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Main author(s):	Ibrahima Faye - (2.1 AGT Senegal)
Internal reviewers:	Christer Anditi (6- UoN) Efua Nyamekye Appiah (11-GAYO)
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1. Executive Summary

Over the past eight months, Africa GreenTec Senegal has been in discussions with various stakeholders at the national level to familiarise the team on the process and regulations to follow in implementing the RePower project, especially under the new government that has been in place since March 2024. At the local level, in Mbelogne village, where the project will be implemented, the local team contracted a consultant to visit the community and engage the local stakeholders. This was undertaken during the feasibility study. The study covered the following areas:

Social and stakeholder analysis: map and engage with the local members of the Mbelogne, including the Association pour le Développement de Namarel (ADENA), that will be involved, and those that will be electrified. This aims to hear their feedback and including them from the beginning of the project. In addition, AGTS aims to work with local institutions to learn from similar projects and implement the learnings in the project.
Technical feasibility: assess the technical viability of implementing plug-and-play compatible modular microgrids with enhanced renewable energy storage and productive energy use for cooling, water purification systems, solar pumps and solar streetlights.
Financial feasibility: assess the financial aspects of the project, including cost estimates, budget allocation and potential funding sources.
Social and environmental impact assessment: carry out an assessment of the project's social and environmental impact on the local community and surrounding environment.
Risk analysis: identify potential risks and challenges associated with project implementation and propose mitigation measures.
Regulatory and legal compliance: ensure compliance with local regulations, permits and legal requirements related to renewable energy projects in Senegal.

This report highlights the project's progress, the involvement of key stakeholders, and the community engagement strategies used, giving a clear overview of the steps taken to align the project with local needs and policies.

Abbreviations

AC	Alternating current
ADENA	Association pour le Développement de Namarel
AGT	Africa GreenTec (partner in RePower)
AGT S	Africa GreenTec Senegal (partner in RePower)
AU	Aarhus University
BCHP	Biomass based combined heat and power unit
BESS	Battery energy storage system
D	Deliverable
DC	Direct current
DTI	Danish Technological Institute (partner in RePower)
EC	European Commission
EIA	Environmental Impact Assessment
EMS	Energy management system
WP	Work Package
WT	Work Task

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1. Introduction

1.1. Background and context

The Repower Project, under Word Package 7, is part of a broader initiative aimed at advancing rural electrification and promoting sustainable energy solutions in Senegal. Senegal, like many countries in sub-Saharan Africa, faces significant challenges in providing reliable electricity access to rural areas, which limits economic development, social services, and quality of life. To address these issues, the government has prioritized renewable energy projects and decentralized solutions as part of its national energy strategy. The Repower Project is aligned with Senegal's Plan Sénégal Émergent (PSE), which emphasizes the expansion of renewable energy infrastructure to achieve universal energy access.

Mbelogne, a village in the northern region of Saint Louis, has been identified as a critical site for implementing the project. The village, like many rural communities in Senegal, relies heavily on agriculture and livestock farming as primary sources of income. However, the lack of reliable energy has limited productivity and the potential for economic growth. The Repower Project aims to address these gaps by providing modular plug-and-play microgrids powered by solar energy, which will include renewable energy storage systems and sustainable energy management solutions. Additionally, productive energy uses such as cooling, water pumping for livestock, and street lighting will be integrated into the community's infrastructure to further enhance local development.

AGT Senegal, the project's implementing partner, will collaborate closely with the local community and the ADENA livestock cooperative, which is essential to the region's economy. ADENA's participation is crucial as it will help ensure that the energy provided by the project will support essential agricultural activities, such as water pumping and livestock cooling systems.

The project's implementation follows a detailed feasibility study that assessed the technical, social, and environmental aspects of the initiative. With plans to install solar power stations equipped with Battery Energy Storage Systems (BESS), build low-voltage distribution networks, and implement street lighting systems, the project is designed to create a stable and sustainable energy supply for Mbelogne. The remote monitoring systems, Energy Management System (EMS) and security measures further ensure the long-term sustainability and resilience of the energy infrastructure.

In this context, the Repower Project aims not only to address the energy deficit in Mbelogne but also to contribute to the overall goal of achieving energy equity across Senegal. By focusing on community engagement, capacity building, and alignment with national policy, the project intends to set a benchmark for how renewable energy can empower rural communities and drive inclusive economic growth.

1.2. Purpose of the report

The purpose of this deliverable report is to provide a comprehensive analysis and strategic plan for the successful implementation of the Repower Project under World Package 7 in the village of Mbelogne, Senegal. This document aims to ensure that the project aligns with both the local community's needs and the national policy framework of Senegal, fostering sustainable development through the deployment of renewable energy solutions.

The primary objective is to guide the establishment of microgrids using modular plug-and-play technology, alongside improved renewable energy storage and energy management systems. The deliverable outlines key components such as the installation of solar power stations, low-voltage distribution networks, street lighting, and productive energy use solutions like water pumping and cooling, all while ensuring active participation and capacity building within the local community. By addressing stakeholder engagement, community integration, site assessment, and feasibility studies, this deliverable ensures that the project is not only technically sound but also socially inclusive, economically viable, and environmentally sustainable. Ultimately, this deliverable serves as a blueprint for AGT Senegal and local partners, including the ADENA livestock cooperative, to achieve energy autonomy and improved livelihoods in the village of Mbelogne, while contributing to Senegal's broader rural electrification and sustainability goals.

1.3. Scope and methodology

The study that was carried out between M5 and M6 focused on assessing the technical, stakeholders, economic, social, and environmental viability of installing renewable energy microgrids in the village of Mbelogne, located in the Saint Louis region of northern Senegal. The specific scope includes:

Energy Demand Assessment:

- Evaluating the current and future energy needs of the village, local households, businesses, and the ADENA livestock cooperative.
- Identifying the energy requirements for productive uses such as water pumping, cooling systems for livestock, and street lighting.

Technical Assessment:

- Identifying suitable locations for the installation of three solar power stations with Battery Energy Storage Systems (BESS) for Mbelogne and one additional solar power station for ADENA.
- Determining the technical specifications for the power generation capacity, storage systems, and distribution networks.
- Evaluating the feasibility of a low-voltage distribution network and the installation of 125 street lanterns for public lighting.

Economic Viability:

- Conducting a cost-benefit analysis to determine the financial feasibility of the project.
- Assessing the capital investment required for installation and the long-term operational and maintenance costs.
- Estimating potential revenue from energy sales and evaluating the economic benefits to the local community.

Social and Community Impact:

- Analyzing the social benefits of the project for the local population, such as improved livelihoods through access to electricity and productive energy uses.
- Assessing the community's capacity and willingness to participate in the management and maintenance of the microgrid systems.

Environmental Impact Assessment (EIA):

- To carry out the assignment, we reviewed the secondary documentation available on the project. This included the project's concept paper, the RePower questionnaire and the technical documentation available on the planned equipment.

The feasibility study was conducted using a combination of data collection methods, technical analyses, and stakeholder consultations.

Data collection and site surveys:

- Energy Demand Surveys: Surveys were conducted in the village and at the ADENA livestock cooperative to gather data on current energy consumption patterns and projected future needs. This included domestic energy requirements as well as productive uses such as water pumping and cooling.
- Technical Site Surveys: Site visits were conducted to assess the physical suitability of the proposed locations for the solar power stations and distribution networks. Factors such as solar irradiance, available land, and proximity to consumers were evaluated.
- Environmental Baseline Data: Data was collected on local environmental conditions, including land use, biodiversity, and water resources. This information was used to assess potential environmental impacts.

We also conducted a series of meetings with our consultants who did a field survey, which had three targets identified for the fieldwork:

- ADENA: umbrella organisation. Discussions with ADENAS using a pre-designed grid gave us the broadest possible view of the development issues in the Mbelogne area.

- The Village: at the level of Mbelogne and the satellite villages. At this level, the entire repower project is reviewed. From this village survey, a list of heads of households were drawn up and a sample, in proportion to the representativeness of each village, were chosen for specific household surveys.

- The Households: this provided a better understanding of the socio-economic profile of each household, its energy situation, its economic activities and its opinion of the facilities proposed by the project.

Field activities:

- Field data collection: Socio-economic survey, technical data collection
- Socio-economic feasibility study
- Technical feasibility study
- Environmental and social impact assessment
- Budget proposal

Deliverables:

- Inception report
- Socio-economic file
- Technical file
- Environmental and social study report
- Project budget estimate report
- Final project feasibility report
- Summary of mission results

2. Stakeholder Analysis and Community Engagement

The local teams in Senegal mapped out the various stakeholders to be engaged in this project. The following section reports on these stakeholders and their role in the project.

2.1. Identification of stakeholders

2.1.1. Government agencies

The Senegalese Rural Electrification Agency (ASER) is an autonomous service unit of the Ministry of Energy and Oil of Senegal, responsible for promoting rural electrification through support for initiatives at the national and international levels, in particular to develop rural electrification projects and programs decided on the basis of a rural electrification plan defined by the technical supervisory authority.

2.1.2. Local communities

The Association for the Development of Namarel and surrounding villages (ADENA) is a local organisation in northern Senegal. It was created on the 9th of September 1989. It is officially recognised by the public authorities under number 06591 MINT. DAGAT DEL/AS of 13 July 1992. It is an initiative of the inhabitants of Namarel and the surrounding villages and its area of intervention is located in the Ferlo, between the Departments of Podor (Saint-Louis Region), Linguère (Louga Region) and Ranérou (Matam Region) and the Dakar Region. The Association now has 22 grassroots community organisations, including two urban ones (Dakar and Ndioum), and a membership of 7,125 people, over 52% of whom are women (3,705 members).

- ADENA aims to achieve sustainable economic, social and cultural development in the area where it operates, 95% of whose population are livestock farmers.
- Livestock farmers: Through ADENA, special attention was also given to the local livestock farmers, as they represent a significant portion of the rural economy in Mbelogne. Meetings were organized to understand their specific energy needs related to animal care and production. The farmers expressed a desire for better reliable cooling solutions for dairy products. By involving them in discussions, AGTS ensured that their perspectives were incorporated into the design of energy solutions that could enhance their productivity and income.
- Local people living at the hamlets: Engagement with the people living in the surrounding hamlets involved several field visits. These residents were asked about their daily challenges, particularly regarding access to water, energy, and agricultural needs. Their feedback was crucial in identifying off-grid energy requirements and possible solutions for improving water supply and irrigation systems. The focus was to ensure that even the more isolated and smaller communities had a voice in the decision-making process, allowing us to develop inclusive solutions tailored to their needs
- Local chiefs: The local chiefs played a key role in the community engagement process. As respected leaders, they facilitated open communication and encouraged community participation. The chiefs were consulted in advance to ensure the project's objectives aligned with the cultural and social values of the community.

2.2. Engagement Strategies

Effective stakeholder engagement is critical to the success of the Repower Project under World Package 7, particularly in the village of Mbelogne. Given the project's emphasis on aligning with local community needs and national energy policies, various engagement strategies have been employed to ensure transparent communication, community involvement, and long-term support. These strategies include meetings and consultations, surveys and feedback mechanisms.

2.2.1. Meetings and consultations

The aim of the meetings and consultations in this context was to establish direct communication channels with key stakeholders, including community leaders, local authorities, national agencies, and project partners, ensuring that their inputs are incorporated into decision-making processes.

- Initial Consultations: early in the project, a series of formal consultations were held with local authorities in Mbelogne, including the village chief and influential community members. These consultations helped to identify key priorities, energy needs, and any potential concerns the community might have regarding the project.

- Ongoing Dialogue: Throughout the project lifecycle, regular follow-up meetings have been scheduled to update ASER, ADENA, the chief, and the locals on progress, seek feedback, and adjust plans as necessary. This ongoing dialogue helps to foster trust and maintain transparency.
- National-Level Consultations: AGT Senegal also engaged with national stakeholders, such as the Ministry of Energy and ASER, to ensure that the project aligns with Senegal's broader renewable energy and rural electrification goals.

These meetings focused on regulatory compliance, funding, and technical support. The notable impact was that these consultations helped build a strong foundation of support for the project by aligning its goals with both community and national priorities. By involving stakeholders from the outset, the project ensures that local voices are heard and that any concerns are addressed early.

2.2.2. Community engagement survey

The aim of this was to gather quantitative and qualitative data on the community's energy needs, expectations, and concerns. Surveys also provide an opportunity for continuous feedback, ensuring that the project remains responsive to local realities.

➢ Energy Demand Surveys: Surveys were distributed to households and businesses in Mbelogne to assess current energy consumption, the need for productive uses such as water pumping and cooling, and future energy requirements. The ADENA cooperative, in particular, participated in detailed surveys regarding their energy needs for livestock operations.

➢ Feedback Forms: During various phases of the project, community members were given opportunities to provide written or verbal feedback on key aspects of the project. These feedback forms allowed residents to share their thoughts on the siting of infrastructure, public lighting needs, and potential social or environmental impacts.

➢ Monitoring Satisfaction: After the installation of the microgrids and related infrastructure, ongoing surveys will be conducted to monitor the community's satisfaction with the energy services. This feedback will guide future adjustments and ensure that the project continues to meet the community's evolving needs.

The impact that these surveys had is that they provided critical data that shaped the technical design of the microgrids and the placement of solar power stations. The feedback mechanisms ensured that community concerns—such as the placement of street lanterns for enhanced safety and access—were integrated into the project design. Continuous feedback loops help maintain community satisfaction and project relevance.

2.3. Outcomes of stakeholder engagement

2.3.1. Stakeholder perspectives and concerns

Through extensive consultations, stakeholders expressed enthusiasm for the project, particularly around improved energy access and economic benefits. The ADENA cooperative highlighted the importance of reliable power for water pumping and livestock cooling, while community members prioritized street lighting for safety. Concerns included the need for long-term affordability of water, energy services and the environmental impact of solar power stations.

2.3.2. Level of community support and involvement

The project garnered strong community support, with active involvement in site selection and feedback on energy needs. The local population that was surveyed, including ADENA, embraced the project's goals and showed readiness to manage the energy systems. This high level of engagement has built trust and ownership, critical for the project's success.

2.3.3. Challenges and lessons learned

Some challenges arose, including initial scepticism about the project's long-term sustainability and concerns about potential disruptions during installation. Also, the location of Mbelogne is very far, and because the target village is geographically set in hamlets, it makes it more difficult to implement such a project without any risks in terms of implementation.

Ideally, a more suitable location would be wiser to avoid those risks. AGT Senegal has multiple villages in their database that are not only closer in terms of distance and accessibility, but that would be better suited and ready to welcome such a project. It might be too late to change the location given all that's been done since the beginning of the project, but we already have Feasibility Study data for those villages, which means there would not be a need to redo another feasibility study with all the process and time that it requires.

It is still possible to implement the project in the currently chosen village, but we believe this suggestion of changing the location is an alternative worth considering.
Overcoming these will require consistent communication and transparency. A key lesson learned was the importance of early and continuous stakeholder engagement to address concerns promptly and ensure alignment with local needs.

3. Site Visits and Feasibility Studies

The feasibility study focused on technical, economic and environmental aspects to ensure the viability of the project.

- Technical feasibility: assessing the technical viability of implementing compatible, plug and play modular microgrids with enhanced renewable energy storage and productive use of energy for cooling, water purification systems, water pumps solar water as well as solar street lights

- Financial feasibility: assessing the financial aspects of the project including cost estimation, resource allocation and sources of potential financing

- Environmental impact assessment: assessing the social and environmental impact of the project on the local community and the environment. In addition, this must be evaluated according to the installation of:

➔ Water purification system: how many people will be interested in purified and drinkable water? Is there a well or water source nearby?

➔ Cooltainer: refrigeration system for farmers at the Mbelogne market. How many people in the village and the market would be interested in cooling their vegetables, fruit or meat?

➔ Solar pumps: is there a water source nearby? How many farmers would be interested in using solar pumps ?

➔ Solar street lights: what are the streets like? How many street lights should be provided to illuminate the market and its surroundings?

Finding the answers to all these questions is the objective of the site visits that were executed.

3.1. Purpose and goals of site visits

Site visits were conducted as part of the feasibility study to assess the suitability of the proposed locations for the installation of solar power stations, low-voltage distribution networks, and other infrastructure. Mbelogne is in the NAMEREL area. It belongs to the DIERI eco-geographical zone. Mbelogne is a large village (Mbelogne Mango) which polarizes a number of hamlets all bearing the name of Mbelogne after the founder. Thus we speak of Mbelogne Ouro Kalidou Mamadel, Mbelogne Ouro Demba Hawa, Mbelogne Wouro Siley Oulette and so on. Even if we later write village of Mbelogne Wouro Siley Oulette, we must understand "hamlet".

Our work has focused on Mbelogne Mango and its hamlets, as shown in Figure 1 on the map below entitled "localities map", which positions them in space. Namarel is taken into account because it is home to ADENA's head office and its dairy processing unit, as well as a number of infrastructures such as boreholes, wells, etc., which play a key role in the area's economy. The localities are naturally grouped in pairs. This can be explained by successive dissociations starting from Mbelogne Mango, which is the central village. The localities are very close to each other. Only Ouro Mbaga, in the south-east, stands out.

The graphic below shows the map of the site, with the village Mbelogne Mango and its hamlets.

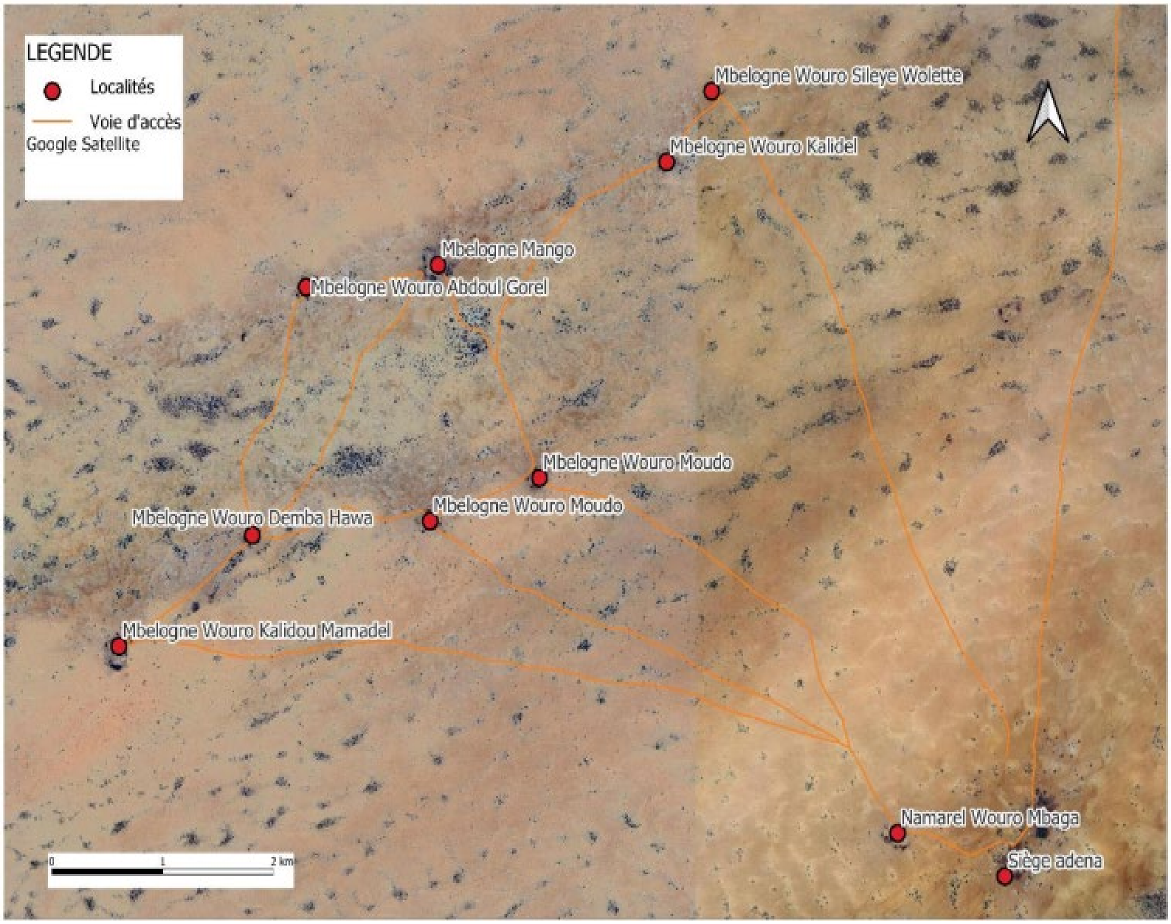

Figure 1 Mbelogne village in Senegal

In terms of human resources, for the entire mission, the following people were involved:

Dr Lamine Ndiaye (Chef de mission)	Socio-economist Expert in bioenergy	• Work supervision • Responsible for socio-economic studies • Approach to the biomass bioenergy study • Customer Relations
Djibril Fall	Electromechanical engineer	• Responsible for the technical feasibility study of the project • Responsible for technical studies (BT network, PV plant, etc.)

MouhamadouEl Amine DIOP	Expert Topographer/Drone	● Field data processing ● Development of aerial images ● Topographic studies
Pape Moussa Kassé	Engineer Planning-Environment-Territorial management Remote pilot	● Digitization and questionnaire training ● Real-time socio-economic infrastructure mapping inventory ● Acquisition of aerial images
Local Survey team	Students	● investigators
Biram Djigo	Driver	● Field mission driver

Material resources

- 1 Toyota PRADO car
- Drone (aerial imagery mapping)
- Smartphones (for data collection)
- Computers (for field processing)

Software: Mobilization of various software:

- Electrical network (drawing and calculations):
- Sizing will be based on current standards. Electrical calculation tools for voltage drops, load rates in cables and power losses using the usual electricity formulas and the NFC 14-100 and NFC 15-100 standards,
- or JOVE BT, electrical calculation software for village electrification, on the condition that the BT plans to be updated are in JOVE format (with the extensions .dev, .aez, .ndx, and libraries.).
- Sizing and design of mini PV and or Hybrid solar power plants: Homer and sunny design 3 and dimensioning tools according to ASER technical minimums.
- Digital survey platform: Kobotoolbox
- Geographic Information System: Argis

3.2. Methodology for conducting site visits

1. Selection criteria for sites

Initially, Namarel was the chosen location for this project. AGT Senegal has a long list of villages in which we can implement electrification projects thanks to our partnerships with entities like ASER. After selecting Namarel, we later realized that it would not be very suitable for the project, and the conditions required to do the necessary in time were not met. The current site, Mbelogne, is located far from SENELEC's intervention area, at least 5 km from the national network. Therefore, the selection of site for the Repower Project's solar power stations and energy infrastructure in Mbelogne was based on several key criteria:

- Solar Potential: Locations were chosen based on optimal solar irradiance levels to ensure maximum energy generation for the solar power stations.
- Land Availability and suitability: Adequate land was required for the installation of solar panels and Battery Energy Storage Systems (BESS). The land needed to be accessible, flat, and free from environmental or legal disputes.
- Environmental Impact: Areas with minimal environmental disruption such as sustainable land use, rain water harvesting, solar energy installation, etc. were prioritized to avoid harming local ecosystems, with consideration given to existing land use and biodiversity.

These criteria ensured the selection of efficient, secure, and environmentally sustainable locations for the project's infrastructure.

2. Data collection techniques

Surveys: Conducted in households, businesses, and the ADENA cooperative to assess current energy usage, future demand, and local energy needs for productive activities like water pumping and livestock cooling. Thirty-nine percent of all households in the Mbelogne area were visited, which is 76 households.

3. **Stakeholder interviews and observations**

In-depth interviews were held with local leaders, community members, and national agencies to understand perspectives on energy access, potential social impacts, and alignment with national policy. ADENA members also provided insights into energy requirements for agricultural operations.
Site visits allowed project teams to observe physical conditions, including land suitability, solar potential, and environmental factors, ensuring informed decisions on infrastructure placement.

3.3. Findings from site visits

3.3.1. Technical feasibility

Solar power plant:

During the mission, particular attention was given to assessing the social acceptance of the project, especially in relation to the construction of four mini-grids. These mini-grids, equipped with Battery Energy Storage Systems (BESS), street lighting, and a low-voltage distribution network, are designed to significantly improve access to reliable electricity in rural communities. Mbelogne and its satellite hamlets are in a very difficult socio-economic environment, and above all lack a modern electricity system. The access to electricity proposed by the project is socially accepted by the local population. Households have defined the type of service they would like to subscribe to, and we have seen that they have enough resources to pay for it. However, as they all have cell phones, they would like payments for electricity and top-ups to be made by "mobile money" instead of being centralized at the future project's headquarters. The village elders are all in favour of freeing up a site to house the planned photovoltaic power plants.

Cooltainer:

During talks with the village, it was found that there is not much need for a Cooltainer right now because households don't have many items that need cooling. ADENA suggested placing the Cooltainer at their site instead, where it could be used to store dairy products. This would be a better use of the Cooltainer and would support the local dairy production.

Solar submersible pump:

Water requirements in the localities are enormous. In Namarel, the only electric pump in the borehole can produce over 500 m3/day. The water is drawn from a very deep aquifer more than 200 meters below ground. The type of "immersed solar pump" proposed by the RePower Project, with a flow rate of 50m3 per day and a maximum depth of 230 m, will be hard pressed to meet these needs. Nor are there any wells where this type of pump could be installed. The ideal solution would have been two surface solar pumps to irrigate ADENA's 50-hectare forage production field in the WALO area.

Solar surface water pumping system:

For all practical purposes, we propose to equip ADENA's 50 ha of land in the WALO region with two solar surface water pumps equipped with a photovoltaic power plant operating on the sun's rays. The volume of irrigation water for a 50-hectare plot is estimated as follows:

- Volume of water per hectare/day is between 60 and 80 m3/ha /d, so the daily requirement for the 50-ha plot is between 3,000 m3 and 4,000 m3/day. The 50-hectare plot will be cultivated all year round with two crops in association: switchgrass and cowpea.

- A dynamic head of 15 m is considered to allow for system losses and guarantee sufficient water pressure to supply the various irrigation technologies available,

- To ensure a secure energy supply, the capacity of the solar PV panels is sized in line with the pump. A pump needs a certain amount of power to produce the desired pressure and flow rate. The PV panel must therefore be optimally sized to deliver the required power.

- Sizing: based on the above elements, the table below shows the configuration of the pumping system to be installed.

- Reformulation of the project: in view of the below, we propose to reconfigure the Repower project offer by putting in place

On the electrification side:
3 solar power stations, each equipped with a BESS, for Mango and its hamlets; 1 solar power station for ADENA; 3 low-voltage distribution networks with 125 Street-Up lanterns for public lighting in Mango and its hamlets; 164 indoor installations for Mango and its hamlets; 164 prepaid meters for marketing electricity in Mango and its hamlets; a remote monitoring system to track the operation of the whole system; 3 site fences to reinforce the security of the power plants installed in Mango and its hamlets; training of at least three people per site to monitor and market energy in Mango and its hamlets.

Solar submersible pump:
This program needs to be reconsidered in its entirety, given the performance of the equipment proposed in such an environment, where water requirements are enormous, the water table is over 200 meters deep and there are no functional wells. The wisest thing to do would be to provide ADENA with two solar-powered motor-driven surface pumps on its perimeter in the Walo area, in place of these pumps.

Filtration unit:
Of the four installations planned, only one is decided to be installed for ADENA.

Storage unit or Cooltainer:
This unit is intended for ADENA and is ideal for milk storage and rental in Namarel.

3.3.2. Economic viability

The feasibility study confirmed the economic viability of the Repower Project through a cost-benefit analysis. Key findings include:

- Cost Efficiency: The use of solar energy, combined with Battery Energy Storage Systems (BESS), ensures low operational costs after initial installation, reducing long-term energy expenses.
- Community Economic Benefits: Access to reliable electricity will enhance productivity, especially in agriculture, water pumping, and livestock cooling, boosting local income and economic activity.
- Affordability: Tariffs were designed to be affordable for the community while covering maintenance costs, ensuring both economic and social sustainability.

3.4. Environmental and social impact

The implementation of this project in its reconfigured version could have a number of positive social and environmental impacts:

- Access to electricity: as none of the target localities have electricity, the installation of the KANI power stations will bring electricity to all these remote areas where the traditional electricity network is not accessible. With the public lighting system that will go with it, the quality of life of more than 1,500 people, 60% of them women, will be improved. The interior installations will provide access to electrical appliances such as refrigerators for preserving foodstuffs. The electrical sockets included in the energy service package will make it easier to recharge mobile phones.

- Economic development: Even if this is not yet the case for the village, which is connected to the medium-voltage electricity network, access to electricity can promote local economic development by enabling small businesses to be set up, agricultural products to be processed using electric mills, etc. This can lead to an increase in incomes, as well as a reduction in the cost of transport. This can lead to an increase in income and the creation of local jobs.
- Reduced deforestation: Many households in the area use firewood for cooking. Solar electrification can reduce dependence on firewood, thereby helping to preserve the sparse vegetation in the area.

- Reducing CO2 emissions: The use of solar photovoltaic energy, a clean and renewable source of energy, reduces greenhouse gas emissions compared with fossil fuel sources such as coal, oil or wood.

- Strengthening resilience to climate change: Rural communities are often closely dependent on their environment for their livelihoods. By providing a reliable and sustainable source of energy, solar electrification can strengthen the resilience of these communities and reduce their contribution, however minimal, to the adverse effects of climate change.

- Improving access to education and healthcare: Electricity can facilitate access to education by enabling the use of computers and the internet in schools, as well as lighting for studying at night. Similarly, it can improve access to healthcare by enabling the use of electric medical equipment and lighting in health centres.

However, it is important to note that the implementation of this project, which is so important for the population, requires adequate planning to minimise delays in the management of its implementation, and the preservation of biodiversity by choosing land without risks of environmental degradation (undergrowth clearance, uncontrolled burning, etc.). Community participation in this development process is essential, as is the involvement of local organisations in leadership, awareness-raising and communication. Community radio is an important communication tool in the area.

3.5. Recommendations based on site visit findings

In view of the above, we propose to reconfigure the Repower project offering by putting in place :

On the electrification side:

- 3 solar power stations, each equipped with a BESS, for all the villages ;
- 1 solar power station for ADENA;
- 3 low-voltage distribution networks with 125 streetUp lanterns for public lighting ;
- 164 household installations in the villages;
- 164 prepaid meters for marketing electricity in the villages;
- A remote monitoring system to keep track of everything;
- 3 site fences to reinforce the security of the power stations installed in the villages;
- Training of at least three people per site to monitor and market the energy in the villages.

Solar submersible pump:
This programme should be reconsidered in its entirety in view of the performance of the equipment proposed in such an environment where the need for water is enormous, the depth of the water table exceeds 200 metres and there are no functional wells. Solar pumps of this kind could be suitable for wells not too far from ponds, thereby encouraging market gardening and/or fodder production. However, this would require wells to be constructed following proper geophysical studies. This is not the current project. The wisest thing to do would be to see how ADENA could be provided with a solar-powered motor-driven surface pump on its perimeter in Walo instead of these pumps. The impact could be real.

Filtration unit:
Of the four installations planned, only one could be selected for ADENA

Storage unit or Cooltainer:
It is intended for ADENA and is very appropriate for the conservation of milk and rental possibilities at Namarel. Mbelogne Mango could also benefit, reducing the project to 2 Cooltainers instead of one.

The reconfiguration of the project is summarized in the table below with the allocation of each equipment.

<u>Overall Feasibility Study Results</u>

Table 1 Summary of key findings

NEW PROJECT CONFIGURATION					
EQUIPMENT	UNITE	Initial Qty	Quantity offered	DESTINATION	
				MBELOGNE	ADENA
SOLAR TAINER	U	4	4	3	1

COOLTAINER	U	1	2	1	1
Water purification unit	U	4	1		1
Pompes Solaires "PumpUp	ENS	40	0		
Surface solar pump irrigation system	U	0	2		2
Substrates+foundation	ENS	0	32	24	8
Floor lamps	U	40	125	125	
Security (perimeter fencing + gate)	MI	0	4	3	1
LV distribution network	MI	ND	9911	9911	
Driver shelters	U	ND	3	3	

Sizing of photovoltaic solar power plants

The sizing of the solar power plants was done based mainly on the data collected during the field surveys of the socio-economic study. These surveys highlight the elements grouped in the table below:

N° ORDER	VILLAGE NAME	LATITUDE	LONGITUDE	POPULATION TOTAL[20]	NUMBER HOUSEHOLDS
1	Mbélogne Wouro Kalidou Mamadél	16.048410	14.827190	150	33
2	Mbélogne Wouro Demba Hawa	16.056210	14.816910	36	14
3	Mbélogne Wouro Moudo	16.057630	14.801240	24	21
4	Mbélogne Wouro Moussa Sofel	16.060320	14.792020	27	19
5	Mbélogne Wouro Abdoul Gorel	16.074610	14.811330	32	15
6	Mbélogne Mango	16.075180	14.801210	90	45
7	Mbélogne Wouro Kalidel	16.083840	14.781310	22	8
8	Mbélogne Wouro Siléye Wollette	16.088430	14.777460	31	9
	TOTAL			**412**	**164**

The sizing process:
Given the demographic size of the localities concerned by the project and the size of the power plants to be installed (30 kWp), we have grouped together localities that can share the same energy source. We therefore based ourselves essentially on their geographical positions to constitute the grouping defined in the table below:

N° ORDER	VILLAGES COVERED	LATITUDE	LONGITUDE	POPULATION TOTAL	NUMBER OF HOUSEHOLDS	DISTANCE BETWEEN VILLAGES IN KM

POWER PLANT 1	Mbélogne Wouro Kalidou Mamadél	16.048410	14.827190	186	47	1,5
	Mbélogne Wouro Demba Hawa	16.056210	14.816910			
POWER PLANT 2	Mbélogne Wouro Moudo	16.057630	14.801240	51	40	1
	Mbélogne Wouro Moussa Sofel	16.060320	14.792020			
POWER PLANT 3	Mbélogne Wouro Abdoul Gorel	16.074610	14.811330	175	77	1,2
	Mbélogne Mango	16.075180	14.801210			0
	Mbélogne Wouro Kalidel	16.083840	14.781310			2,2
	Mbélogne Wouro Siléye Wollette	16.088430	14.777460			0,7
TOTAL				**412**	**164**	

The locations of the power stations are defined at the barycenters of the loads which must be supplied. They are chosen taking into account the distances to be covered by the electrical distribution network and the security of electrical infrastructures (not far from localities).

Sizing results:
The result of the dimensioning of the components of the three power plants is recorded in the table below:

ELECTRIC EQUIPMENTS	Power Plant 1	Power Plant 2	Power Plant 3
POWER OF THE PHOTOVOLTAIC FIELD (kWp)	11,15	8,52	21,59
INVERTER CHARGER POWER (kW)	3,54	2,91	6,78
FIELD INVERTER POWER (kW)	11,00	9,00	22,00
BATTERY STOCK CAPACITY (Ah)	989,52	756,56	1916,45
CAPACITY OF THE BATTERY STOCK (kWh)	44,70	34,18	86,58

3.6. Risk assessment and mitigation strategies

The implementation of the Repower project presents a number of risks and challenges.

1. Risk related to the durability and reliability of the solar equipment

The solar equipment may experience reduced performance or premature failure due to harsh environmental conditions or manufacturing defects.

Mitigation measure: this risk is mitigated by the quality of the equipment proposed by AGT. Equipment that has already proved its worth. The characteristics of the solar panels, lithium ion batteries, etc., the streetup and all the other equipment are of high quality and have been tried and tested. The training of local players and, above all, a local maintenance agent is also a guarantee of sustainability, as is the involvement of the local partner, ADENA.

2. Risk of lack of local technical skills

Insufficient technical expertise within the local community could lead to improper operation or maintenance of the solar infrastructure.

Mitigation measure: this risk is mitigated by setting up a technical training programme for local residents on the installation, maintenance and repair of solar systems. Close monitoring of the activity is also a way of mitigating any lack of local technical skills.

3. Risk of conflicts over land ownership or use

Disputes may arise between community members or with external parties regarding the allocation of land for solar infrastructure, potentially delaying the project or causing tension

Mitigation measure: the targeted villages have already identified and taken the decision to allocate plots of land to accommodate the power plants. This voluntary act will have to be validated by the town hall, which will issue a deed officially allocating the land to the project.

4. Risk of vandalism or theft of solar equipment:

Solar panels, batteries, or other equipment could be damaged or stolen, disrupting energy supply and increasing costs.

Mitigation measure: Appropriate security systems will have to be installed, the simplest of which is a fence and a guardhouse for the operator. Installing the equipment on a site close to the village is also a mitigation measure, but is not sufficient. Raising awareness among local communities of the importance of protecting solar infrastructure and reporting any acts of vandalism or theft is of great importance in mitigating the risk of vandalism and theft of equipment. Last but not least, equipment can be fitted with an anti-theft system to protect it from thieves.

5. Fire risk

The area is often subject to bush fires. There is a real risk of fire. Faulty wiring or overheating of equipment could lead to fires, posing a threat to both the infrastructure and surrounding areas

As a mitigation measure, we recommend installing the power stations on sites with as little vegetation cover as possible and not too far from villages for rapid intervention.

6. Risk of environmental degradation:

Improper installation or disposal of solar equipment could harm local ecosystems or lead to land-use conflicts.
It may be necessary to clear undergrowth in order to install the power plants. Holes will also be dug to support the containerised solar power plant.

To mitigate this risk, the land will have to be returned to its natural state at the end of the works. Planting live hedges around the power station will also help to counteract the harmful effect of the clearing and preserve biodiversity. The environmental impact of the project will need to be regularly monitored and mitigation measures adjusted in line with the results.

Accessibility and logistics: The Mbelogne area is a long way from urban centres and can be difficult to access due to the lack of adequate road infrastructure. Transporting the solar equipment and necessary materials can therefore be a major challenge. Well-equipped trucks will need to be identified in good time to transport the equipment. The tarmac road stops at Ndioum. From Ndioum, it will be necessary to take a lateritic track to the village of Bombodé and then a series of sandy tracks to reach the sites.

Generally speaking, effective risk management in a solar photovoltaic electrification project in a non-electrified agro-pastoral environment requires a proactive approach, involving meticulous planning, community participation, strategic partnerships and ongoing monitoring by the operator.

4. Conclusions and Recommendations

Overall conclusions of the feasibility study

The Repower Project under World Package 7 is a comprehensive initiative that aligns with both local community needs and the national energy policy of Senegal. Through thorough stakeholder analysis, extensive community engagement, and detailed site visits, the project has been carefully planned to ensure its success. The feasibility study confirms the viability of the proposed work, which includes the installation of solar power stations, distribution networks, and other energy solutions. The project’s success will depend on continued collaboration between AGT Senegal, the local community, ADENA, and national stakeholders.

Overall, the feasibility study confirms that the Repower Project is technically feasible, economically viable, and socially beneficial for the village of Mbelogne.

Strategic recommendations for project implementation

The strategic recommendations for the implementation of this project are to follow the new project configuration illustrated in the table showcased in the key findings, following the feasibility study. For an even better and easier project implementation process, we could recommend a change of location in an even more suitable and accessible village, if possible.

Next steps and action plan

- Permits and licenses
- Generate load profiles and plan the grid.
- Dimension the Solartainer RePower system.
- Purchase locally sourced components.

Long-term sustainability considerations

- Develop a robust maintenance plan with AGT Senegal and local technicians.
- Implement affordable tariff structures to ensure the financial sustainability of the microgrid system.
- Establish a monitoring system to track performance and adapt to future energy needs.
- Promote productive energy uses to stimulate local economic growth, ensuring long-term community benefits.

5. References

Feasibility study report
Field study data
Survey results