...
   Cost of energy No Impact …... Beneficial …... Harmful …... Not Sure …...
   Aesthetics No Impact …... Beneficial …... Harmful …... Not Sure …...
   Governance No Impact …... Beneficial …... Harmful …... Not Sure …...
   Agriculture No Impact …... Beneficial …... Harmful …... Not Sure …...
   Education No Impact …... Beneficial …... Harmful …... Not Sure …...
   Health No Impact …... Beneficial …... Harmful …... Not Sure …...
2. What are the anticipated impacts of the cooltainer on
   Food losses No Impact …... Beneficial ….Harmful …... Not Sure…...
   Food preservation: No Impact …... Beneficial …... Harmful …... Not Sure …...
   Food shelf life: No Impact …... Beneficial …... Harmful …... Not Sure …...
   Income: No Impact …... Beneficial …... Harmful …... Not Sure …...

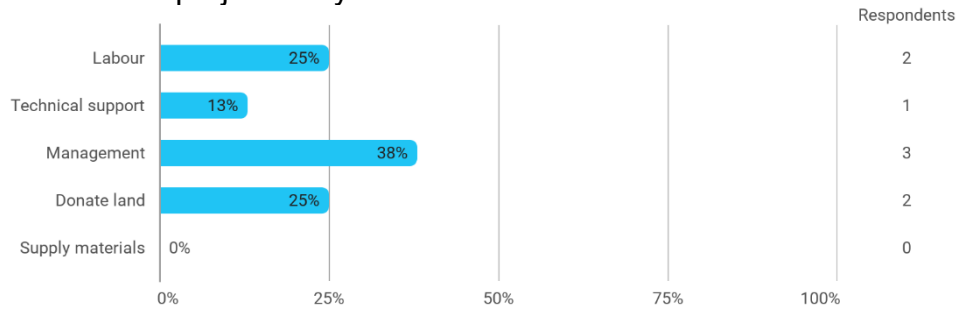
3. What are the anticipated impacts of the solar pump on
   Food security: No Impact …... Beneficial ….....Harmful …... Not Sure…...
   All year farming: No Impact …... Beneficial …... Harmful …... Not Sure …...
   Crop quality No Impact …... Beneficial …... Harmful …... Not Sure …...
   Income No Impact …... Beneficial …... Harmful …... Not Sure …...

Appendix 5 Results from the Survey

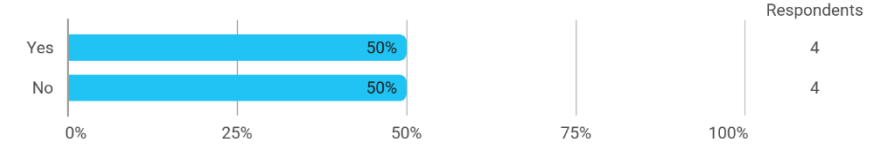
1.Have you participated in any meeting or durbar relating to the AEP project in the last three months?



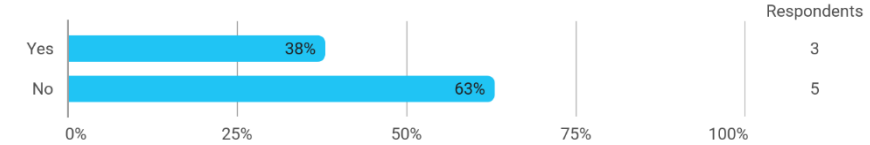
2. Which aspects of the AEP project will you contribute to?



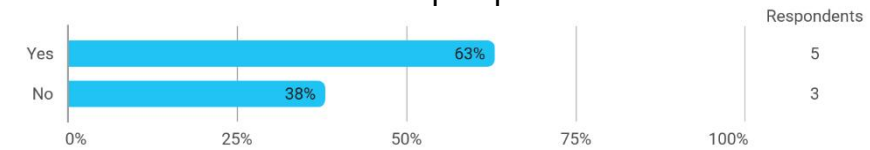
4. Do you have any concern with the site for the microgrid system?



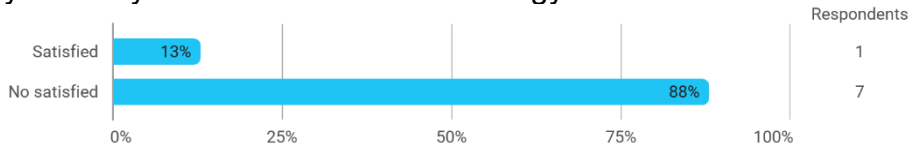
5. Do you have any concern with the site for the cooltainer?



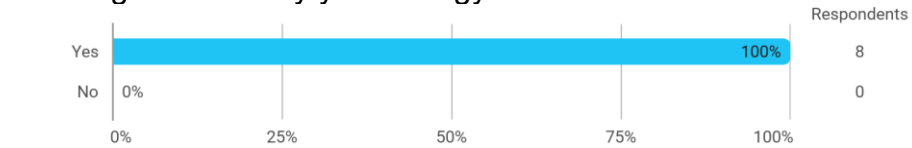
6. Do you have any concern with the site for the solar pump?



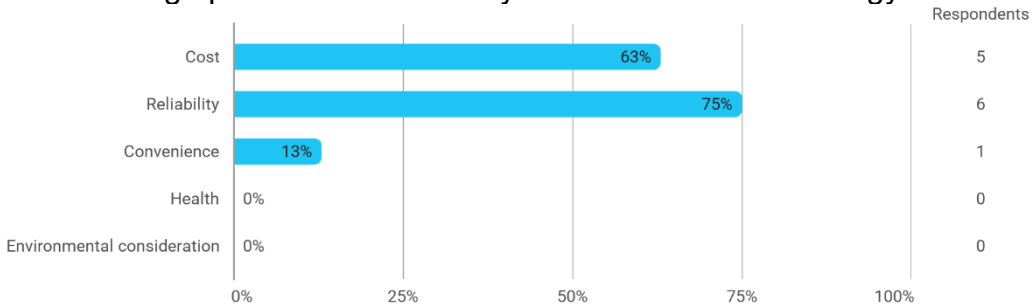
7. How satisfied are you with your current sources of energy?



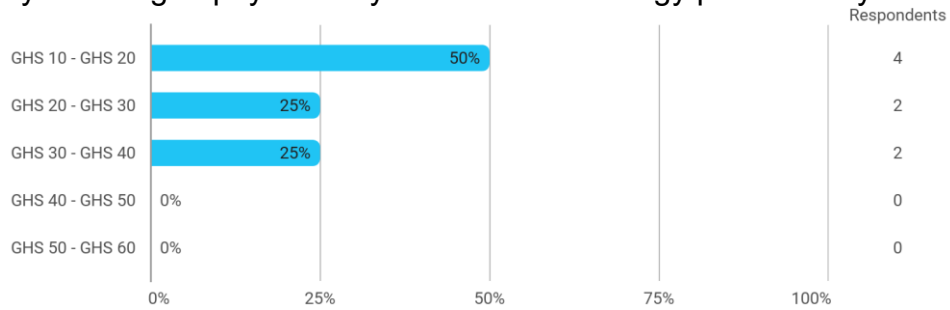
8. Are you prepared to change or diversify your energy source?



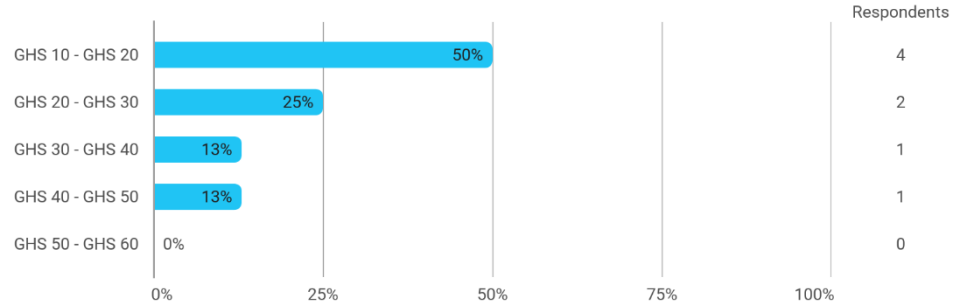
9. Which of the following options can influence your choice of a new energy source?



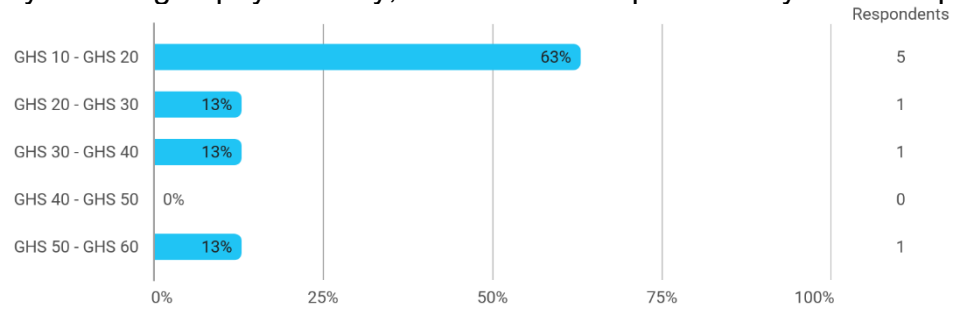
10. How much are you willing to pay monthly for the use of energy produced by the microgrid?



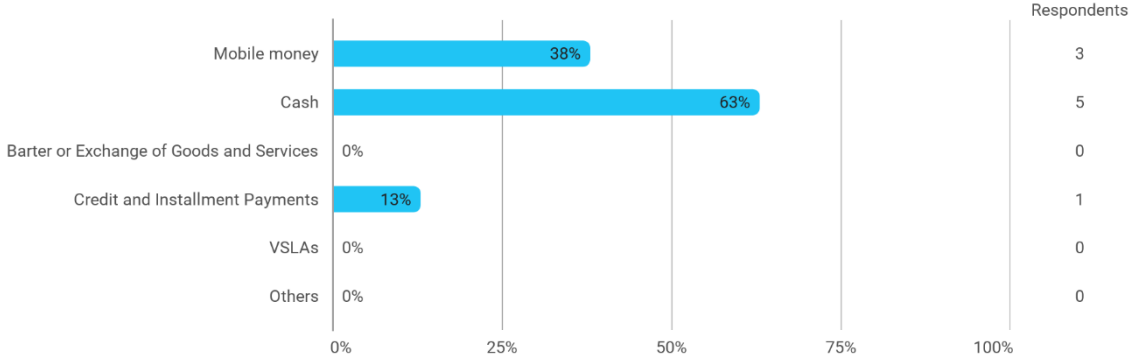
11. How much are you willing to pay monthly, for the use of services provided by the cooltainer?



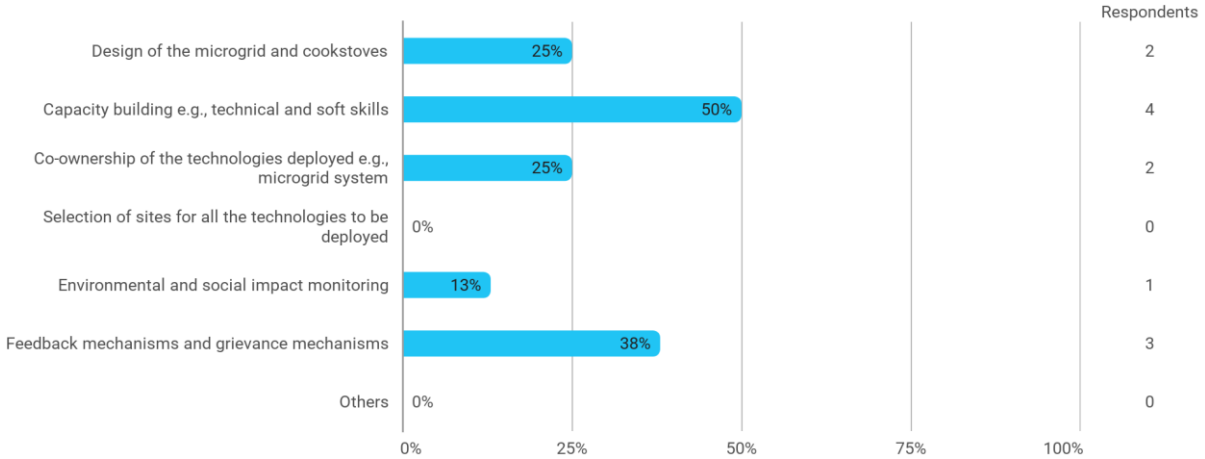
12. How much are you willing to pay monthly, for the services provided by the solar pump?



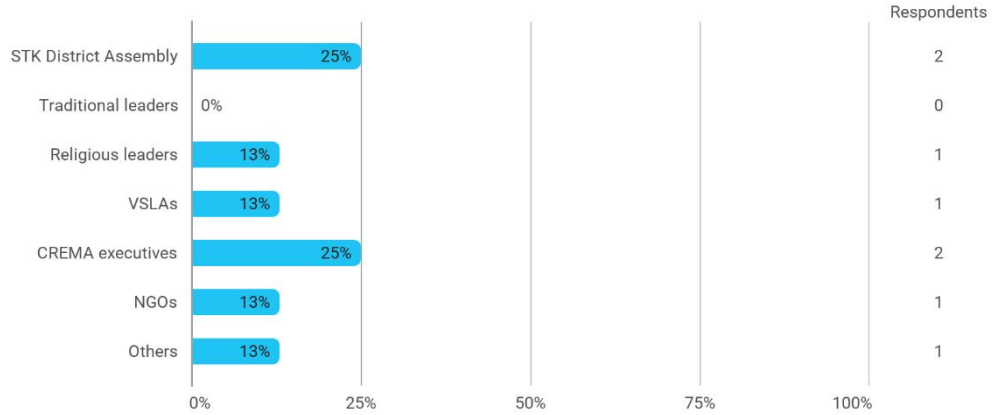
13. How do you intend (mode) to pay for services provided?



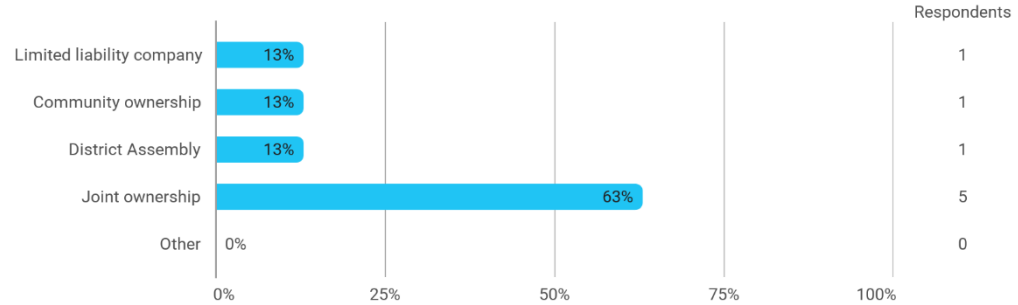
14. Which type of community involvement would you like to see in the AEP project?



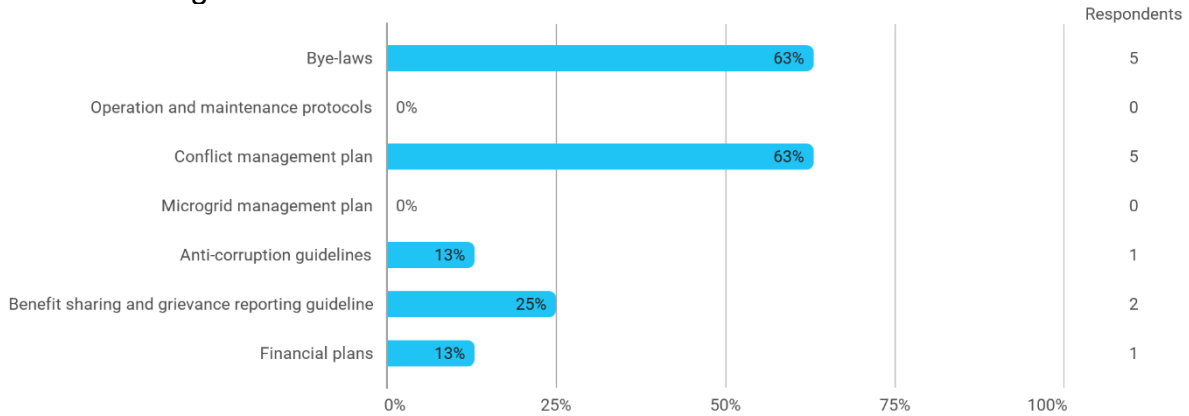
15. Which key community actors' participation do you think could be critical for managing the microgrid and other technologies sustainably?



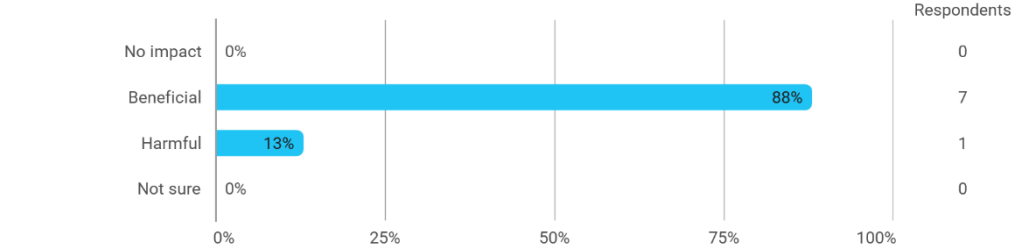
16. Which of the following ownership arrangements will you prefer?



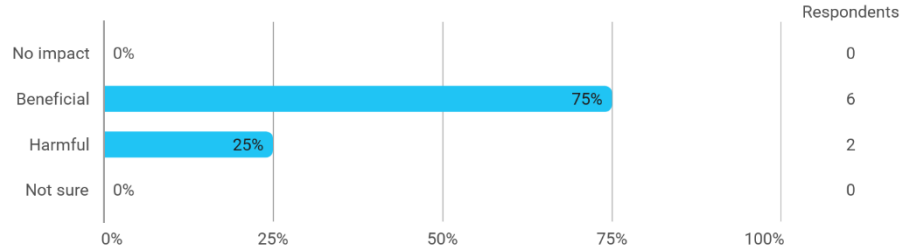
17. Identify the appropriate governance instruments that can help regulate and ensure the sustainable use of the microgrid and other technologies.



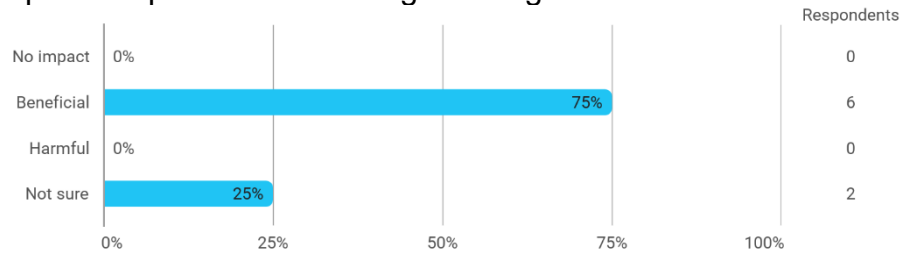
18. What are the anticipated impacts of the microgrid on job creation



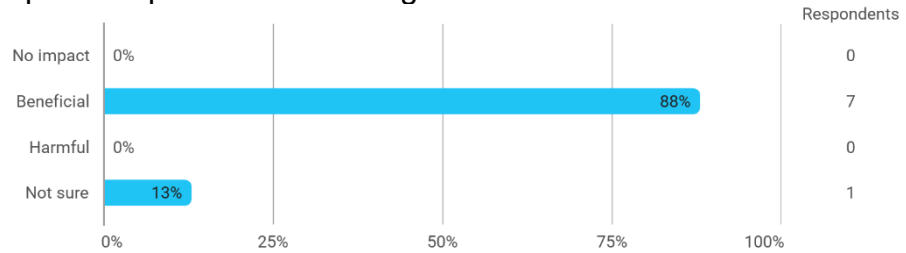
19. What are the anticipated impacts of the microgrid on cost of energy?



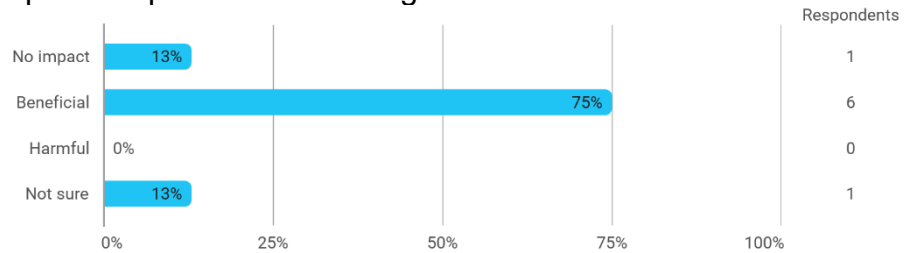
20. What are the anticipated impacts of the microgrid on agriculture?



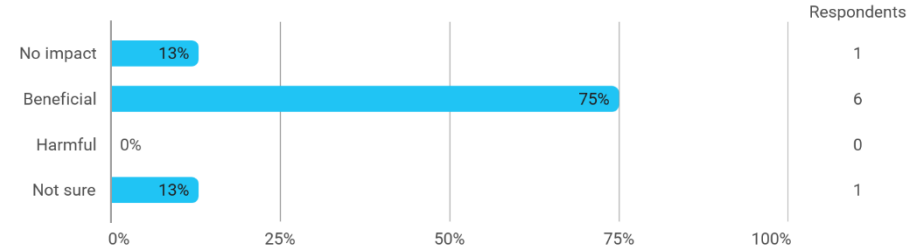
21. What are the anticipated impacts of the microgrid on aesthetics?



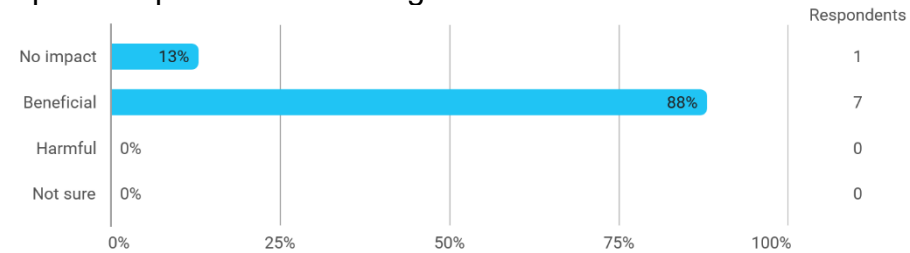
22. What are the anticipated impacts of the microgrid on health?



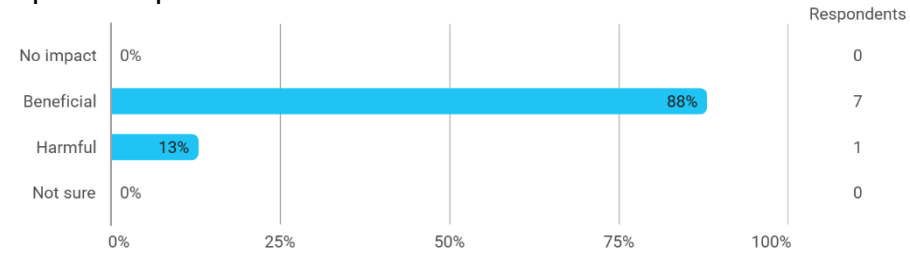
23. What are the anticipated impacts of the microgrid on energy goverance?



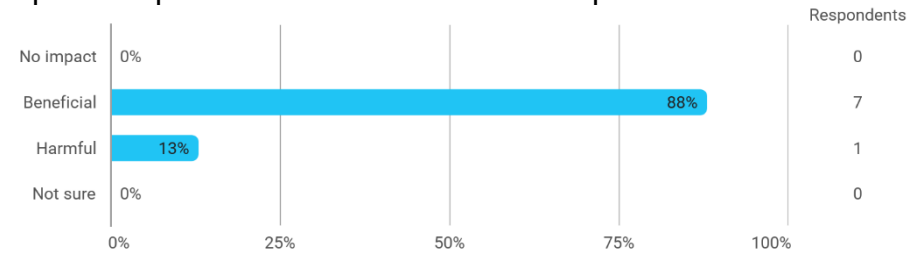
24. What are the anticipated impacts of the microgrid on education?



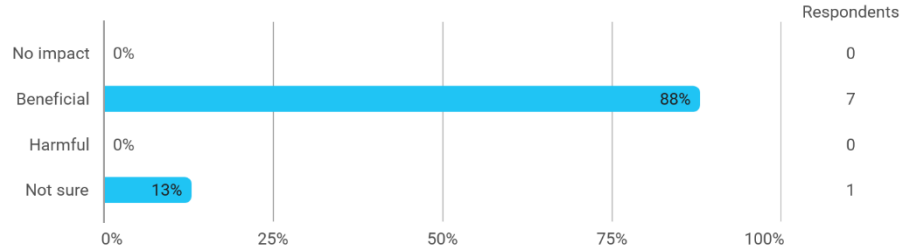
25. What are the anticipated impacts of the cooltainer on food losses?



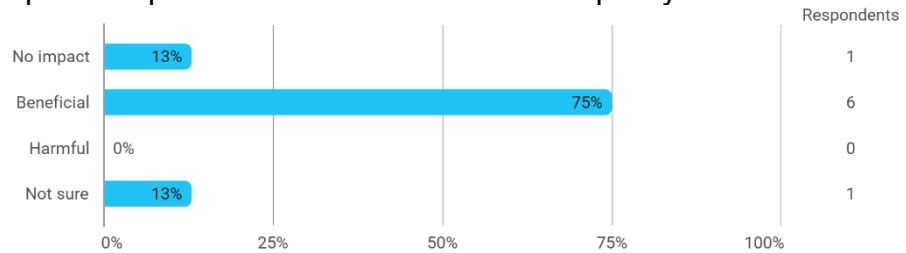
26. What are the anticipated impacts of the cooltainer on food preservation?



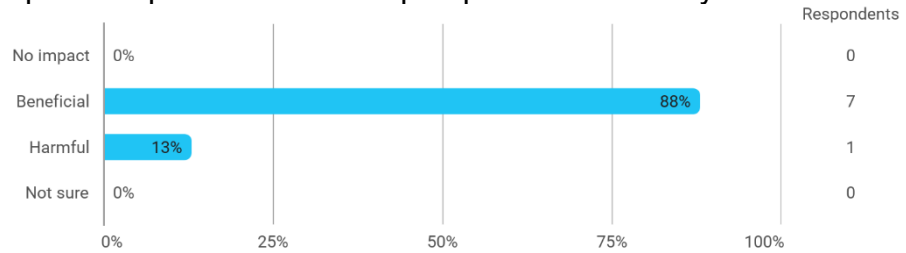
27. What are the anticipated impacts of the cooltainer on incomes?



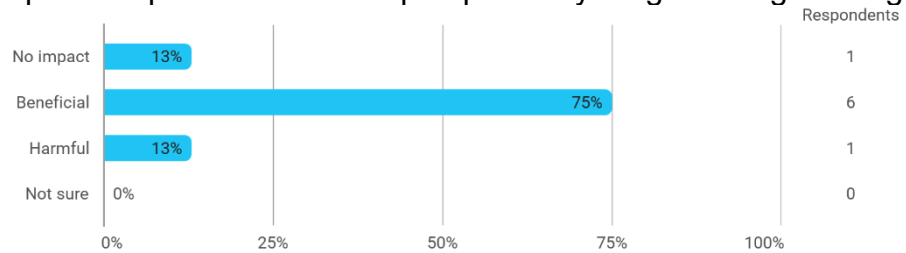
28. What are the anticipated impacts of the cooltainer on food quality?



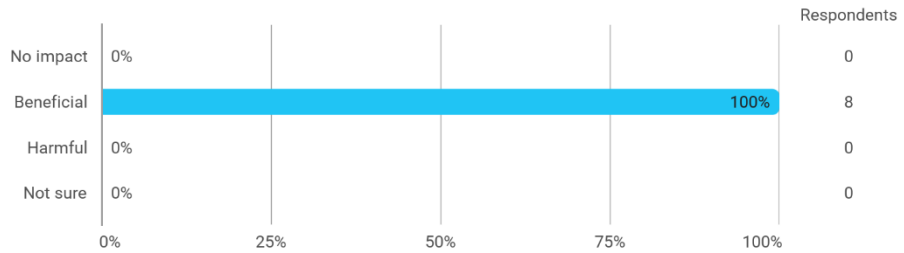
29. What are the anticipated impacts of the solar pump on food security?



30. What are the anticipated impacts of the solar pump on all year gardening/farming?



31. What are the anticipated impacts of the solar pump on the incomes of community members?



Note: Some of the questions allowed for the selection of multiple answers.