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LEAP-RE
Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy

Detailed Implementation and Sustainable Action Plans

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LEAP-RE

Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy

Research & Innovation Action

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D14.6 - Detailed Implementation and Sustainable Action Plans

as a deliverable 14.6 for WP14

Version - Final

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Abbreviations and Acronyms

Acronym	Description
AASTU	Addis Ababa Science and Technology University
BIUST	Botswana International University of Science and Technology
DoE	Department of Energy
EV	Energy Village
MU	Moi University
MaK	Makerere University
RE	Renewable Energy
SDG	Sustainable Development Goals
UVA	University of Vaasa
WP	Work Package

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Summary

This deliverable 14.6 presents the steps to realization of a smart self-sufficient energy community, including scheduled and prioritized order of separate actions, according to the mutual decision by the stakeholders in respective village. The detailed implementation and sustainable action plans require considering: smart self-sufficient energy community; key stakeholders and their role in the implementation; authorities and actors; and what amount and who is giving the funding. These all have been considered and analysed by all nation in Work Package 14 of LEAP-RE. Those are Botswana; Uganda; Ethiopia and Kenya.

Among the descriptions of implementation Roadmap 2025 - 2029 plans of nations if we take a close look of the four nations they can be described in 9 minor sections. Those are - 1) Resource analyses, planning and feasibility study: use the already conducted detailed assessment the village renewable energy potential and current energy consumption; conduct technical, economic and environmental evaluations. 2) Infrastructure planning and design: develop blueprints for energy system (solar, wind & biogas); 3) Securing funding and partnerships: mobilize financial resources (grants, subsides & investment) and establish partnerships with suppliers and contractors. 4) Infrastructure development and installation: install renewable energy systems (solar panel, wind turbines & biogas digester); build smart grid, storage systems and build or retrofit energy-efficient buildings; 5) Identify land and secure permits; 6) Implement smart grid and energy management systems. 7) Community engagement and capacity building: Educate residents about renewable energy systems and train local technicians for maintenance and operations. 8) Systems testing and optimization: Pilot installed systems, address technical issues and optimize and distribution systems. Moreover, 9) full-scale operations, monitoring and sustaining: e.g. Launce energy systems for all users' energy villages. Establish long-term monitoring and evaluation frameworks and success criteria. The other nations Botswana, Kenya and Uganda did present their own 2025 – 2029 Roadmaps.

As a conclusion of this deliverable all African nations requires their own detailed EVs roadmaps, implementation and sustainable actions plan. That way all developing nations including African ones can help locals to use and secure energy in rural self-sufficient communities by taking these four African nations as an interesting example.

Keywords: Road-Map for 2025 -2029; Renewable energy; Energy Village; Self-sufficient energy community; Key stakeholders

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1. Introduction

The WP14 endeavoured to establish smart, self-sufficient energy communities capable of generating, managing, and utilizing their own energy resources, with minimal reliance on external power grids. In Kenya, Moi University studied five such villages that integrate various technologies to optimize energy use and improve overall efficiency while reducing the environmental impact. The other nations EVs are in Botswana, BIUST University studied five EVs; in Uganda, Makerere University studied five EVs and AASTU at Ethiopia studied four EVs.

Giving a glams of the sections of this deliverable 14.6 per country - in Botswana, a self-sufficient energy community of the Botswana Power Company (BPC) coal powered national grid energy supply. The village source is clean and renewable ensuring a reduction in the village carbon footprint. For example, in Uganda, valuable stakeholders are Refugee community; Host community; Government through the OPM (Office of the Prime Minister); Design and engineering consultants and Local authorities. For example, authorities in Ethiopia include federal, regional, and local governments, as well as regulatory bodies overseeing energy, environment, and rural development. Their involvement ensures that the project aligns with national and regional policies, benefits from regulatory and financial support, and gains legitimacy within the broader framework of sustainable development. Actions of Kenya as a Roadmap example are: feasibility assessments; stakeholders' engagement; obtain funding and investment; design the smart energy infrastructure; build or retrofit energy-efficient buildings; implement smart grid and energy management systems; promote community engagement and education; monitor progress; and ensure long-term maintenance; sustainability and funding.

Energy Village (EV) concept has been seen as a facilitator for change in the strive to attain energy self-sufficiency of villages including the rural settings. These villages have been developed across different countries in African including Uganda, Kenya, Botswana and Ethiopia as listed in the Table 1. For the Energy Villages in Ethiopia; Botswana; Uganda and Kenya the detailed implementation and sustainable action plans were described.

Table 1. List of energy villages in Africa chosen.

S/N	Energy village	Country
1	Cheboiwo, Langas, Nandi Hills, Kerio Valley and Lelan	Kenya
2	AASTU, Tulefa, Wonji and Langano	Ethiopia
3	Regent Hill School, Regent Hill School, Jamataka, Majwannaadipitse and Matsaudi	Botswana
4	Nakasengere, Wanale, Refugee Camp, Maziba Murole and Kayanzi	Uganda

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2. Detailed Implementation and Sustainable Action Plans

The detailed implementation and sustainable action plans and described below for the country of Botswana, Ethiopia, Uganda and Kenya. The written description of implementation and action plan can be seen blow.

2.1 Botswana

2.1.1 Smart self-sufficient energy community (Description: what does it mean in this deliverable in different countries? What it consists of)?

This community is energy self-sufficient, independent of the Botswana Power Company (BPC) coal powered national grid energy supply. The village source is clean and renewable (PV micro-grid, Biodigesters and solar cookers) ensuring a reduction in the village carbon footprint. The PV micro-grid is run (energy distribution, maintenance and billing) by an energy distribution company formed by trained villagers, the biodigesters and solar cookers are constructed and fabricated by trained and empowered villagers. Although the technology is imported into the village, governance, running, and maintenance is all at a local level. Smart energy is used to enhance agricultural activities which in turn improves food self- sufficiency and generates waste that is used in waste-energy generation.

Clean and high-quality energy becomes available for domestic use. The community becomes energy resilient and minimize the impact of factors that emanate from outside the village, such as energy price fluctuations and disruptions caused by extreme weather, such as storms, floods, or droughts. Revenue generated from energy is kept within the community, in turn it can be used to create jobs in system maintenance, management and can be used to stimulate other activities of economic value such as food preservation and processing. Having control over their energy resource, the villagers are able to foster collaboration through cooperatives leading to mutual understanding and togetherness.

2.1.2 Key stakeholder and their roles in the implementation

Villagers: These are the beneficiaries and active participants whose buy-in must be sought. They provide input on energy needs, preferences and local conditions. They are the primary users of the energy. The villagers participate in training for the maintenance and operation of energy systems, must adopt energy-efficient practices and their buy-in is required for the long-term sustainability of the project.

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Academia/ Research Institutions (Research, innovation and monitoring): Academics can originate the whole concept of the EV by conducting feasibility studies, research and provision of technical innovation to improve the efficiency of energy solutions. Academics will collect data, monitor the project, evaluation services, and provide recommendations for improving the design or scaling of the EV. Their work helps to ensure the sustainability and efficiency of the rural energy system.

Ministry of Minerals and Energy: This ministry provides oversight, regulates investments and installations in the energy sector of Botswana. Through the Botswana Regulatory Authority (BERA), the ministry provides technical standards, and ensures compliance with local and national regulations. BERA will therefore licence the power generation project according to their strict regulations and oversee any tariff and energy up-take issues that may crop up. Normally governments ensure that the project aligns with national energy policies, address rural electrification goals, and may provide support in the form of subsidies, tax exemptions, import duty rebates, and sometimes grants.

Environmental Assessment Practitioners: Will carry out a study to predict and evaluate the environmental consequences of the project, plans, programmes and products so that negative outcomes will be minimized and that government regulations can be met. The impact assessment report is also a planning tool that promotes sustainable development by integrating environmental considerations into the proposed project. It guides planners and developers on issues of location, design, sizing and advises on compliance issues.

Funding Agencies/Financial Institutions/Donor Agencies - Financing and financial management: They are responsible for providing financing options to both the community and businesses involved in the project. They may offer loans, microcredit, and other financial products to individuals or cooperatives for setting up energy systems. Funding bodies ensure access to financing for adopting the energy technologies for rural populations have, especially where such populations may not raise the required finances. Donor agencies typically finance the project through grants, loans, or investments and support the project's feasibility studies, planning, and technical design. They assist bridge the funding gap, in rural areas resources are usually limited.

Renewable Energy Companies/ National Utility Company: These are expert companies that will be engaged starting with a feasibility study that looks at the current energy scenario in terms of sources, current demand and future use predictions, the renewable energy resources available to the village and may extend to a skills audit of the villagers. The companies will then do the designs and cost the energy supply systems to be installed.

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Renewable energy companies are responsible for installation of the PV microgrid. RE companies are also expected to offer support during the operation phase. The National Utility Company can be engaged as an advisor, specifically with billing mechanisms and quality controls, it's possible that in future, the EV may want to sell its power to the national utility if they produce more than they require when perhaps the grid has been extended to reach the village. Involving the national utility company ensures that the PV microgrid is aligned with the broader energy grid infrastructure and regulations.

IT Companies: The energy distribution, billing and service charge collection requires modern IT methods and so an IT company should be engaged.

2.1.3 Authorities

Villagers/The Chief and the VDC (Village Development Committee): The Chief is the highest authority on the ground. He is assisted in governing the village by a village development committee. Engaging the Chief and the villagers can ensure that their needs and their aspirations are correctly captured. This is important because it shapes the nature of the proposed solution. The village leadership dictate land allocation and use in the village, though they will need to be cleared by higher authorities in local and national government. The villagers are the starting point of engagement in planning the project.

Ministry of Minerals and Energy: The EV project has a theme that falls within this ministry. They are required to approve the ethics in the research before research can assume.

The Land Board: In Botswana, there are Land Boards (in the Ministry of Land Management, Water and Sanitation Services) which derive their mandate from the Tribal Land Act and are responsible for management of Tribal land. They are the government arm who has the ultimate authority in land allocation and its use. For land acquisition, tenure issues, and legal requirements are around land use or land rights. The Land Board should be consulted to ensure that land ownership and use comply with the law.

Environmental Authorities/ The Department of Environmental Affairs (DEA): An application should be made to this department outlining the nature of the activities to take place in the intended project. The activities can be authorized to proceed without being subjected to a detailed Environmental Assessment study; or an Environmental Management Plan (EMP), which emanates from an environmental impact assessment may be required prior to project implementation. In this case a certified Environmental Practitioner will have to be engaged. An Environmental Impact Assessment report will have to be scrutinised by DEA to eventually approve the project.

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Health and Safety Authorities: Occupational Health and Safety authorities are supervising all aspects of the construction and operation of the energy village to ensure compliance with health and safety regulations for workers and residents.

Botswana Regulatory Authority (BERA): The government of Botswana are through BERA (in the Ministry of Minerals and Energy) overseas and provides policy and regulations for the energy sector of Botswana. BERA can license and ensures service providers in the energy sector adhere to the set standards and in generally oversees compliance. BERA will therefore license the power generation project according to their strict regulations and oversee any tariff and energy up-take issues that may crop up (see Table 2 for roles and required permits from Authorities for EV implementation in Botswana).

Table 2. Table presenting roles and required permits from Authorities for EV implementation in Botswana.

No	Authority	Summary of the roles	Required permits
1	Villagers/ The Chief and the VDC (Village Development Committee)	Permission to interact with villagers and do a needs assessment	No permit required
2	Ministry of Minerals and Energy	Approval if research	Ethics permit
3	The Land Board	Responsible for authorising and approving land use	Land title deeds
4	The Department of Environmental Affairs (DEA)	Responsible for overseeing the Environmental Impact Assessment process	Certificate of environmental impact assessment
5	Health and Safety Authorities	Responsible systems safety	No permit but general register required
6	Botswana Regulatory Authority (BERA)	Responsible approving power production	Power production permit

2.1.4 Actions (What, who, how, when? How different actions are interrelated?) 2025 – 2029

Village Needs Assessment: The village will be assesed to determine who will consume the energy, the current energy needs of the villagers, their activities, culture and practices, living standards, norms and values and finding out what their aspired energy uses are. Also, a preliminary assessment of the geography and climate are done here in order to determine the possible and available sources.

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Feasibility Study: This is aimed at assessing the existing infrastructure, whatever energy technologies that may be available, and compatibility with the local grid (in future the system may become grid tied). Also, the study is looking at the environmental sustainability of the project and recommends measures to ensure minimal negative environmental impact. The study will also calculate the required investment, estimate maintenance costs, potential earnings and savings, and economic benefits such as access to cleaner and sustainable energy, jobs and improved agricultural practice, etc.

Stakeholders/ Authorities Engagement: The energy policy and regulations department are the government of Botswana need to be convinced to support the initiative. The local community is involved in planning to ensure the energy village meets their needs and gains their support. Potential investors, collaborators, technology suppliers, and local contractors can be identified at this stage.

Funding and Grants: Potential national, regional, and international grants, loans, or partnering bodies are then approached at this juncture to convince them about the viability and benefits of funding the EV. A financial analysis are showing return on investment (ROI) with projections on energy savings, job creation, and the social impact should be prepared whose purpose is to convince funders.

Design and Development: The layout of solar microgrid, and biodigesters are finalised here. Included here should be the grid that distribute energy to points of use such as homes and boreholes. All necessary permits from the Botswana government for construction, operation, and environmental compliance should be secured at this point. BERA will be consulted in order to align with national energy regulations. Energy equipment are such as solar panels, battery storage, digestor construction materials such as bricks and cement will then be procured.

Energy Systems Construction and capacity building: The construction of the PV microgrid together with related infrustructure and the biodigesters is undertaken. Related systems such as energy meters are installed. Capacity building in the form of training of local community members in the operation and maintenance of renewable energy systems is implemented to ensure sustainability. Outreach programs to raise awareness about energy conservation, technology, and sustainability practices are conductucted. Operational tests of the energy systems to ensure that they’re running as planned, troubleshooting and adjustment of operations where necessary are carried out.

Monitoring, Maintenance and Evaluation: The energy systems performance is monitored and evaluated, so is community satisfaction, and financial viability. It is important to regularly evaluate the impact on energy access, economic growth, and environmental sustainability. Maintenance of energy infrastructure is key to prevent breakdowns. Where

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necessary adjustments and upgrades should be carried out to mitigate redundancy or increased demand.

Scaling/ Model Replication: Once the energy village has been evaluated and certified successful, other villages can be convinced to adopt the same model and possibly larger-scale renewable energy projects that can serve multiple villages or towns may be explored. (see below Figure 1 and Table 3 for Roadmap 2029 – 2029 for Botswana).

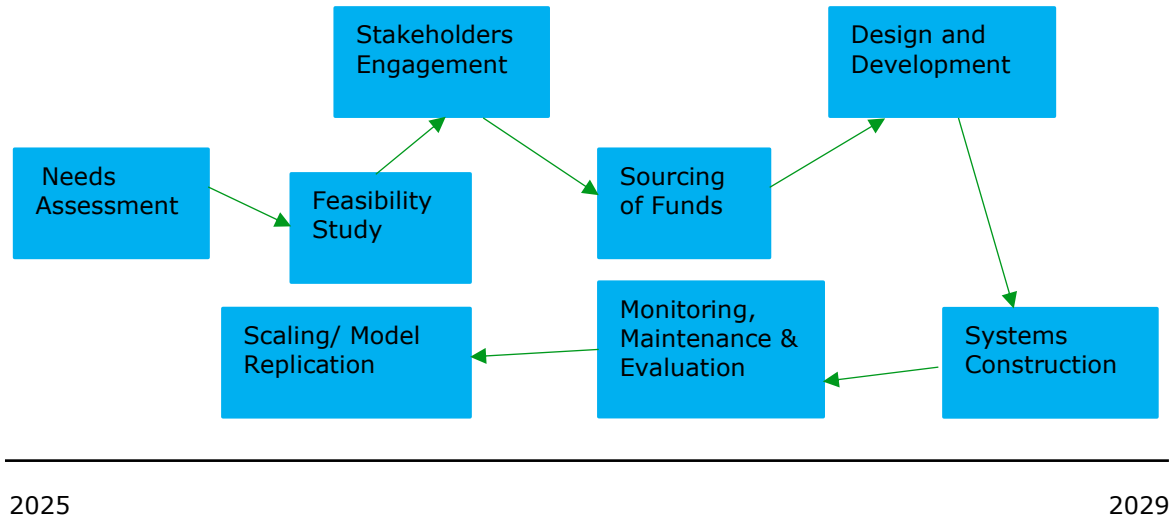

Figure 1. Road Map to an energy village in Majwanaadipitse, Botswana.

Table 3. Road Map table for actions and its descriptions for 202 up to 2029.

Action	What	Who	How	When	Interrelations
Village Needs Assessment	The current and future energy needs are assessed	Academic Institution/ Project research team	Questionnaires, interviews, and desktop research	Jan-Feb 2025	This data is crucial in solution choice and system sizing.
Feasibility Study	Assess environment and do a cost-benefit analysis	An impact assessment company & Research team	Qualified practitioners are engaged	Mar-July 2025	Guides planners and developers on location, design, size
Funding and Grants	A hunt for grants/loans for project implementation	Research team	Market proposal to funding bodies	Jul-Dec 2025	Funding is tied to project realisation
Design and Development	Detailed designs, procurement of equipment	Specialised Renewable Energy Company	Renewable Energy Company Engaged	July2025 -Dec 2026	Designs must suit needs and equipment suit designs
Energy Systems Construction	Construction of Energy village	Specialised Renewable	Renewable Energy Company Engaged	Jan 2027-	Village needs, impact assessment and

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and capacity building		Energy Company		Dec 2027	funding are required for construction
Training and capacity development	The project implementation team will undergo capacity development inform of training	This will be done by the project managers	Through workshops, seminars and formal filed trainings	Jan 2028 Dec 2028	This will relate to proposed implementation of the project
Monitoring, Maintenance, Evaluation	systems is monitored and evaluated, so is community satisfaction, and financial viability	Research team/ Maintenance company	Data collection, processing and analysis	Jan 2029 Dec 2029	The success of the EV hinges on it
Scaling/ Model Replication	Setting up similar and larger scale projects	Research team/ All stakeholders	A repeat of the processes resulting in an EV	Dec 2029 and beyond	Replication is a result of success of the first EV

2.1.5 Get funding

Possible sources of funding such as departments in the government of Botswana, Non-Governmental Organisations (NGOs) and financial institutions, e.g., banks will be approached with a request to fund the energy village project. Examples are:

Botswana Government & Multilateral Initiatives: The Botswana Ministry of Mineral Resources, Green Technology, and Energy Security are often working with international donors and private companies to fund renewable energy projects in rural areas.

International Development Agencies & Donors: The World Bank are providing funding for energy access projects, including PV microgrids, in Sub-Saharan Africa. They are often focus on initiatives that improve rural electrification and last year approved funds for renewable energy projects for Botswana.

The African Development Bank (AfDB) has various energy-focused funding programs, including the Sustainable Energy Fund for Africa (SEFA), which supports renewable energy projects such as PV microgrids. The United Nations Development Programme (UNDP) are supporting renewable energy projects that aim to improve access to clean and affordable energy, often with a focus on rural areas. The European Union (EU) has provided funding previously through various instruments such as the European Development Fund (EDF), which supports energy projects in African countries. The U.S. Agency for International Development (USAID) are supporting energy access projects, especially those focusing on clean energy in underserved areas of Africa. The Global Environment Facility (GEF) are funding clean energy projects, including PV microgrids, through its support for sustainable energy development. The Green Climate Fund (GCF) are financing projects that combat

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climate change, with a focus on renewable energy initiatives in developing countries, including Botswana.

Local and Regional Partnerships: The Botswana Development Corporation (BDC) is a national investment arm of the government of Botswana, which may fund or partner on energy projects. The Southern African Development Community (SADC) region have programs promoting energy access that include financing for PV microgrids. The Energy Access Relief Fund can support energy access programs for rural or off-grid communities, particularly those utilizing solar power.

2.2 Uganda

2.2.1 Smart self-sufficient energy community (Description: what does it mean in this deliverable in different countries? What it consists of)?

An energy village concept in this case is focused at development of self-sufficient villages with well-organized energy demand and supply systems. In this context, energy in humanitarian setting was considered as a model village. The Refugee Camp EV focused on energy self-sufficiency in refugee and host community. The self-sufficiency of this EV was as a result of:

- Community recycling programmes: The EV focused on a cycler energy system. This was through effective utilization of the by-products of the energy generation plants especially biogas plant. The waste slurry is used as organic manure.

- Adoption of efficient energy technologies: This EV embraced the use of efficient energy conversion technologies. This was resulted into reduction in use of inefficient systems like three-stone fire metallic stoves among others.

- Affordable energy systems: The community will be availed with lost cost energy supply through cheap ECS (Energy Cleaning Systems), flexible financing option and subsidies from the humanitarian agencies.

- Environmental protection: The system employed environmentally friendly technologies that limited the amount of emission to the environment. This minimized the pressure imposed by the project onto the environment.

- Installation of intelligent energy and power systems: Metering, monitoring and control technology employed will be an intelligent system that will ensure reliability of the energy system.

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2.2.2 Key stakeholder and their roles in the implementation

- Refugee community: This comprised of the asylum seekers from the neighbouring countries of South Sudan and Democratic Republic of Congo. These form 70% of the potential user/customers for the installed energy system in this energy village.

- Host community: The is made of the indigenous people in this area. The refugees upon arrival will be integrated with these community, and they all access the same services. The refugees and host communities are very important stakeholders in the energy village model and development. They form the greatest proportion of the customer clientele (75%). They offered useful data in the design phase of the energy village. The remaining proportion of customers comprise offices and reception centres, small businesses among others.

- Government through the OPM: Government through the Office of the Prime Minister (OPM) is an important stakeholder that will ensure harmony between the project team and the project beneficiaries.

- Design and engineering consultants: The implementation of the EV greatly depends on the design and engineering teams. This will include the designers, consultants, construction firms and among others. They are playing a role of ensuring actualization of the project.

- Local authorities: The local council body was played a great role in process of data collection, and community engagement and sensitization.

2.2.3 Authorities

- UNHCR/NGOs: Since the refugee camp falls under the jurisdiction of the United Nations High Commissioner for Refugees (UNHCR), they will be key partners in the success of this project. This will be through the funding opportunity, collaborations, subsidies to refugees among others. Other energy related Non-governmental Organizations (NGOs) that work in the settlement especially German Agency for International Cooperation (GIZ) will be of great value as well.

- OPM: The government energy policies are implemented in the refugee camp with coordination from the Office of the Prime Minister (OPM). This authority will ensure harmony in the project implementation at all stages.

- ERA: Electricity Regulatory Agency (ERA) is the body responsible for electricity generation and supply regulation in the country. Since the project involved generation of electricity, there will be need to have an approval of ERA to ensure compliance with

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the national energy generation and supply policy. They will play a great role in regulation and policy guidance.

- REA: The modelled energy is for a rural community. This brings in the involvement of this agency in the energy loop. They will ensure the project is implemented as per the rural energy policy of the country.

- UNBS: Standards of the energy systems such as solar panel, battery banks among others shall be regulated by the Uganda National Bureau of Standards (UNBS).

- Electricity dispute tribunal: This agency comes in to play in case of any electricity related complains. This agency ensures amicable resolution of any disputes.

In summary, the key role and documents including clearances that will be required from the different authorities in the EV project are as follows (please consider seeing Table 4 below).

Table 4. Authorities and required permits.

S/N	Authority	Summary of the roles	Required permits
1	UNHCR/NGOs	Provision of the clearance for access to the village Availing relevant data for the community	• Clearance permit for data collection
2	OPM	Responsible for the administrative operation of the village	• Camp access permit
3	ERA	Responsible for managing all the electricity related projects in the country	• Project development and implementation permit
4	REA	Responsible for rural electricity projects	• Development permit
5	UNBS	Responsible for quality of products and services the consumers receive	• ISO certification of the project

2.2.4 Actions (What, who, how, when? How different actions are interrelated?) 2025 – 2029

- Demand mapping for the village: The demand mapping was done by the project team. This does involve estimation of the community's load profile and eventually finding out the required energy for the community.

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- Detailed system design, specification and selection: The detailed design that depended on the available potential, and they will be obtained by the project design team. This will focus on coming up with the specifications of the energy systems, their sizes and the potential suppliers.

- Training and capacity development: A team of personnel that will work directly in the project will be trained on the basic skills required for them to effectively execute their mandates for the success of the project.

- Equipment acquisition: This will be done by the project procurement and engineering contractors. Credible suppliers will be considered for this phase. This is at the implementation stage of the project.

- Supply, installations and operation: After the equipment acquisition, installation training and operation will follow.

- Evaluation and success criteria: Periodical evaluation of the project success and impact on the community will be done. This will help point out the prospective areas of improvement required. Please see for the actions and their associated interrelations (see Table 5 for compressive view).

Table 5. Actions and their associated interrelations.

Action	What	Who	How	When	Interrelations
Demand mapping and load profiling	This will focus on estimation of load profile for the village	Project research team	Questionnaires, Structured interviews and Desk reviews	Jan-Feb 2025	This will guide in system configuration for optimal load matching and modelling
Detailed system design, specification and selection	This involved development of the supply options by generating the specification of ECS	This will be done by project design team	The system simulation software will be used to come up with the detailed and feasible design	Mar-June 2025	This will be based on the available potential and the demand earlier profiled
Sourcing of funds	This will involve sourcing for funds for the project implementation	Project team	Through proposal writing to potential funders for grants	Jul-Dec 2025	The will relate to the budget as per the detailed and implementation plan
Training and capacity development	The project implementation team will undergo capacity development inform of training	This will be done by the project managers	Through workshops, seminars and formal filed trainings	Jan 2026	This will relate to proposed implementation of the project
Equipment acquisition and procurement processes	The configured equipment will be procured at this stage	The procurement and project team	Sourcing from potential suppliers as per the specifications	Feb-Jun 2026	The required equipped will be shipped

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System installation, configurations and operations	The required ECS will be installed at this stage	The subcontracted installation firms and project team will take charge of this exercise	Installing the energy conversion systems at the generation site	Jul-Dec 2029	The delivered ECS shall be installed at the site for operation to kick off
Evaluation and success criteria	To ensure that the project goals are achieved	This will be done by the project (Monitoring and Evaluation) M&E team	Through the project success criteria, the M&E team will evaluate the project key milestones against the proposed objectives	Jan 2028	This will be in relation to all the previous activities

2.2.5 Get funding

- Government of Uganda: Through the rural energy funding policy, we shall explore options of bidding for government funds in this case.
- UNHCR: This humanitarian agency puts a lot of money in meeting refugee needs of which energy is part and partial. Therefore, proposals will be forwarded for possible funding opportunities.
- Refugee agencies and NGOs: Funding options through partnership with NGOs will be in consideration.
- Research and innovation grants: We shall apply for research and innovation grants to fund the project.

2.3 Ethiopia

2.3.1 Smart self-sufficient energy community (Description: what does it mean in this deliverable in different countries? What it consists of)?

A smart self-sufficient energy community is a localized energy system designed to meet all energy demands through renewable and sustainable resources while integrating advanced technologies for efficiency, reliability, and user engagement. Such a community aims to reduce dependence on external energy sources, enhance energy security, and promote environmental sustainability. In the case of Tulefa, the vision is to establish a self-sufficient energy village powered by wind, solar, and biomass resources, with smart technologies ensuring optimal energy generation, storage, and distribution. This system are not only addresses household needs but also supports community service providers, agricultural activities, and small enterprises, fostering overall socio-economic development.

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A smart self-sufficient energy community are consisting of several core components. First, a renewable energy generation infrastructure can form the foundation, including solar panels, wind turbines, and biogas production units. Second, an energy storage system, are batteries or thermal storage, ensures energy availability during periods of low generation. Third, a smart grid enables efficient energy distribution and real-time monitoring of energy usage, are supported by advanced metering systems. Fourth, the community are relying on integrated energy management systems that optimize energy use and balance supply and demand. Lastly, community engagement programs are playing a critical role, educating residents on energy conservation and system maintenance while fostering a sense of ownership and responsibility.

The realization of a smart self-sufficient energy community can involve seven key steps: conducting a resource assessment and feasibility study to evaluate renewable energy potential; planning and designing infrastructure for solar, wind, and biogas systems; securing funding and partnerships to support the project; developing and installing the necessary energy generation, storage, and distribution infrastructure; engaging the community through education and capacity building; testing and optimizing the installed systems to ensure reliability; and finally, launching full-scale operations with ongoing monitoring and maintenance to sustain the community's energy self-sufficiency.

2.3.2 Key stakeholder and their roles in the implementation

The successful realization of the Tulefa model energy village can hinge on the active participation and collaboration of a diverse set of stakeholders, each playing critical roles in the planning, implementation, and long-term sustainability of the project. These stakeholders are including government entities, NGOs, technology providers, local community leaders, academic and research institutions, private sector partners, and the residents of Tulefa.

Government Agencies: government bodies are playing a central role in providing regulatory support, funding, and policy frameworks that enable the project. They can facilitate access to subsidies, tax incentives, and grants for renewable energy infrastructure. Local governments are also essential in integrating the project into regional development plans and ensuring compliance with environmental and energy regulations.

Non-Governmental Organizations (NGOs): NGOs can provide technical expertise, funding, and capacity-building programs. They are instrumental in community engagement, educating residents on the benefits of renewable energy, and empowering marginalized groups, such as women and youth, to participate actively in the project. NGOs shall also assist in monitoring and evaluation efforts to measure the project's impact.

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Technology Providers and Equipment Suppliers (SMEs): these stakeholders are supplying and installing the renewable energy infrastructure, including solar panels, wind turbines, biogas digesters, and smart grid systems. They are ensuring the quality, efficiency, and reliability of the equipment while offering technical support for system integration and maintenance. Partnerships with these providers are crucial for accessing cutting-edge technologies tailored to Tulefa's specific needs.

Local Community Leaders: community leaders are acting as liaisons between the project team and the residents, fostering trust and facilitating engagement. They are helping to identify local needs, mobilize community participation, and ensure the project aligns with cultural and social contexts. Their leadership is essential for conflict resolution and promoting a sense of ownership among residents.

Academic and Research Institutions: Universities and research organizations can contribute to the project by conducting feasibility studies, resource assessments, and energy modelling. They are also providing innovative solutions to optimize energy generation, storage, and usage. These institutions can assist in training local technicians and building the technical capacity required for long-term operations.

Private Sector Partners: private companies, including energy service providers and financial institutions, can play a vital role in financing, delivering energy services, and offering innovative business models, such as pay-as-you-go systems. They can also assist in developing market-based mechanisms to ensure financial sustainability.

Local Residents: the residents of Tulefa are the end-users and ultimate beneficiaries of the project. Their active participation is critical, from contributing biomass resources for biogas production to attending training programs and maintaining household energy systems. It is possible to build their capacity and creating a sense of ownership ensures the project's sustainability and success.

Maintenance and Operations Teams: skilled personnel for ongoing maintenance and repair services are indispensable for ensuring the system operates reliably. These teams are sourced locally or regionally, ensure quick response times to technical issues and enhance system longevity.

2.3.3 Authorities

Authorities at various levels of governance are essential stakeholders in the implementation of the Tulefa energy village project. Their involvement are ensure that the project aligns with national and regional policies, benefits from regulatory and financial support, and gains legitimacy within the broader framework of sustainable development.

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These authorities are federal, regional, and local governments, as well as regulatory bodies overseeing energy, environment, and rural development.

Federal Government: the federal government are playing a strategic role in creating an enabling environment for renewable energy projects. It is setting national energy and environmental policies, provides grants or subsidies, and enforces regulations to support the adoption of renewable energy. One can integrate energy villages into national development goals, such as renewable energy targets or rural electrification plans, the federal government ensures long-term support and visibility for the project.

Regional Authorities: regional governments are bridging the gap between national policies and local implementation. They can provide administrative oversight, facilitate the allocation of resources, and coordinate with local governments to ensure project execution aligns with regional development priorities. Regional authorities can also offer technical expertise, assist with community outreach, and monitor the project's impact on the region’s socio-economic development.

Local Government: local government bodies are directly involved in the day-to-day implementation and management of the project. They are serving as a point of contact between project implementers and the community, helping to identify local needs and priorities. Local authorities are assisting with permitting, land allocation for infrastructure, and mobilizing the community for participation in training and outreach programs. Their proximity is to the community makes them vital for conflict resolution, fostering trust, and promoting a sense of ownership among residents.

Energy Regulatory Authorities: energy regulators are ensuring the project complies with technical standards, safety protocols, and energy pricing regulations. They are overseeing the licensing of renewable energy generation and distribution, help streamline permitting processes, and facilitate grid integration. Regulatory authorities can also assist in developing tariff structures that balance affordability for residents with financial sustainability for the project.

Environmental Agencies: environmental authorities are responsible for ensuring the project adheres to environmental standards and regulations. They are evaluating the project's environmental impact, particularly concerning land use, resource management, and emissions reduction. Their role are include issuing environmental permits, monitoring the sustainability of biomass usage, and supporting the project's alignment with climate change mitigation goals.

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Rural Development Authorities: rural developments are agencies focus on improving the living standards of rural communities. They are viewing for example one of the energy village project as a key driver for rural development, supporting it through technical advice, capacity building, and financial assistance. These authorities are helping integrate the project into broader rural development initiatives, such as improving health, education, and agricultural productivity.

- **Permitted Documents Required to Implement a Self-Sufficient Energy Village in Ethiopia's Rural Areas**

To implement a self-sufficient energy village, the following documents are typically required:

- Investment Permit: Authorization for the project to operate as an investment in renewable energy.
- Land Use Agreement: Approval for the allocation of land for renewable energy infrastructure such as solar panels, wind turbines, and biogas facilities.
- Environmental Impact Assessment (EIA) Approval: Certification confirming that the project complies with environmental regulations and minimizes negative impacts.
- Energy Generation License: Permit to generate and supply energy as per national energy policies.
- Construction Permit: Approval for the construction of energy facilities and infrastructure.
- Business Registration and Tax Identification: Legal documentation to register the project as a business entity and comply with tax regulations.
- Community Agreement: Formal consent from the local community or kebele administration, ensuring local support for the project.
- Power Purchase Agreement (if applicable): Authorization to sell surplus energy to the national grid or local users.

- **Government Bodies Responsible for Granting Permissions**

The following governmental bodies in Ethiopia are responsible for permitting these documents:

- Ethiopian Investment Commission (EIC): Issues the investment permit for renewable energy projects.
- Ministry of Mines and Energy (MoME): Grants the energy generation license and oversees compliance with energy policies.

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- Ministry of Agriculture (MoA) and Regional Land Administration Offices: Approves land use agreements and provides permission for land allocation.
- Environmental Protection Authority (EPA): Reviews and approves Environmental Impact Assessments (EIA).
- Regional and Local Authorities (Woreda and Kebele Administrations): Provide local land use permissions and ensure community approval for the project.
- Ministry of Urban Development and Construction: Issues construction permits for renewable energy facilities.
- Ethiopian Electric Utility (EEU) and Ethiopian Electric Power (EEP): Regulate power purchase agreements and connections to the national grid (if applicable).
- Ethiopian Revenue and Customs Authority (ERCA): Handles business registration and tax compliance.

Collaborating with these authorities are ensuring legal compliance and smooth implementation of the project, with each document and approval forming a critical part of the process.The required documents and the government bodies responsible are summarised in the following table (see Table 6).

Table 6. Required document and permitting organization for implementing EV.

Required document	Permitting Organization
Investment Permit	Ethiopian Investment Commission (EIC)
Land Use Agreement	Ministry of Agriculture (MoA) and Regional Land Administration Offices
Environmental Impact Assessment (EIA) Approval	Environmental Protection Authority (EPA)
Energy Generation License	Ministry of Mines and Energy (MoME)
Construction Permit	Ministry of Urban Development and Construction
Business Registration and Tax Identification	Ethiopian Revenue and Customs Authority (ERCA)
Community Agreement	Regional and Local Authorities (Woreda and Kebele Administrations)
Power Purchase Agreement (if applicable)	Ethiopian Electric Utility (EEU) and Ethiopian Electric Power (EEP)

2.3.4 Actions (What, who, how, when? How different actions are interrelated?) 2025 – 2029

The realization of Tulefa Energy Village as a model smart self-sufficient energy community requires a well-structured action plan, detailing what needs to be done, who will be responsible, how it will be executed, and when each activity should take place. Below is a comprehensive timeline of actions, interdependencies, and key stakeholders involved (see Table 6 and see Figure 2 for EV roadmap in Ethiopia). Implementing a self-sufficient energy

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village in Ethiopia's rural areas are requiring a comprehensive approach that aligns with national regulations and local community needs.

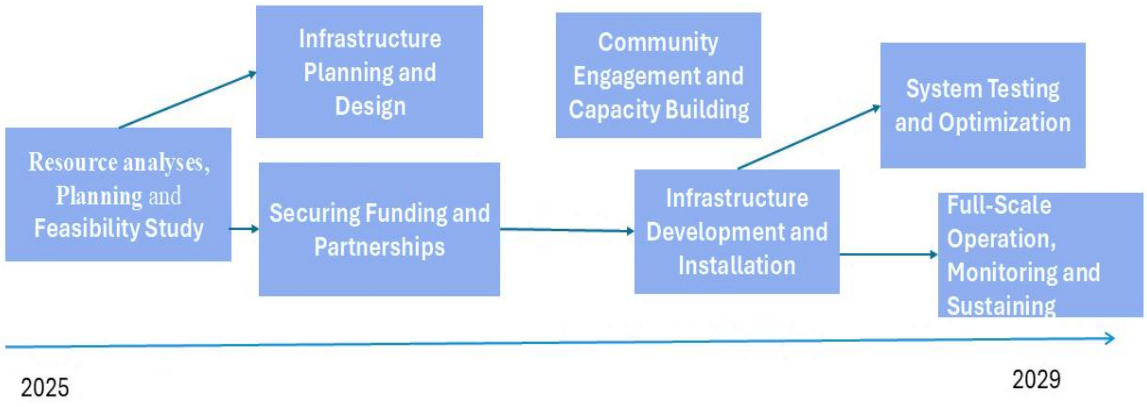

Figure 2. The roadmap for Actions on developing the EV projects in Ethiopia.

This initiative are aiming to harness renewable energy resources such as solar, wind, and biomass to meet the energy demands of communities sustainably. To realize this vision, obtaining the necessary permits and approvals from various government bodies is essential. These are including investment licenses, land use agreements, environmental clearances, and energy generation permits, among others. Collaborating with key authorities and ensuring compliance with legal and regulatory frameworks will enable the successful establishment and operation of the energy village, fostering economic development and improving the quality of life for rural residents. Below are the main permitted documents require to implement the project and the governmental body permitting the documents (Table 7 shows one parts of Roadmap for Ethiopia).

Table 7. This Table one presents the actions (What, who, how, when? How different actions are interrelated?) required for Roadmap, 2025-2029.

Action	What	Who	How	When	Interrelations
Resource analyses, Planning and Feasibility Study	Use the already conducted detailed assessment of Tulefa's renewable energy potential and current energy consumption patterns and project future energy demands to design an optimized energy system tailored to the village's specific needs. Conduct technical,	Academic institutions, energy consultants, environmental agencies and local authorities	Using different tools to analyse data to design effective renewable energy systems	Jan–Jun 2025	Results inform system design, infrastructure planning, and funding proposals

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	economic, and environmental evaluations				
Infrastructure Planning and Design	Develop blueprints for energy systems (solar, wind & biogas). Identify land and secure permits	Engineering firms, local government, regulatory authorities and technology providers	Combine resource assessment data with stakeholder consultations. Finalize designs and obtain necessary permissions	Jul 2025–Mar 2026	Provides the foundation for procurement and construction activities
Securing Funding and Partnerships	Mobilize financial resources (grants, subsidies and investments) and establish partnerships with suppliers and contractors.	Project management team, government agencies, NGOs, and private investors	Submit proposals, negotiate contracts, and secure agreements for equipment supply and technical support	Jan 2025–Dec 2026	Critical to initiating procurement and infrastructure development
Infrastructure Development and Installation	Install renewable energy systems (solar panels, wind turbines and biogas digesters). Build smart grid and storage systems.	Contractors, equipment suppliers, local labour and project engineers	Procure equipment, mobilize construction teams, and conduct phased installation with quality and safety checks	Apr 2026–Dec 2028	Dependent on infrastructure planning and funding. Sets the stage for testing and operations
Community Engagement and Capacity Building	Educate residents about renewable energy systems and train local technicians for maintenance and operations	NGOs, academic institutions, local government and community leaders	Conduct workshops, training sessions, and awareness campaigns. Develop user manuals and establish energy committees.	Mid-2025–2029 (Ongoing)	Ensures community readiness, acceptance, and a trained workforce for long-term sustainability
System Testing and Optimization	Pilot installed systems, address technical issues, and optimize energy generation and distribution systems.	Project engineers, maintenance contractor and local operators	Conduct trial runs, monitor system performance, collect feedback, and adjust systems as needed	Jan–Dec 2028	Ensures system reliability before full-scale deployment
Full-Scale Operation, Monitoring and Sustaining	Launch energy systems for all users in Tulefa. Establish long-term monitoring and evaluation frameworks	Project operators, local maintenance teams and government agencies	Use smart grid technology for real-time monitoring. Schedule regular maintenance and collect data for	Jan 2029 Onward	Culmination of all actions, achieving Tulefa's energy self-sufficiency vision

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			periodic evaluation		

2.3.5 Get funding

Funding is required for several critical activities to establish and sustain the smart self-sufficient energy community. These include the installation and setup of renewable energy infrastructure such as solar panels, wind turbines, biogas systems, and distribution networks. It also covers regular maintenance and operational costs are ensuring system reliability, as well as community outreach programs to educate residents on renewable energy use and system maintenance. Additionally, funding is essential for administrative tasks like billing and customer support, capacity-building initiatives to train local technicians, and monitoring and evaluation to optimize energy systems over time. See Table 8 below listing aspects and details of funding resources.

Table 8. Aspects and details of funding resources.

Aspect	Details
What	Securing funding to cover infrastructure setup (solar panels, wind turbines, biogas systems and smart grids), maintenance, community programs, and operations
Who	- **Government Agencies:** For grants and subsidies - **NGOs & International Organizations:** Funding for sustainability and social impact - **Private Investors:** Equity or debt financing - **Academic Institutions:** Research and development grants - **Local Community:** Small-scale contributions
How	- **Government Grants:** Submit proposals aligned with renewable energy and rural development goals - **NGOs & International Funding:** Approach organizations like UNDP or regional banks with impact-driven proposals - **Private Investors:** Present financial models with clear ROI and CSR benefits - **Crowdfunding:** Launch campaigns for local and global audiences - **Carbon Credits & Green Bonds:** Leverage environmental benefits to secure additional financing
When	- **2025:** Begin funding applications and partnerships alongside feasibility studies - **2026–2027:** Finalize agreements and allocate funds for infrastructure - **2028–2029:** Seek additional funding from energy sales, carbon credits, or green bonds for sustainability
Interrelation	- Resource assessment provides data for funding proposals - Infrastructure planning depends on secured funding - Community engagement builds trust and encourages contributions - Carbon credits and green bonds ensure long-term project viability and scalability

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2.4 Kenya

2.4.1 Description of a smart self-sufficient energy community (Description: what does it mean in this deliverable in different countries? What it consists of)?

The WP14 endeavoured to establish smart, self-sufficient energy communities capable of generating, managing, and utilizing their own energy resources, with minimal reliance on external power grids. In Kenya, Moi University studied five such villages that integrate various technologies to optimize energy use and improve overall efficiency while reducing the environmental impact. The key features of the smart self-sufficient energy community involve: (i) The community generates its own electricity primarily through renewable sources such as solar panels, bioenergy which provide clean, sustainable energy for residential, commercial, and communal needs. (ii) To manage fluctuations in energy generation, the community employs advanced energy storage solutions like batteries. These systems allow excess energy generated to be stored for use during low-production times, such as at night or on calm days. (iii) A smart grid is implemented to intelligently manage the flow of electricity within the community.

It allows for real-time monitoring of energy production and consumption, optimizing energy distribution and reducing waste. The grid can also balance supply and demand efficiently, ensuring that every home and business receives power when needed. (iv) The homes, businesses, and public spaces within the community are equipped with energy-efficient appliances, insulation, and building designs that reduce the overall demand for energy. Smart home technologies, like thermostats and lighting systems, further help residents reduce consumption by adjusting to real-time needs. (v) By being self-sufficient, the community is less vulnerable to energy supply disruptions or outages from the larger grid.

This resilience is particularly valuable in the face of climate change, natural disasters, or geopolitical instability. (vi) Residents actively participate in energy conservation efforts, monitor their individual and collective energy consumption. Education campaigns and incentives encourage people to adopt more sustainable habits, such as reducing energy use during peak times. (vii) The community may also incorporate circular economy principles, where waste materials (such as food waste or organic matter) are converted into energy through biogas production or waste-to-energy technologies. Therefore, the smart self-sufficient energy community is an integrated, eco-friendly environment where technology and renewable resources work together to provide reliable, affordable, and clean energy, while fostering a sense of collaboration and sustainability among its members.

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2.4.2 Key stakeholder and their roles in the implementation

In the implementation of a smart energy community, various stakeholders play crucial roles in the design, development, and ongoing operation of the system. Each stakeholder brings expertise, resources, and influence on different aspects of the project. The key stakeholders include:

1. Renewable energy providers:
These are companies that supply and install renewable energy systems such as solar panels and biogas digesters. They are playing a key role in making the community's energy production green and sustainable. They are responsible for installing renewable energy systems across homes, businesses, and public spaces; offering maintenance and repair services for renewable energy technologies; as well as providing consulting and planning to optimize the energy generation mix for the community.

2. Technology providers:
These are stakeholders including companies that provide the technology infrastructure for the smart grid, energy storage solutions, and IoT devices that monitor and control energy use in homes and businesses. They are developing and install smart grid technologies, smart meters, and sensors to optimize energy distribution; provide energy storage solutions such as batteries and other backup systems; and implement software platforms and apps for energy management and monitoring.

3. Residents and community members:
The residents are not just end users but also active participants in the community's energy system. Their behaviour, choices, and engagement are essential to the success of the energy model. They are responsible for adopting energy-efficient practices and smart home technologies; contributing to the energy supply through personal renewable energy installations (like rooftop solar panels); and participating in energy-sharing or local energy marketplace models if available.

The implementation of a smart energy community is a collaborative effort that involves diverse stakeholders working together to build a sustainable, energy-efficient, and self-sufficient ecosystem. Each stakeholder brings specialized knowledge and resources, and their roles are interconnected in creating a seamless, smart, and resilient energy system for the community.

2.4.3 Authorities

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The local governments are instrumental in supporting the policy, regulatory frameworks, and incentives needed for smart energy communities to thrive. They can create regulations that encourage energy efficiency, the use of renewable energy, and the integration of smart grid technologies. They are setting energy efficiency and renewable energy targets; establish regulations and standards for energy production, distribution, and storage; provide incentives or subsidies for sustainable energy technologies; and ensure that the community meets legal requirements and safety standards. The next Table 9 summarizes authorities and required permits.

Table 9. Authorities and required permits for Kenya.

	Authority	**Summary of the roles**	**Required permits**
1	The Energy and Petroleum Regulatory Authority (EPRA)	Technical and economic regulation of electricity, petroleum and renewable energy subsectors in Kenya	Project development and implementation
2	Kenya Bureau of Standards (KEBS)	Responsible for quality of products and services the consumers receive	Standardization of materials and equipment used in the project
3	The National Environment Management Authority of Kenya (NEMA)	Supervising and coordinating environmental activities and serving as the main national body to implement environmental policies in all sectors within the country	Environmental impact

2.4.4 Actions (What, who, how, when? How different actions are interrelated?) 2025 – 2029

Implementing a smart energy community involves a series of coordinated actions that span planning, design, construction, and ongoing operation. These actions focus on establishing an energy-efficient, sustainable, and self-sufficient energy system, where renewable energy sources, smart technologies, and community involvement work together.

1. Feasibility assessment:

Conduct a comprehensive feasibility study to evaluate the potential for renewable energy generation, storage, and smart grid integration within the community.

2. Stakeholders engagement:

Establish a collaborative framework with key stakeholders (local government, residents, utilities, developers, energy providers, etc.).

3. Obtain funding and investment:

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This aims to identify and secure funding sources to finance the infrastructure, technologies, and development of the smart energy community.

4. Design the smart energy infrastructure:
Design a comprehensive energy system that incorporates renewable energy, energy storage, and smart grid technologies.

5. Build or retrofit energy-efficient buildings:
Ensure that buildings within the community are energy-efficient, utilizing smart technologies, and equipped with renewable energy systems.

6. Implement smart grid and energy management systems:
This is intended to deploy the smart grid infrastructure and energy management systems that enable real-time monitoring, data collection, and optimization of energy consumption.

7. Promote community engagement and education:
This aims to foster active participation from residents by providing education, incentives, and platforms for involvement in the community's energy system.

8. Monitor progress:
Continuously monitor the community's energy systems, optimize their performance, and scale the model for wider application.

9. Ensure long-term maintenance and sustainability:
Establish a governance and management structure to ensure the ongoing operation and sustainability of the smart energy community. These actions described above are summarized in Table 10.

Table 10. Summary of actions taken to establish a smart energy community.

Action	What	Who	How	When	Interrelations
Feasibility assessment	Conduct a comprehensive feasibility study to evaluate the potential for renewable energy generation, storage, and smart grid integration within the community	Project research team	Analyse local energy demand, availability of renewable resources (solar, wind, geothermal), and existing infrastructure	Jan-Feb 2025	Define specific sustainability, energy efficiency, and self-sufficiency goals for the community

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Stakeholder engagement	Establish a collaborative framework with key stakeholders	Local government, residents, utilities, developers and energy providers	Organize stakeholder workshops or meetings to align on common goals and responsibilities	March-April 2025	Form public-private partnerships with renewable energy providers, technology vendors, and financing institutions
Obtain funding and investment	This aims to identify and secure funding sources to finance the infrastructure, technologies, and development of the smart energy community	Community to apply for government grants, green bonds, and subsidies for renewable energy projects	Seek investment from private investors or venture capital interested in sustainable infrastructure	May-July 2025	Explore energy-as-a-service models or other innovative financing options to make the project financially viable
Design the smart energy infrastructure	Design a comprehensive energy system that incorporates renewable energy, energy storage, and smart grid technologies	Project team plan the integration of renewable energy sources (solar, wind, etc.) based on local resources and needs	Design energy storage solutions (e.g., batteries, hydrogen storage) to store excess renewable energy for use during peak demand or cloudy days	August-October 2025	Develop the smart grid architecture, ensuring real-time monitoring, demand response, and efficient energy distribution
Implement smart grid and energy management systems	This is intended to deploy the smart grid infrastructure and energy management systems that enable real-time monitoring, data collection, and optimization of energy consumption	Project team install smart meters and sensors across the community to track energy production and consumption	Implement demand response systems that incentivize residents to adjust their energy usage during peak hours, reducing overall demand	November-December 2025	Integrate local energy trading systems to enable residents to buy and sell excess energy within the community
Promote Community Engagement and Education	This aims to foster active participation from residents by providing education, incentives, and platforms for involvement in the community's energy system	Community to launch educational programs to inform residents about the benefits of energy efficiency, renewable energy, and how they can contribute to the community's goals	Create platforms or apps for residents to monitor their energy usage and track their contributions to the community's overall sustainability goals	January - March 2026	Organize workshops, webinars, or community events to raise awareness and gather feedback from residents
Ensure Long-Term Maintenance	Establish a governance and	Community to create an energy cooperative or	Regularly update and maintain the	April-July 2026	Ensure long-term financial sustainability by

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and Sustainability	management structure to ensure the ongoing operation and sustainability of the smart energy community	management body to oversee operations, maintenance, and upgrades	smart grid and energy systems to incorporate new technologies and improve performance		continually optimizing energy consumption, reducing costs, and securing ongoing investment

The successful implementation of a smart energy community requires careful planning, coordinated action across multiple stakeholders, and an ongoing commitment to innovation and sustainability. By following a structured roadmap, communities can build self-sufficient, resilient, and energy-efficient environments that reduce their carbon footprint and offer long-term benefits to residents, businesses, and the environment. The next Figure 3 shows the implementation roadmap for 2025 -2029.

Figure 3. Implementation Roadmap, 2025 – 2029 for Kenya.

2.4.5 Get funding

Financing stakeholders such as banks, investors, and grant agencies provide the capital needed for developing the infrastructure of the smart energy community, including renewable energy projects, smart grid technologies, and energy storage systems. This is achieved through: (i) providing loans, grants, or investments to fund the initial and ongoing costs of energy infrastructure; (ii) supporting financial models such as green bonds, energy-as-a-service, or pay-per-use systems; and collaborating with other stakeholders to assess the financial feasibility and sustainability of the project.

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3. Conclusions

The key features of the smart self-sufficient energy community involve: (i) The community generates its own electricity primarily through renewable sources. (ii) To manage fluctuations in energy generation, the community employs advanced energy storage solutions like batteries. (iii) A smart grid is implemented to intelligently manage the flow of electricity within the community. (iv) The homes, businesses, and public spaces within the community are equipped with energy-efficient appliances, insulation, and building designs that reduce the overall demand for energy. (v) By being self-sufficient, the community is less vulnerable to energy supply disruptions or outages from the larger grid. (vi) Residents actively participate in energy conservation efforts, monitor their individual and collective energy consumption. Moreover, (vii) the community may also incorporate circular economy principles, where waste materials (such as food waste or organic matter) are converted into energy through biogas production or waste-to-energy technologies.

Among the descriptions of implementation Roadmap 2025 - 2029 plans of nations if we take a close look of the four nations they can be described in 9 minor sections. Those are - 1) Resource analyses, planning and feasibility study: use the already conducted detailed assessment the village renewable energy potential and current energy consumption; conduct technical, economic and environmental evaluations. 2) Infrastructure planning and design: develop blueprints for energy system (solar, wind & biogas); 3) Securing funding and partnerships: mobilize financial resources (grants, subsides & investment) and establish partnerships with suppliers and contractors. 4) Infrastructure development and installation: install renewable energy systems (solar panel, wind turbines & biogas digesters); build smart grid, storage systems and build or retrofit energy-efficient buildings; 5) Identify land and secure permits; 6) Implement smart grid and energy management systems. 7) Community engagement and capacity building: Educate residents about renewable energy systems and train local technicians for maintenance and operations. 8) Systems testing and optimization: Pilot installed systems, address technical issues and optimize and distribution systems. Moreover, 9) full-scale operations, monitoring and sustaining: e.g. Launce energy systems for all users' energy villages. Establish long-term monitoring and evaluation frameworks and success criteria. The other nations Botswana, Kenya and Uganda did present their own 2025 – 2029 Roadmaps.

As a conclusion of this deliverable all African nations requires their own detailed EVs roadmaps, implementation and sustainable actions plan. That way all developing nations including African ones can help locals to use and secure energy in rural self-sufficient communities by taking these four African nations as an interesting example.

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