AMDA

Cost and Pace of Minigrid Deployment in Kenya

Public vs. Private Sector

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December 2024

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1. Foreword

As part of its continued commitment to advancing sustainable electrification, the African Minigrid Developers Association (AMDA) commissioned this report. It reflects a shared ambition to put the Global Compact on Refugees and the Humanitarian-Development-Peace (HDP) Nexus into practice, especially through energy solutions that are inclusive, efficient, and scalable.

This work is situated within broader national and global energy policy goals. The German Federal Ministry of Economic Cooperation and Development (BMZ), through GIZ's Global Program[1] "Support to UNHCR in the Implementation of the Global Compact on Refugees in the HDP Nexus (SUN-GP)", has supported a range of interventions in livelihoods, social housing, employment, sustainable energy solutions, and policy support. Within this framework, the Energy Solutions for Displacement Settings (ESDS) project is being implemented in Turkana West Sub-County, Kenya, where it supports private sector-led minigrid development for both refugee and host communities.

ESDS has also partnered with Turkana County government to shape enabling policies, such as the County Energy Policy, to attract private sector investment. At the national level, it works closely with the Ministry of Energy and Petroleum to ensure refugee energy needs are integrated into the ongoing development of key strategic documents like the National Cooking Transition Strategy and the planned revision of the Kenya National Electrification Strategy (KNES).

Across these efforts, AMDA and its members play a central role. Private minigrid developers, some of whom operate in Turkana, and other off-grid regions, are demonstrating how market-driven electrification can meet the growth and expansion of high-tier electricity supply to last-mile communities. Through its partnership with GIZ and participation in the Sustainable Energy Technical Assistance (SETA) program, AMDA is contributing to the development of Kenya's first Integrated National Energy Plan (INEP), as envisioned in Section 5 of the Energy Act (2019).

It is in this context that AMDA initiated this study, comparing the cost and pace of delivering private versus public minigrids. The findings are intended to inform decision-makers on optimal transition pathways within INEP's vision of "100% access to electricity services for households, communities, and industry". If private minigrid developers can deliver faster and more cost-effectively, then Kenya's electrification policy must evolve to formally incorporate and scale these solutions.

[1] Jointly creating perspectives for displaced and host populations: A Global Programme supporting UNHCR in facilitating the operationalization of the Global Compact on Refugees (CGR) in the Humanitarian-Development-Peace (HDP) Nexus.

Acknowledgements

We express our sincere gratitude to these organizations for their input in the development of this report.

Abbreviations and Acronyms

AfDB	African Development Bank
Ah	Ampere-hour
AMDA	Africa Minigrid Developers Association
A2EI	Access to Energy Institute
BMZ	The German Federal Ministry of Economic Cooperation and Development
BoP	Balance of Plant
CAPEX	Capital Expenditures
CBA	Cost Benefit Analysis
CBK	Central Bank of Kenya
CEI Africa	Clean Energy and Energy Inclusion for Africa
DART	Demand Aggregation for Renewable Technologies
DoD	Depth of Discharge
EARF	Energy Access Relief Fund
EOI	Expression of Interest
EPC	Engineering, Procurement, and Construction
EPRA	Energy and Petroleum Regulatory Authority
ESDS	Energy Solutions for Displacement Settings
ESMAP	Energy Sector Management Assistance Program
GDC	Geothermal Development Corporation
GEAPP	Global Energy Alliance for people and Planet
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GMGs	Green Minigrids
GPS	Global Positioning System
HDP Nexus	Humanitarian-Development-Peace Nexus
HH	Household
HQs	Headquarters
INEP	Integrated National Energy Plan
IPP	Independent Power Producers
IRR	Internal Rate of Return
KEDCO	Kano Electricity Distribution Company
KEMP	Kenya Electricity Modernization Project
KENGEN	Kenya Electricity Generating Company
KES	Kenya Shilling
KETRACO	Kenya Electricity Transmission Company Limited
KII	Key Interview Information
KKCF	Kakuma Kalobeyei Challenge Fund
Km	Kilometer

KNES	Kenya National Electrification Strategy
KOSAP	Kenya Off-grid Solar Access Project
KPLC	Kenya Power and Lighting Company (Kenya Power)
KRA	Kenya Revenue Authority
kVA	Kilovolt-ampere
kW	Kilowatt
kWh	Kilowatt Hour
kWp	Kilowatt Peak
LCOE	Leveled Cost of Electricity
LMCP	Last Mile Connectivity Project
MoEP	Ministry of Energy and Petroleum
MV	Medium Voltage
MW	Megawatt
NPV	Net Present Value
NUPEA	Nuclear Power and Energy Agency
OPEX	Operational Costs
O&M	Operations and Maintenance
PPPs	Private-Public Partnerships
PSC	Public Sector Comparator
PUE	Productive Use of Energy
PV	Photovoltaic
RBF	Results-Based Funding
REREC	Rural Electrification and Renewable Energy Corporation
RFP	Request for Proposal
ROE	Return on Equity
SEforAll	Sustainable Energy for All
SERC	Strathmore Energy Research Centre
SETA	Sustainable Energy Technical Assistance
SHS	Solar Home System
TAM	Standard Tariff Application Model
UNHCR	United Nations High Commissioner for Refugees
UNT	Uniform National Tariff
VAT	Value Added Tax
WACC	Weighted Average Cost of Capital
WRI	World Resources Institute

Definitions of Key Technical Terms

A: Statistical Terms[2]

- **Mean:** This is the expected value or the average calculated value of a data set.
- **Median:** Also known as the 'Middle Value' is the value that separates the Highest half from the lower half of a data sample. So, basically, median refers to the mid-value or mid-point of any situation or object.
- **Mode:** This refers to the most popular/prevalent/common or recurring value in a data set.

B: Engineering Terms

- **Ampere-hour (Ah):** A unit of electric charge used to measure battery capacity. It indicates how much current a battery can supply over time.
- **Kilometer (Km):** In minigrid systems, it is the length of distribution lines or the distance between system components or customer clusters.
- **Kilowatt (kW):** A unit of power (rate of flow of energy per unit of time). It denotes the power ratings of an appliance or power system e.g. minigrid.
- **Kilowatt per hour (kWh):** A rate of change of power flow with time. It is usually used to measure customers' energy consumption from a utility including minigrids.
- **Kilowatt peak (kWp):** The maximum power output of a photovoltaic (solar) system under standard test conditions. It expresses the capacity of solar panels and helps in sizing and comparing systems.
- **Kilovolt-ampere (kVA):** A unit of apparent power used to rate transformers, generators, and other electrical equipment. It accounts for both real power (kW) and reactive power in alternating current (AC) systems.
- **Megawatt (MW):** A unit of power used to describe the capacity of large-scale energy systems of power plants.
- **Photovoltaic (PV):** The technology that converts sunlight directly into electricity using solar cells. PV systems are commonly used in minigrids to generate renewable energy in off-grid areas.
- **Tier 1 Service:** The most basic level of electricity access as defined by the Multi-Tier Framework (MTF) developed by the World Bank. It provides enough power (at least 3 watts) for a few hours per day to run simple appliances like LED lights or charge a phone. Higher tiers (2-5) offering increasing power capacity, duration, appliance compatibility, and reliability, progressing toward full, grid-like service.

C: Commercial/Financial Terms

- **Average revenue per unit/user (ARPU):** An indicator of the profitability of a product based on the amount of money that's generated from each of its users or subscribers. For minigrids, this would be electricity customers.

[2] Other terms one needs to know; (1) **Kurtosis** is a descriptive statistic used to help measure how data disperse between a distribution's center and tails. (2) **Skewness** is a measure of asymmetry or distortion of symmetric distribution.

- **Balance of Plant (BoP):** All the supporting infrastructure side from the main power generation units, such as inverters, batteries, wiring, and control systems, essential for ensuring the safe, efficient, and reliable operation of the minigrid.
- **Depth of discharge:** The percentage of battery's capacity that has been used. In minigrids, managing DoD is crucial for balancing system reliability, battery lifespan, and overall cost-effectiveness, especially in remote or off-grid areas where maintenance and replacement are challenging.
- **Humanitarian-Development-Peace (ESD) Nexus:** Kenya, UNHCHR and GIZ partnered to integrate refugees' energy needs into local and national energy planning in Turkana County, focusing on strengthening Turkana County government's capacity to address energy need in Kakuma Camp and Kalobeyei Settlement.
- **Integrated National Energy Plan (INEP):** Kenya's first comprehensive, cross-sectoral energy planning framework, mandated by the Energy Act of 2019. It aims to aligns national and country energy priorities to guide coordinated investment, policy, and regulatory decisions that ensure sustainable, affordable, and reliable energy access.
- **Net Present Value (NPV):** The difference between the present value of cash inflows and the present value of cash outflows over a period of time. If NPV is +ve then it is a good investment.
- **Return on Equity (ROE):** Measures the profitability of a corporation in relation to stockholders' equity.
- **Sustainable Energy Technical Assistance:** A government-led initiative implemented by the Ministry of Energy and Petroleum, with support from development partners, to strengthen energy planning and policy formulation in Kenya. Its core objective is to develop the country's first Integrated National Energy Plan, promoting a coordinated, data-driven, and inclusive approach to achieving universal energy access.
- **The Internal Rate of Return (IRR):** The discount rate that makes the net present value (NPV) of a project zero.
- **Last Mile Connectivity Project (LMCP):** A government-led initiative in Kenya aimed at increasing electricity access by connecting low-income and underserved households, particularly in rural and peri-urban areas, to the national grid. The project subsidizes the cost of connection, making grid electricity more affordable and accessible to the "last mile" of unconnected populations.
- **The Leveled Cost of Electricity (LCOE):** The average cost per kilowatt-hour (kWh) of electricity generated over the lifetime of a power system. It includes all the costs, capital, operations, maintenance, and fuel, divided by the total electricity produced, making it a useful metric for comparing the cost-effectiveness of different energy generation technologies.
- **The Standard Tariff Application Model (TAM):** A regulatory tool used by EPRA to evaluate proposed electricity tariffs by minigrid developers. It provides a standardized framework to ensure transparency, cost-effectiveness, and consistency in tariff setting, while allowing developers to demonstrate their projected costs and returns.
- **Weighted Average Cost of Capital (WACC):** The average rate of return a company is expected to pay its investors for financing its assets. In minigrid projects, WACC influences tariff setting and investment decisions as it reflects the cost of capital from all funding sources, weighted by their proportion in the capital structure.

Executive Summary

Photo Credit: Hydrobox

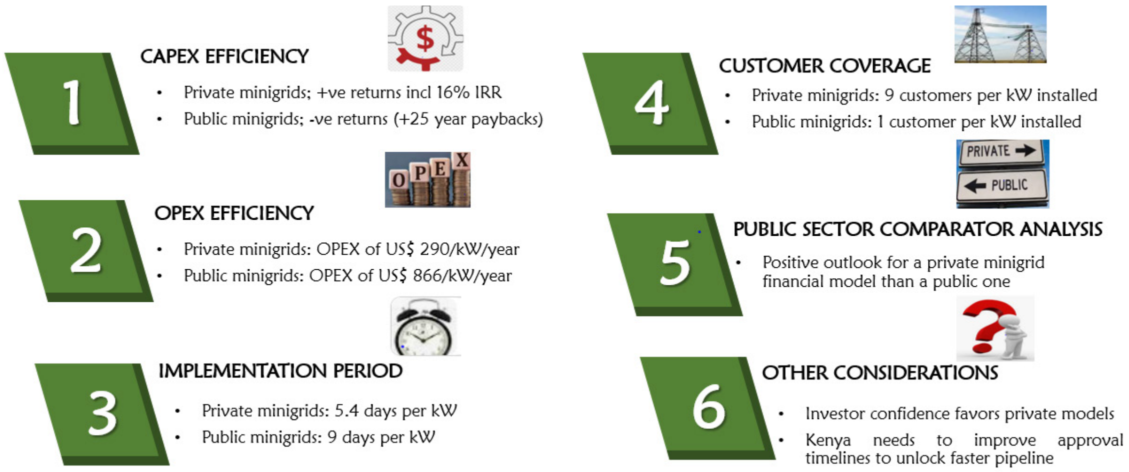
2. Executive Summary

The objective of this study is to analyze and compare the costs and pace of deploying minigrids developed by the public and private sectors. Its findings aim to inform the Ministry of Energy and Petroleum's (MoEP) decision-making in the development of Kenya's Integrated National Energy Plan (INEP) and the planned revision of the Kenya National Electrification Strategy (KNES), particularly regarding the effective allocation of subsidy budgets.

To achieve this objective, the consultant tackled three main tasks:

1. Literature review and stakeholder consultations;
2. Case study of select minigrid sites; and
3. Cost-benefit analysis.

From the study, we realized several key insights summarized below:



From the above, we see that private minigrids exhibit high economic sustainability in terms of Internal Rate of Return (IRR) and payback period potential due to Capital Expenditure (CAPEX) efficiency. They also have a deeper impact as they typically have a higher customer coverage per kW installed (i.e. 9X the public sector equivalent). They have better operational control of their operational costs (OPEX) and can largely implement their projects faster once funds are available.

Recommendations in Summary

Following extensive analysis drawn from primary and secondary information, we propose the following collaborative interventions going forward:

- **Refining regulations to improve project implementation timelines:** Minigrid regulations need to be adapted to reflect the decentralized nature of the industry. This may include an end-to-end digitized regulatory regime.
- **Implementing data-driven government approaches to subsidy funding targeting private minigrids:** From the KNES, $33.1 million in minigrid capital expenditure is required as part of the national electrification strategy with an annual subsidy

element of about $3 million.[3] Given private minigrids have a better performance in terms of lower CAPEX, OPEX, timelines and higher customer coverage, it would be sustainable to allocate a higher subsidy budget (both supply and demand side, if any) to private minigrid pipeline to leverage this impact.

- **Reconstitution of current working groups to absorb other sector players:** More collaborative policy development must be encouraged in future updates to the INEP and KNES. For instance, representation from government agencies, private developers, industry associations, key minigrid investors and donors, as well as policy think tanks.

- **Explore the potential for enhanced PPP:** While programs like the Kenya Off-Grid Solar Access Project (KOSAP) and tenders under last-mile connectivity are sighted as successful examples of private-public partnerships (PPPs) between the Kenya Power and Lighting Company (KPLC), Rural Electrification and Renewable Energy Corporation (REREC) and private developers, it will be more strategic if such partnerships can be explored beyond traditional time-bound build and transfer models. Some of the areas in PPP that can be enhanced include:

    - *Joint project development.*
    - *Network management and Operations and Maintenance (O&M) partnerships.*
    - *Shared learnings on Productive Use of Energy (PUE).*
    - *Bulk procurement partnerships.*

[3] Ministry of Energy, Kenya National Electrification Strategy: Key Highlights (2018).

Introduction

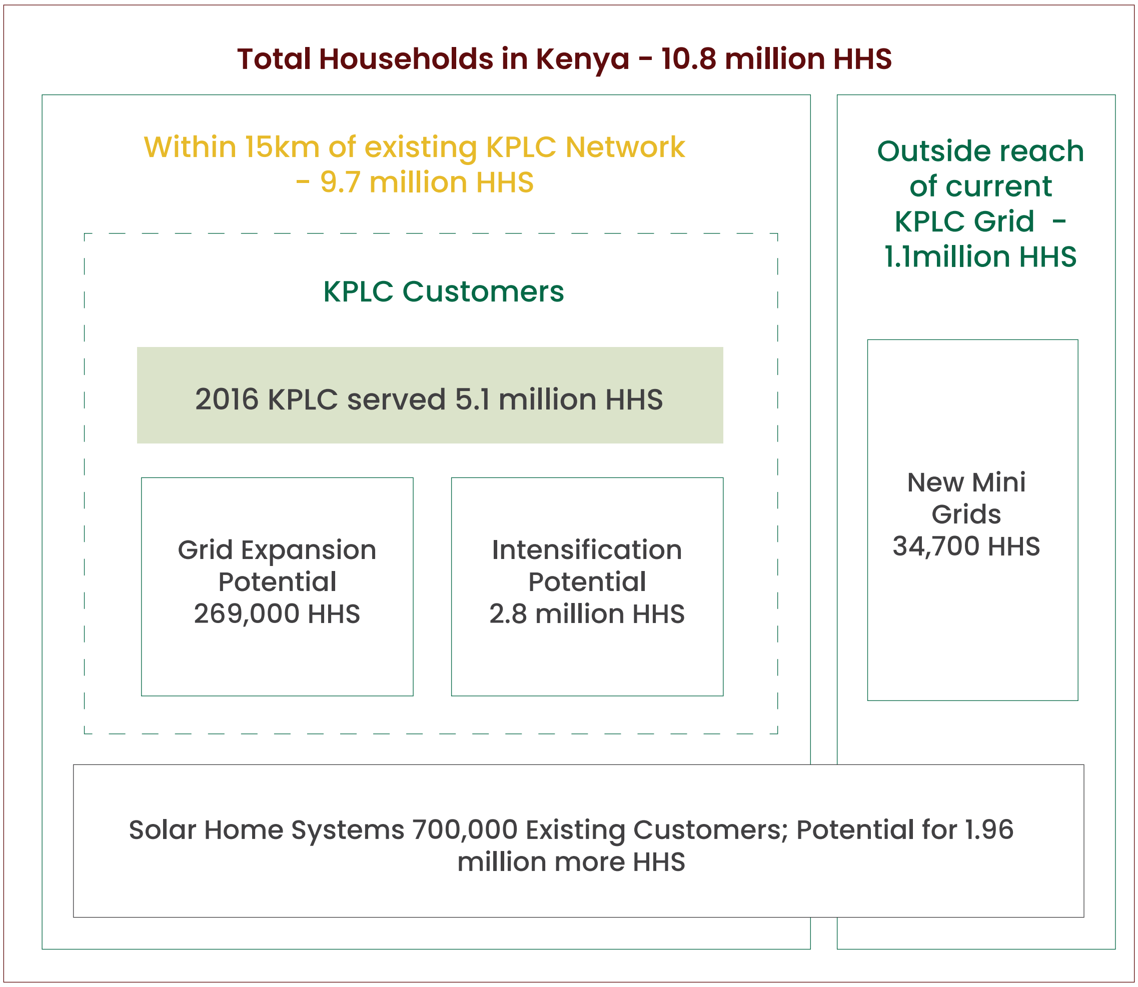
Photo Credit: Hydrobox

3. Introduction: Justification for the Study

Kenya has made tremendous strides in energy access and is regarded as a leader in electrification in Sub-Saharan Africa. Some of Kenya's achievements include a 75%+ electrification rate, with about 90% of the energy generated from the main grid coming from renewables.[4] While traditionally, rural electrification has been the preserve of the National Government, in the last decade or so, the private sector has invested heavily in minigrid development. Currently, there are close to 34 public-sector solar minigrids implemented by the National Government through the KPLC and the REREC. The private sector on the other hand, has implemented more than 50 minigrids as of March 2023.[5] As per the visual below, the minigrid and public utility efforts have also been complemented by standalone solar home systems (SHS).

Some of Kenya's achievements include a 75%+ electrification rate, with about 90% of the energy generated from the main grid coming from renewables.

Summary of Electrification Targets



Source: Ministry of Energy and Petroleum, KNES Key Highlights, 2018.

[4] Kenya Power and Lighting Company PLC. (2023). Kenya Power Strategic Plan 2023/24-2027/28, page 4.

[5] ESMAP - Expanding Minigrids for Economic Growth, 7th Minigrids Action Learning Event, Nairobi February 27-March3, 2023, Page 6.

The above approach provides a snippet into MoEP's efforts in developing the INEP as provided for under section 5 of the Energy Act, 2019. Indeed, this involvement necessitates a study to compare the cost and the efficiency of delivering private-sector minigrids vis-a-vis public-sector minigrids, among others. From this, the overall objective is to advise on an informed transition pathway for the energy access thematic area of INEP. This will then align with INEP's goal of *"100%" Access to Electricity Services for Households, Communities, and Industry through Electrification Approaches that Optimally meet their evolving electricity needs.*[6]

According to the Kenya National Electrification Strategy developed by MoEP, about $33.1 million is needed to unlock 38,661 connections by minigrids.[7] Similarly, the government had also mapped the level of subsidy incentives needed to realize this milestone (Note: This may need to be revised to account for inflation and other economic realities since then).

<table>
<tr><th>Indicator</th><th>Description</th></tr>
<tr><td>Estimated investment required</td><td>
<table>
<tr><th>Programme</th><th>Impact (Connections)</th><th>Projected Cost ($millions)</th></tr>
<tr><td>Grid Intensification & Densification</td><td>3,133,308</td><td>$ 1,875.8</td></tr>
<tr><td>Grid Expansion</td><td>299,601</td><td>$ 381.5</td></tr>
<tr><td>Mini-Grids</td><td>38,661</td><td>$ 33.1</td></tr>
<tr><td>Solar Home Systems</td><td>2,179,730</td><td>$ 457.5</td></tr>
<tr><td>Total</td><td>5,651,300</td><td>$ 2,747.9</td></tr>
</table>
</td></tr>
<tr><td>Subsidies for off-grid technologies</td><td>
<table>
<tr><th>System</th><th>Households</th><th>Annual Subsidy</th></tr>
<tr><td>Mini-Grids</td><td>35,000</td><td>$ 3,377,500</td></tr>
<tr><td>Solar Home Systems</td><td>1,070,000</td><td>$ 16,050,00</td></tr>
<tr><td>Total</td><td>1,105,000</td><td>$ 19,427,500</td></tr>
</table>
</td></tr>
</table>

Source: Ministry of Energy and Petroleum, KNES Key Highlights, 2018.

To this effect, this study analyzes and compares the cost efficiency and deployment speed of minigrids developed by public versus private sector actors. Its purpose is to inform strategic decisions under INEP and KNES, especially on how to allocate energy subsides effectively.

[6] Ministry of Energy and Petroleum, Integrated National Planning Framework Page 59.

[7] Ministry of Energy, Kenya National Electrification Strategy: Key Highlights (2018).

Approach & Methodology

Photo Credit: Renewvia Energy

4. Approach and Methodology

The approach and methodology relied on both primary and secondary qualitative and quantitative data across the three tasks of the project, as follows:

Table 1: Methodology in detail

Task 1 - Literature Review and Stakeholder Consultation - This was the initial information-gathering phase where the team appraised themselves of legacy literature and sought verbal context from key industry players.	
Desk research	This involved identifying and collecting documents, reports, and publications related to solar PV minigrids. The study focused on the scope of the projects, the number of minigrids developed, the location and size of minigrids, duration of delivery, total capital and operational expenditure, and costs per connection. The study also reviewed policy and regulatory frameworks affecting the development and operation of minigrids.
Stakeholder consultations	The key stakeholders identified include representatives from MoEP, REREC, KPLC, Energy and Petroleum Regulatory Authority (EPRA) and Private Minigrid Developers. Key Interview Information (KII) questionnaires were developed, to guide discussions with the key stakeholders. The questionnaires were approved by AMDA before circulation, then interviews were conducted and the findings documented. The KII questionnaire is given in Annex 2.
Analysis and synthesis of information	The information gathered from the desk research and stakeholder consultations was then analyzed and synthesized.
Task 2 - Case Study of Select Minigrid Sites - The task involved conducting standardized case studies of selected minigrids sites to assess their operational status and site-specific challenges, among other parameters. The step unlocked insightful findings that complemented the desk study and stakeholder consultations from Task 1.	
Methodology development	This involved interviews, observations, and surveys with operators, customers, and local authorities. Key assessment parameters were identified, which included operational efficiency, reliability, financial sustainability, impact on local communities, and any challenges faced.
Preparation of tools for data collection	Tools such as questionnaires, interview guides, and checklists were tailored to each site's specific context and study objectives. A technical and financial data collection form is given in Annex 1.
Selection of minigrid sites	Minigrid selection criteria were established selecting four minigrid sites for the case studies, ensuring a balance of two private and two public sites and prioritizing sites that offer a diverse representation of operational models, geographical locations, and the challenges faced.
Obtaining necessary authorizations	This involved coordination with GIZ/AMDA to secure the required permissions for site visits. This included access to the sites themselves and authorization to collect data from these locations.

Site visits	We conducted visits to the selected minigrid sites, and engaged site operators, local governments, community leaders, end users.
Data collection	We utilized the prepared tools to systematically collect data, ensuring a mix of qualitative and quantitative insights for a comprehensive understanding of each site's operations and context as attached in Annex 1 and 2.
Data analysis	Data collected from each site was analyzed to identify patterns, successes, and challenges. The operational status and impact of each minigrid were also evaluated, considering the specific contexts and challenges of their respective locations.
Draft interim report	We compiled the findings from both Task 1 and Task 2 into a draft interim report. The report articulated the operational realities of the system, its challenges, and how findings differ from the desk study and stakeholder consultations.
Client review and feedback	GIZ and AMDA reviewed the report and shared feedback on improvements.
Task 3 - Cost Benefit Analysis - The task compared initial investment costs, connection fees, future management and operational costs, and reliability to assess and establish the cost-effectiveness of producing a unit (kWh) of electricity. This involved a deep dive into various financial indicators of project performance.	
Defining analysis parameters	This involved clearly defining the cost benefit analysis (CBA) parameters, including initial capital investment, connection fees, ongoing management and operational expenses, system reliability, and any applicable subsidies or incentives.
Gathering data	We used the data collected from Tasks 1 and 2 as a foundation, focusing on the financial and operational performance metrics of the selected minigrids.
Financial modelling	Using the gathered insights, the team developed financial models for both private and public solar PV minigrids. These models incorporated discounted cash flow analysis to evaluate net present value (NPV), internal rate of return, and payback period. Existing models included the Standard Tariff Application Model (TAM) for Minigrids and the Leveled Cost of Electricity (LCOE). Also, the capital structure models were reviewed to understand the capital structure mix adopted by both public and private minigrids, e.g. debt, equity, or grant, and, or a mix of the three structures.
Cost-effectiveness analysis	We analyzed the cost of generating a unit of electricity (kWh) for both private and public minigrids using the LCOE methodology/model.
Sensitivity analysis	Finally, the team conducted a sensitivity analysis to understand how changes in key assumptions (e.g. fuel prices, technology costs, and government policies might impact the cost-effectiveness of both types of minigrids).

Note: With regards to completing Task 2, we critically assessed the suitability of the case study sites against nine categories or criteria (as captured below):

Table 2: Selection criteria of minigrids

No:	Criteria	Description
1	Compliance with new regulations	Adherence to the latest national and local regulations governing minigrids.
2	Size	The average capacity of the minigrid should be around 40-60 kWp.
3	Location	Specific geographical area, with a focus on Turkana County or County with similar social-economic and demographic characteristics.
4	Infrastructure	Similar quality and extent of infrastructure and ease of access to the site.
5	Number of connections	Serves approximately 100-200 customers (Not mandatory as long as infrastructure for connection (distribution network) is there).
6	Socio-economic status of users	The economic status of the population served should be similar.
7	Technology used	Types of technologies used, such as solar PV, storage systems, and diesel generator combinations to be similar.
8	Operational Status	To be operational supplying electricity to customers 24/7.
9	Data	Technical and financial data (CAPEX and OPEX) of the site available during the literature review.

Once the case study sites were selected, the team analyzed the underlying data based on various perspectives:

- **Financial model:** This study evaluated the financial models used for the deployment of minigrids, including assumptions on funding sources, tariff structures, and revenue collection mechanisms. This helped in understanding the economic viability and sustainability of each approach.
- **Procurement process:** This metric involved assessing the procurement process for the public and private sectors, the time taken during the procurement process, and valuation criteria.
- **Initial investment costs:** This involved an assessment of the costs of installation for public and private sectors.
- **Maintenance and operations cost:** The study compared the maintenance costs and how often maintenance is carried out, among other considerations.
- **Reliability and quality of service:** This involved an assessment of the reliability of the electricity supply and the quality of service provided by each minigrid, including factors like uptime, voltage stability, and customer satisfaction.

- **Community engagement and impact:** This considered the human element, e.g. the level of community engagement and the socio-economic impact of the minigrids on the local communities, including job creation, income generation, and improvement in living standards.
- **Regulatory environment:** This variable took into account the regulatory frameworks governing the operation of minigrids in each sub-sector, including licensing requirements, permitting processes, and regulatory oversight.
- **Long-term viability and sustainability:** This aspect assessed the long-term viability and sustainability of each minigrid model, including factors like maintenance upgrades and scalability.
- **Technology:** Here, the study considered the types of technology used in the minigrids, such as solar PV, wind, hydro, or hybrid systems. This helped assess and stress test the performance of different technologies under similar conditions.

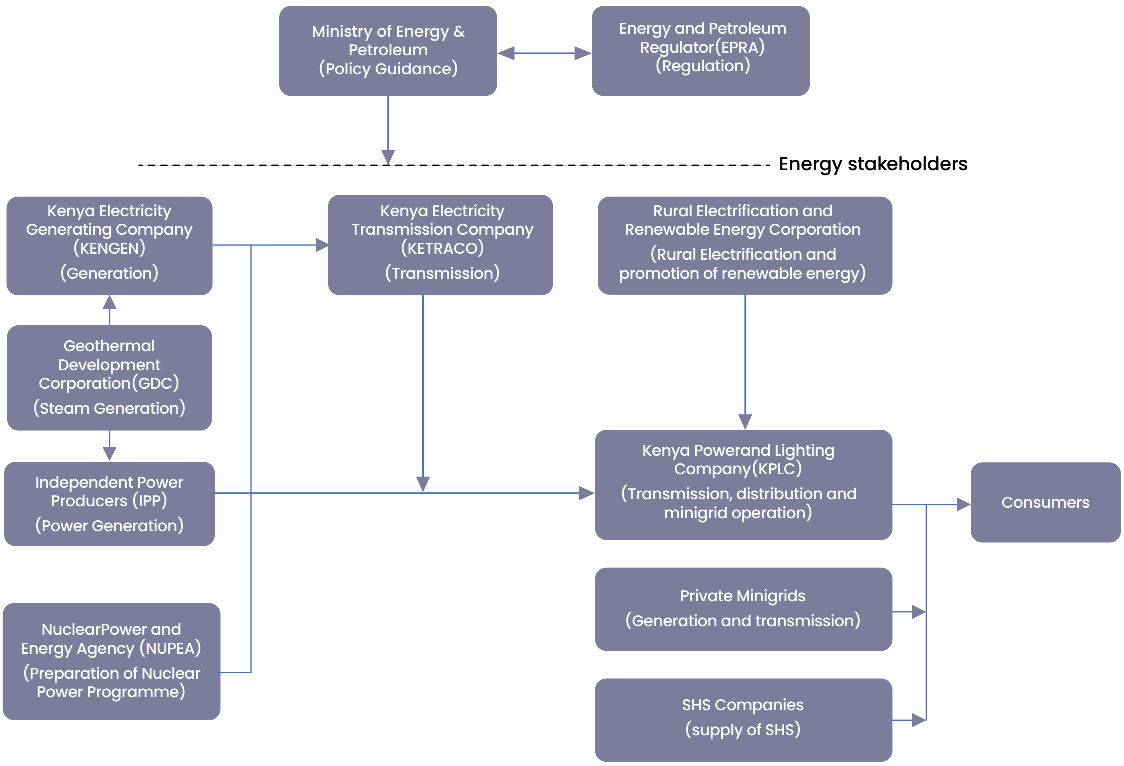
Regulatory Ecosystem

Photo Credit: Kudura Power East Africa

5 Regulatory Ecosystem

Kenya has a liberalized energy ecosystem with both public and private actors involved.

Stakeholder map of the energy sector



Source: Kenya Investment Prospectus 2018-2022

5.1 The KNES in summary

The KNES is the roadmap for achieving access to electricity that is critical to the realization of Kenya's Vision 2030.

The implementation of KNES proposed the connection of new customers through two supply methodologies, grid and off-grid. The two further comprises of the following:[8]

Methodology	Description
Grid supply	• Grid densification and intensification: The last mile electrification comprises connecting new customers that are within 600 meters of existing transformer—densification, and installing additional transformers on existing MV feeders and laterals to connect consumers whose houses/premises are beyond the 600-meter radius of existing transformers— intensification. • Grid expansion: Expanding the geographical coverage of the electric system to reach communities and housing clusters that are beyond the reach of the existing MV network.

[8] Ministry of Energy, Kenya National Electrification Strategy, 2018.

Off-grid supply	• Minigrid expansion: This is considered the most practical and pragmatic approach to providing energy service to households, businesses, and public facilities in rural and remote areas beyond the area that is served by KPLC distribution service and beyond those communities where KPLC service will be expanded (beyond a 15 Km buffer zone). The areas with sufficiently high housing density justify investment in a centralized power plant and a distribution network through which individual clients can receive service. • Stand-alone energy service: To be employed where grid extension and minigrid service are not viable. Comprises of off-grid and stand-alone energy systems such as solar photovoltaic systems with a minimum level of service complying with Tier 1 service.

With regards to the off-grid component of minigrid expansion shown above, EPRA has the role of guiding the sector on such implementation.

In 2021, EPRA developed the draft minigrids regulations to better support minigrids in Kenya by providing a clear regulatory regime for minigrid development (and effectively transitioning from the legacy 2012 regulations).[9]

5.2 Key highlights of the minigrid regulations

The regulatory framework for minigrids is defined by the following key elements:

Permits and licensing

Investors wishing to undertake such projects are required to obtain a minigrid construction permit to design and construct the minigrid project and an operation license to operate the infrastructure.

Expression of Interest process

Developers are required to submit an Expression of Interest (EOI) to the Cabinet Secretary of the Ministry of Energy for Exclusive Site Reservation and Allocation and development of one or more minigrid projects.[10]

The EOI shall typically include the following, inter alia:

1. The description of the site(s);
2. Proposed technology of the generation;
3. Pre-feasibility study report;
4. Future plans to integrate with the Main Grid where applicable;
5. Demonstration of the technical and financial capacity to undertake the project;
6. Demonstration of initial engagement with the Local Community with evidence of the consultation, including documented written minutes, signed attendance registers, and photographs;

[9] Energy and Petroleum Regulatory Authority (2021) The Draft Energy (Mini-Grid) Regulation -Regulatory Impact Statement.

[10] Energy Act No 1 (2019), Page 7.

7. A letter of no objection from the host County government considering:
   - Site availability;
   - Alignment of the minigrid Project to County development plans;
   - The minigrid Developer's technical and financial capability; and
   - The minigrid Developer's engagement with the community.
8. An indicative tariff and how the proposal is aligned with the Kenya National Electrification Strategy (KNES) and the Integrated National Energy Plan (INEP).

Community contract

The local community and the minigrid developer must enter into a Community Contract for each project site. The contract should be valid for 12 months from the Effective Date, defined as the later of i) the date of execution of the Community Contract or ii) the date of EOI approval and site reservation. The contract must be submitted to EPRA along with a document confirming the appointment of a Community Representative and supporting meeting records, such as minutes and attendance register.

> In 2021, EPRA developed the draft minigrids regulations to better support minigrids in Kenya by providing a clear regulatory regime for minigrid development (and effectively transitioning from the legacy 2012 regulations).

Tariff approval process

Developers must submit a tariff application to EPRA within 11 months of the Effective Date, along with applications for a construction permit. EPRA's tariff review process includes:

- Detailed analysis of the submitted tariff model
- Review of the project's feasibility study
- Stakeholder consultations

Developers may apply for the construction permit, operation license, and tariff approval simultaneously. Failure to observe these timelines or obtain an extension will lead to the minigrid developer losing the Exclusive Site Reservation and Allocation.[11]

License modification upon arrival of the main grid

If the main grid reaches an area with an existing licensed minigrid, the operator may apply to EPRA to modify its license to adopt one of the following roles:[12]

1. A power producer selling to the Distribution Licensee;
2. A power distributor purchasing power in bulk from the Distribution Licensee and reselling to consumers under an Energy Supply Agreement;
3. A hybrid model where the operator continues to generate and distribute power in the area while purchasing additional supply from the Distribution Licensee in addition to the existing generation and selling this to consumers; or
4. Any other operating model approved by EPRA.

Project completion requirements

A significant point of discussion within the draft regulation requires developers to complete 30% of planned customer connections before EPRA issues the operation

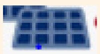
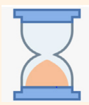
[11] Energy Act No 1 (2019), page 3.

[12] Energy Act No 1 (2019), page 22.

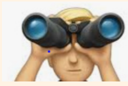
license. This provision is intended to ensure minigrids are built within the envisaged timelines and support the government's ambitious electrification targets. However, this can be a significant hindrance to the bankability of the project.[13]

5.3 The integrated national plan (INEP)

The INEP framework provides comprehensive insights into the implementation and management of minigrids in Kenya. Here are the key aspects related to minigrids:

No:	Criteria	Description
1 	Role of GIS & Geospatial Data	GIS and other geospatial technologies play a crucial role in planning and optimizing energy pathways, including minigrids. These tools help identify optimal locations for minigrids by analysis of various datasets such as topography, demographics, climatology, and existing infrastructure.[14]
2 	Data Inputs for Planning	The planning process involves using data on population density and distribution, socio-economic factors, electrification status, and the locations of social services and productive uses. This data helps in identifying un-electrified households and institutions and in calculating and characterizing energy demand.[15]
3 	Existing & Planned Infrastructure	Information on existing and planned high-voltage, medium-voltage, and low-voltage lines, as well as substations and power plants, is essential for determining the feasibility and placement of minigrids. Additionally, data on current minigrid locations and distribution networks for solar PV home systems (SHSs) is considered.
4 	Institutional Framework	Various institutions are involved in the energy sector in Kenya, including the MoEP, EPRA, KPLC (the public utility) and REREC. These bodies are responsible for different aspects of energy planning, regulation, and implementation, including the development and support of minigrids.[16]
5 	Energy Resource Assessment	The assessment of natural resources such as solar irradiation and hydropower potential is crucial for planning minigrid projects. This assessment ensures that minigrids are established in locations with adequate renewable energy resources to support sustainable and reliable power generation.[17]
6 	Regulatory & Licensing Requirements	Stakeholders interested in developing minigrid projects must comply with various regulatory and licensing requirements. This includes consultations with MoEP, EPRA, REREC, and other relevant bodies to ensure that projects align with national energy plans and regulations.

[13] Energy Act No 1 (2019), page 22.
[14] Ministry of Energy (2021) Integrated National Energy Planning Framework (Page 84).
[15] Ministry of Energy, Kenya National Electrification Strategy: Key Highlights, 2018, page 40.
[16] Ministry of Energy, Kenya National Electrification Strategy: Key Highlights, 2018, page 17.
[17] Ministry of Energy, Kenya National Electrification Strategy: Key Highlights, 2018, page 55.

7 	Challenges & Recommen-dations	The framework outlines challenges such as the need for clarity on land ownership and the coordination between national and county-level energy plans. It recommends specific actions and financing mechanisms to support the implementation of minigrid projects, emphasizing the importance of a coordinated approach involving all relevant stakeholders.[18]

5.4 Other regulatory aspects

Site Approvals: The Ministry of Energy has established an elaborate site approval process for the private minigrids developers. Upon identifying a site, the private developer assesses the site and develops an EOI submitted to the Cabinet Secretary in charge of Energy for approval. The Ministry reviews the EOI to check if it aligns with or conflicts with existing government plans. Approval is granted where no conflict is established. In contrast, public minigrids such as REREC coordinates directly with EPRA and the County governments to obtain concurrence/approval. These public minigrids are evaluated primarily on the basis of public service and not profit.

Incentives: To promote investment in clean energy, the Government assists private minigrids developers in Value Added Tax exemptions for certain products like solar panels, inverters, and batteries to make solar energy more affordable and accessible. Private developers seeking these exemptions must submit a formal request to the Cabinet Secretary in the Ministry of Energy. Upon review and endorsement, the Cabinet Secretary forwards the request to the Commissioner General, Kenya Revenue Authority (KRA) for the exemption.

To promote investment in clean energy, the Government assists private minigrids developers in Value Added Tax exemptions for certain products like solar panels, inverters, and batteries to make solar energy more affordable and accessible.

5.5 Current market status of public minigrids

5.5.1 Government and donor funded minigrids

The following table shows the government-owned minigrids, funded either by the government or donors, along with their average implementation periods.

*Table 3: **Government-funded solar minigrids***

No	Funding	Number	Average Implementation Period (months)
1	Government	27	12
2	Donor	7	6

i. **Government:** The total installed capacity of the 27 government minigrids is 1,865 kW, consisting of:

   - Twenty-six minigrids with a capacity of 60 kWp solar PV, each with 3200 Ah (153.6 kWh) of battery storage capacity and a 50 kVA diesel generator as a backup, and

[18] Ministry of Energy, Kenya National Electrification Strategy: Key Highlights, 2018, page 18.

- One minigrid with an installed capacity of 305 kWp solar PV with 18,000 Ah (921.6 kWh) battery storage capacity and 300 kVA diesel generator as a backup.

ii. **Donor-funded minigrids:** The seven donor-funded minigrids are under the Kenya Electricity Modernization Project supported by the World Bank to be designed and constructed by a contracted Engineering, Procurement, and Construction (EPC) firm with 15 years of operation and maintenance services reliable power supply to the consumers for 15 years. The minigrids were advertised for procurement in July 2018, and up to date, only two minigrids, Wasin and Mageta, have been commissioned, that is, in November 2023 and August 2024, respectively. Takawiri and Ngodthe are at the pre-commissioning stage. The operation and maintenance function are under consideration for signing between the EPC contractor and KPLC. Given the long delay in their delivery periods, the donor-funded minigrids have been excluded from the study analysis as they might distort the output/findings.

5.5.1.1 Overall implementation periods of the government minigrids

The average implementation period from the commencement date of the contract to the commissioning of the 27 public minigrids was 627 days, about 20 months. Taking into account 2 months of procurement process (one month for tender advertisement and one month for evaluation and contracting) the total project timeline from procurement notice to commissioning was around 22 months.

Several factors contributed to the long delivery periods; these were the first minigrids of their kind in the country; there was a local technical capacity gap; and most of the technologies had to be imported. Since then, local availability of solar technologies has improved, with many manufacturers now represented in Kenya.

However, Buna Minigrid, a 305 kWp solar PV minigrid with a 300 kVA backup diesel generator, a 600 kVA 0.415/11 kV step-up transformer, and accessories which were done later, had the longest delivery period of 917 days or 30 months (Contract date to commissioning) or 32 months inclusive of the tendering process.

However, Buna Minigrid, a 305 kWp solar PV minigrid with a 300 kVA backup diesel generator, a 600 kVA 0.415/11 kV step-up transformer, and accessories which were done later, had the longest delivery period of 917 days or 30 months (Contract date to commissioning) or 32 months inclusive of the tendering process.

5.5.1.2 REREC-to-KPLC transition for minigrid operations

Following development by REREC, public minigrids are typically handed over to Kenya Power for O&M. This transfer is governed by a Service Level Agreement between the two organizations, under which REREC retains responsibility for funding the replacement of major equipment.

A total of 26 minigrids with a capacity of 60 kWp have been handed over for O&M, along with the Buna minigrid, which has a capacity of 305 kWp. This brings the total number of public minigrids operated and maintained by KPLC to 27. Each 60 kWp minigrid features a solar installed capacity of 60 kWp, an effective battery capacity of 76.8 kWh at 50% depth of discharge (DOD), a diesel generator capacity of 40 kW (50 kVA), and a three-phase distribution network with an average circuit length of 3 km.

In contrast, the Buna solar minigrid is configured with a solar installed capacity of 305 kWp, an effective battery capacity of 737.29 kWh at 80% DOD, and a backup diesel generator capacity of 240 kW (300 kVA). Additionally, it includes a step-up transformer substation rated at 600 kVA (0.415/11 kV).

The responsibility for connecting new customers lies with REREC. However, since 2019, no new customers have been connected, as Kenya Power does not provide subsidies for connections and applies commercial connection fees. Coordination between Kenya Power and REREC for any new customer connections is ongoing.

5.5.1.3 Connection fees

The connection fee under the Last Mile Connectivity Project (LMCP) is $116.12 for a service connection that includes service cable, meter, and other associated costs for all customers within 50m. This was a Government of Kenya Policy to extend service to all willing customers.

5.5.1.4 Tariff

The tariff used by Kenya Power for the connected minigrid customer is the Uniform National Tariff (UNT) of $0.20/kWh. The minigrid household consumers are charged the UNT so that there is no disparity between tariffs charged across the country for the same consumer type.

5.5.1.5 O&M

Despite a backup generator having been installed in every minigrid, they have not yet been used so far as there was a design gap by REREC to incorporate diesel fuel storage facilities for all the minigrids. Kenya Power has plans underway to upgrade the minigrids to incorporate a 5,000-liter fuel storage tank and change all the lead acid batteries to lithium-ion batteries as after every 3 to 4 years the 96 pieces of lead acid batteries in each minigrid require replacement. The lithium-ion batteries can last 7-10 years with the 48V, 200 Ah battery costing about $3,776.09 each.

5.5.2 Private minigrids

The private sector has been complimenting the public sector with implemented business model minigrids, especially solar PV-based minigrids. Their innovative business models around the minigrid sector are necessary for the prompt rollout of minigrids at lower and affordable costs. Currently, more than 50 private minigrids are in operation, with 150 under development in the country. More than 400 minigrids (ESMAP page 6) will be required to be developed in the short and medium term to achieve universal electricity access. Their development is guided by minigrid guidelines issued by the sector regulator in 2017, the Energy and Petroleum Regulatory Authority (EPRA), and the developed Energy (Minigrid) Regulations, 2022, awaiting gazettement by the Cabinet Secretary for Energy.

The following section provides aggregated insights from a sample of private developers in Kenya.

5.5.2.1 Procurement

Some developers have shortlisted suppliers for critical project equipment/components (e.g. solar modules, inverters, and storage batteries). Others outsource EPC contractors through a competitive bidding process of a Request for Proposals (RFP), where the best EPC firm is selected based on cost and performance. Developers typically source components from China, and in some cases, India.

5.5.2.2 Timelines

Most private developers complete projects within 3-5 months if funding is available. A participatory approach is adopted in the development of the minigrids.

5.5.2.3 Connection fees

Each private minigrid developer determines the connection fees to charge the consumers independently. This is with the aim to balance affordability for consumers with financial sustainability for the business, particularly in the absence of government subsidies.

5.5.2.4 Operations & maintenance

The private developers operate and maintain their minigrids through participatory approaches with the local communities. They use remote monitoring technologies to monitor the performance of the minigrids, including knowing when there are faults and arranging for maintenance.

5.5.2.5 Tariff

Cost-reflective tariffs are determined by the private developers based on prudent development and operation and maintenance costs, which are then approved by the regulator—EPRA.

Analytical Insights

Photo Credit: NAL Offgrid

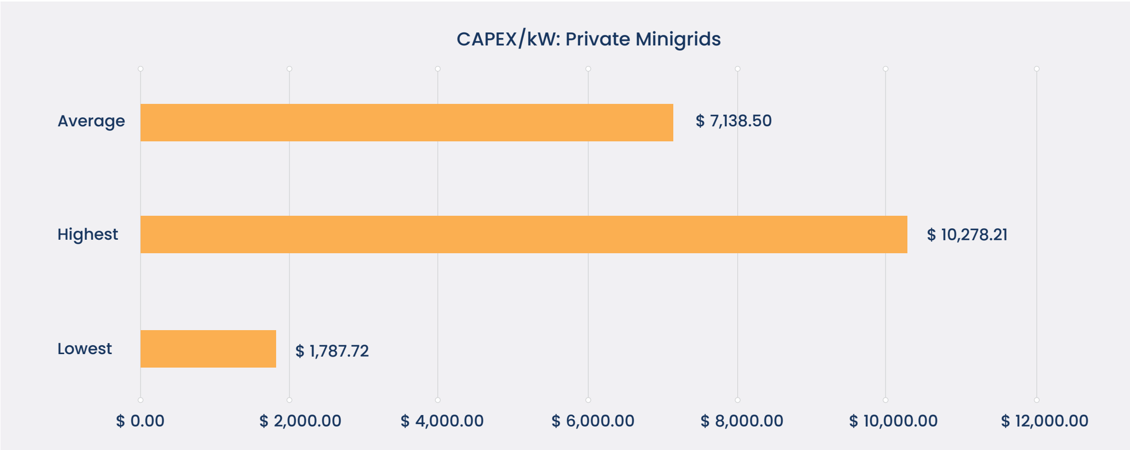
6. Analytical Insights: Cost and Pace of Public vs. Private Minigrids

The below analysis uses data from one public developer and three private developers, labeled A, B, and C. Based on analyzing the data collected, the following key findings are highlighted:

6.1 Cost Metrics: Private minigrids [CAPEX & OPEX]

A: CAPEX cost of developing private minigrids

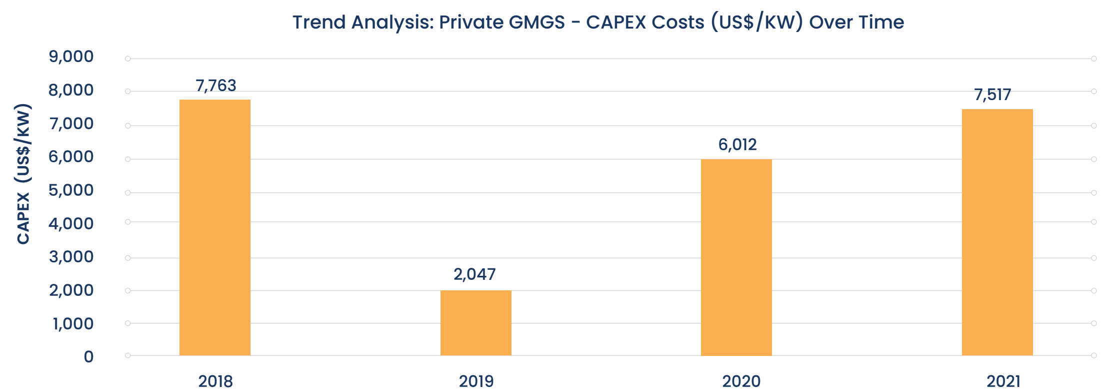
Figure 1: CAPEX/kW – private minigrids



As per Figure 1, the average CAPEX cost per kW is $7,138.50. However, there is an up to 10x spread between the lowest and the highest values from the data sampled. This shows that there is a lot of variability, given developers have different uncontrollable variables, such as availability or the lack of economies of scale, among others. It could also be inferred that the mode of project development may ultimately have an impact on the overall CAPEX costs. For instance, developers who manage the EPC process in-house as opposed to through external expertise may reap efficiencies assuming they have prior assets that they invested that can be leveraged, e.g. design software and context knowledge of the site (Note: AMDA members have reported better CAPEX efficiencies in follow on projects due to implementation insights from prior learnings).

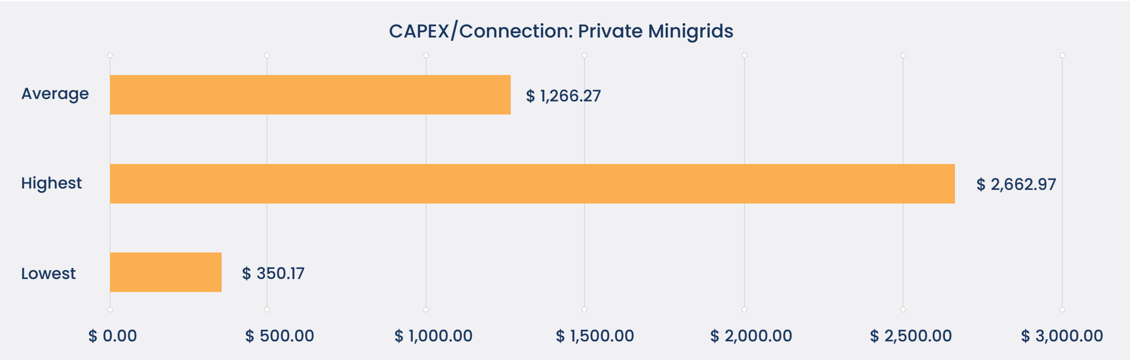
Moreover, if we take an annualized trend analysis of the unit cost of CAPEX, we can derive further analytical insights (see below visual):

Figure 2: Trend analysis CAPEX/kW over time – private minigrids



Here, we see that there was a total of 20 projects sampled between 2018 and 2021 (as shown below) with as many as nine in a single year (i.e. 2021) and as low as two (2) (i.e. in 2018 and 2019). Nonetheless, there was little variability in the unit Capex costs (US$/kW) except for 2019. This shows that there is a greater visibility of such costs by developers and an overall better price discovery over time.

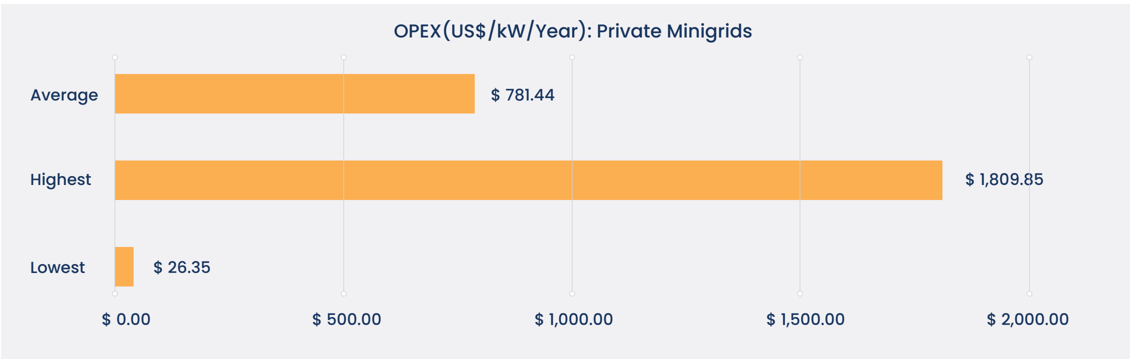
Figure 3: CAPEX/connection – private minigrids



The average CAPEX cost per connection from the sites' data collected was $1,266.27 (as shown above). The highest sampled CAPEX per connection was $2,662.92, while the lowest was $350.17. It is likely that in the long run, the average costs will keep trending downwards (i.e. closer to the lowest value) instead of upwards. However, for this to happen to private developers in Kenya, there is an opportunity to improve the connection costs by assuming a better fiscal and monetary policy environment, such as the implementation of VAT exemptions across all key generation assets (e.g. solar PV, batteries, and inverters) as well as stability of the shilling vis-à-vis the US dollar. Moreover, the projected global cost reduction in battery storage will likely be a game changer for minigrid developers, particularly those with decent exposure to battery storage in their site designs.

B: OPEX cost of developing private minigrids

Figure 4: OPEX/kW – private minigrids

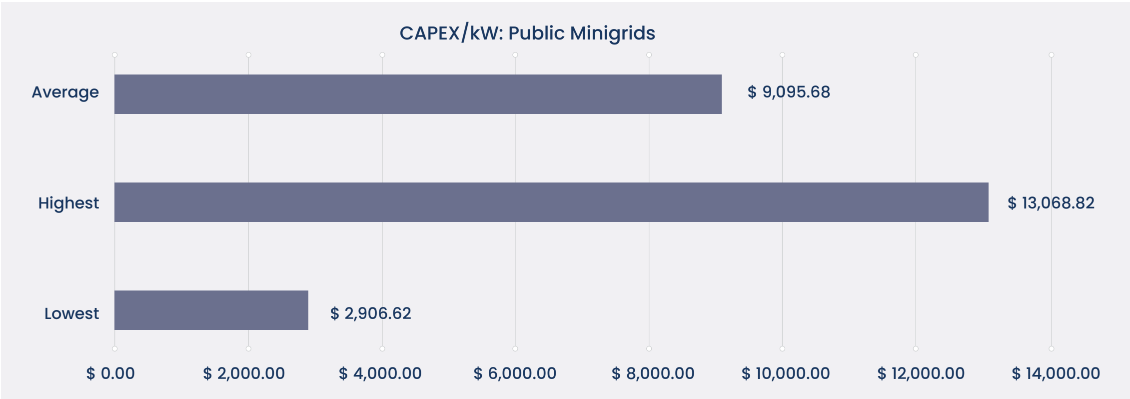


The above representation shows that the average annual OPEX per US dollar per kW is $781.44, with the highest and lowest recorded values of $1,809.85 and $26.35, respectively, from the sample. Given the relatively small difference between the highest/largest and the average value compared to the corresponding difference between the same variables for CAPEX/kWp and CAPEX per connection, we can safely assume that most developers have much better visibility of and control over OPEX costs compared to CAPEX. With the advent of smart metering, automated billing, and remote monitoring technology, private minigrids will likely continue to gain efficiencies in this metric.

6.2 Cost metrics: Public minigrids [CAPEX & OPEX]

A: CAPEX cost of developing public minigrids

Figure 5: CAPEX/kW – public minigrids



As shown in Figure 5, the average CAPEX/kW for public minigrids is $9,095.68, with the highest sampled value at $13,068.82 and the lowest sampled value of $2,906.62. This huge variability between the highest and lowest values, as well as the average and lowest value, may show the likelihood of oversizing systems and the lack of procurement standardization as the EPC procurement process may be spread across different engineering firms. Also, given the time it takes to develop a public project, there may be a lag between CAPEX assumptions at design vis-à-vis implementation. Further, the graph below shows the CAPEX performance over time (i.e. between 2016 and 2024). Note, that there was no available data for 2017, 2018 and 2022.

Figure 6: Trend analysis: CAPEX/kW over time – public minigrids

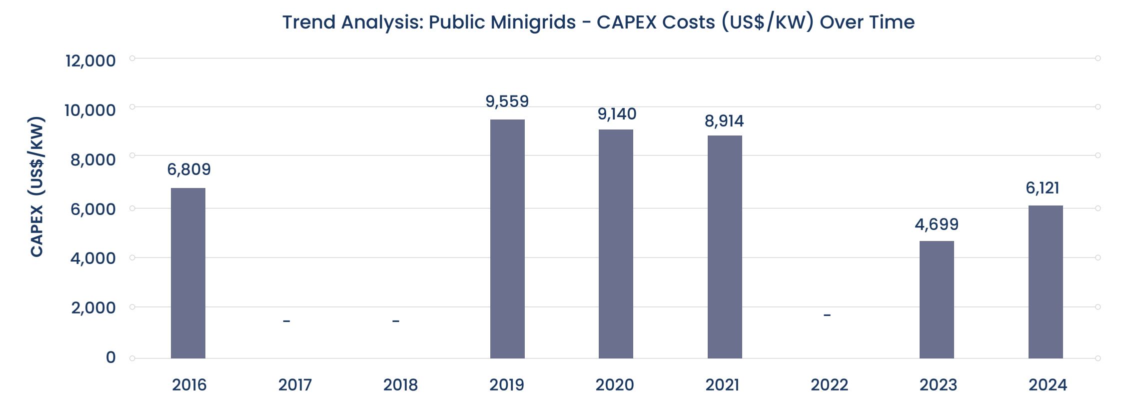
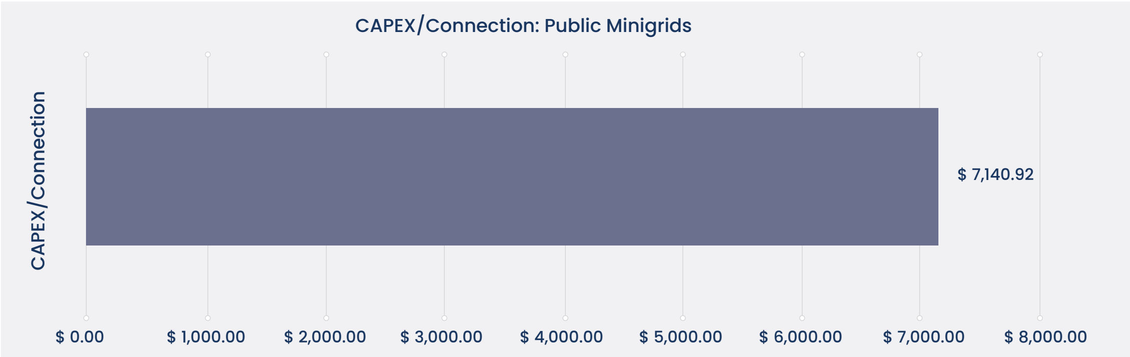


Figure 6 shows that the period between 2019-2021 recorded the highest CAPEX costs per kW. The high record in 2019 was partly because it was the highest recorded period of sampled activity, with a total of 23 minigrids being installed at a total cost of $13.19 million and achieving an installed capacity of 1,380 kW. This study also noted that public minigrid projects have a lot of variability in this metric. For instance, in 2020, one project (i.e. 60 kW) cost $408,551, thus a unit cost of $9,140/kW while six projects in 2024 (i.e. 810 kW total) had a total cost of $4.96 million and consequently the unit cost of $6,121/kW. This shows there is still some level of price discovery and inefficiency in implementation.

Further, the study analyzed the CAPEX cost per connection for public minigrids as shown in the graph below:

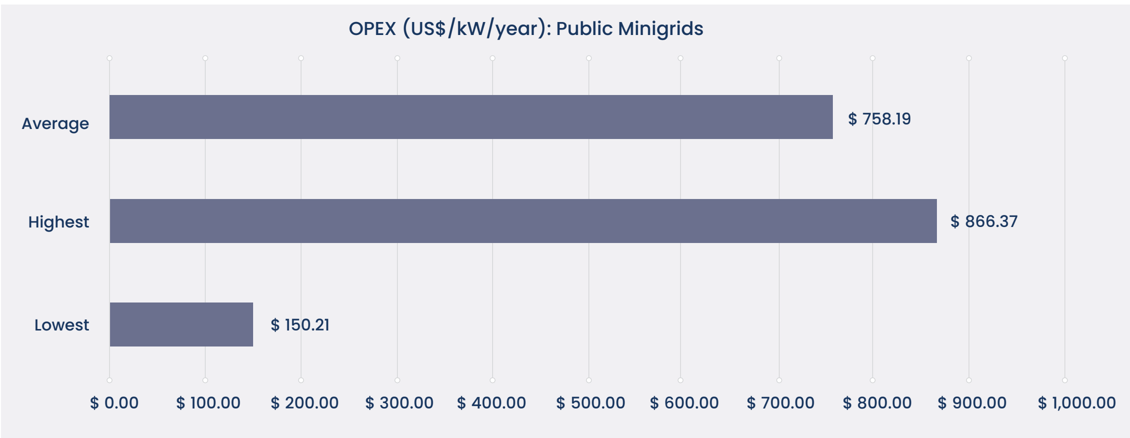
Figure 7: CAPEX/connection – public minigrids



A total of 34 public minigrid projects were tracked during the study, cumulatively absorbing over $23.89 million in total CAPEX and unlocking 3,346 connections. This translates to $7,140.92 per connection as shown in Figure 7. This insight shows some inefficiency in these sites given that the cumulative CAPEX was higher by about five times (i.e. compared to the private sector's equivalent of $4.68m for 31 sites but with the latter having three times more connections at 10,869). This data calls for more clarity on the need for improved governance in government procurement and better design to avoid system oversize. There is also a need to explore better ideas for the on-site location to improve the coverage per site, which still is in favor of private minigrids. The upfront connection fees from public minigrids may also be an inhibiting factor to achieving connections. Lastly, given that public minigrids do not demonstrate an active PUE strategy compared to private equivalents, it may be that potential high-value PUE connections are not targeted because of this demand stimulation oversight.

B. OPEX cost of developing public minigrids

Figure 8: OPEX/kW – public minigrids

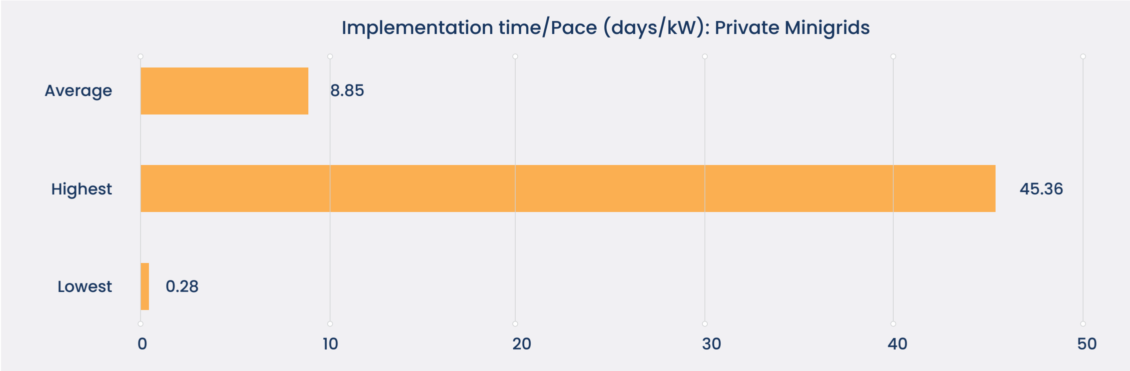


As shown in Figure 8, the average annual OPEX costs per kW is $758.19. However, there is more than a 5x difference between the lowest and highest sampled thresholds. This spread may be due to the fact that there is a handover process with public green minigrids (GMGs) from REREC to KPLC post-commissioning, there may be switching costs associated with the transition that leads to less standardized OPEX. Nonetheless, the average cost shown from the sample more or less reflects current market realities. Given the huge commercial risks of public minigrids in terms of IRR and ROE performance as explained in other sections of this analysis, controlling costs should be a critical KPI for such sites.

6.3 Implementation metric/pace [private vs. public]

A: Private minigrids

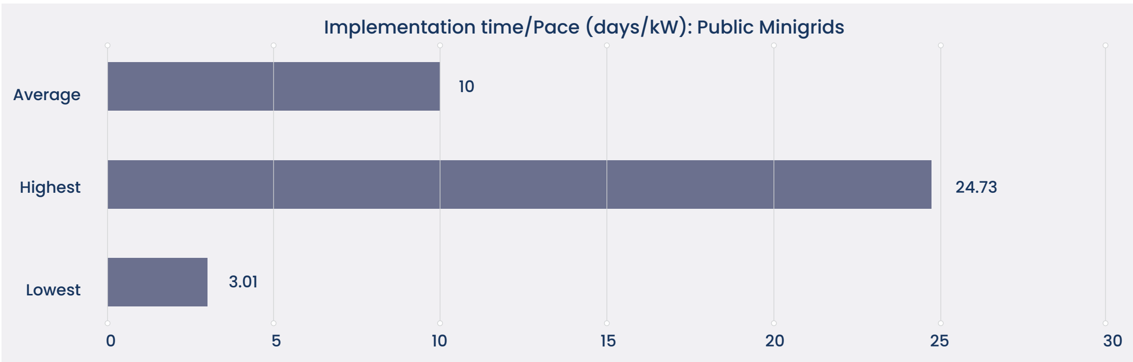
Figure 9: Implementation time/pace – private minigrids



It takes the highest limit of 45 days per kW and an average of 8.85 kW to implement a private minigrid project. It appears the lowest limit of 0.28 was an outlier that's not reflective of most projects. However, most developers confirm they can implement a single small project within 3-5 months if funding is available. Moreover, most developers can bundle project implementation across different sites and construct projects as a portfolio, thus lowering costs. Nonetheless, the regulatory processes are still punitive for minigrid projects, given there is some overlap in their comparative regulatory treatment that is similar to large Independent Power Producers (IPPs).

B: Public minigrids

Figure 10: Implementation time/pace – public minigrids



It takes an average of 10 days per kW to implement a public minigrid with a lowest and highest of 3 and 24.73 days, respectively, from the sample collected. Theoretically, if we prorate this to a 100kW site capacity, this may represent up to a maximum of 1,000 days (i.e. 3 years) to implement. This means that there is often a huge regulatory burden for a project under a megawatt. It remains to be seen, given current funding delays to both counties and government agencies, how these timelines will be affected going forward.

While the project implementation timeline may be manageable, underlying government-backed programs supporting public minigrids like the Kenya Off-Grid Solar Access Project (KOSAP) have taken longer to launch compared to other privately managed Results-Based Funding (RBF) and/or tender programs such as Clean Energy and Energy Inclusion for Africa (CEI Africa). Hence, it is not enough to assess implementation only at the minigrid site level but also at the programmatic level, and thus, it acts as a basis to drive efficiency there as well.

6.4 Comparative analysis: Private vs. public

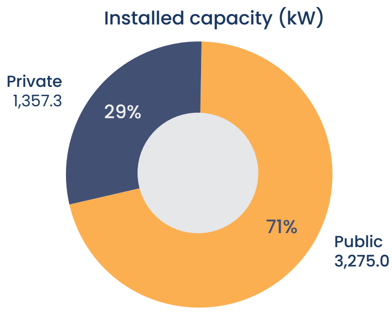
This section pairs the performance of private minigrids against public minigrids across key metrics such as:

- Installed capacity
- Customer coverage
- CAPEX
- OPEX
- Implementation duration (pace)

6.4.1 Installed capacity: Private vs. public

The total installed capacity from privately owned and managed minigrids is 1,357.3 kW compared to 3,275 kW from publicly owned minigrids. This represents a 29% and 71% distribution between private and public minigrids, respectively (as shown below):

Figure 11: Installed minigrids capacity - public and private (in kW)

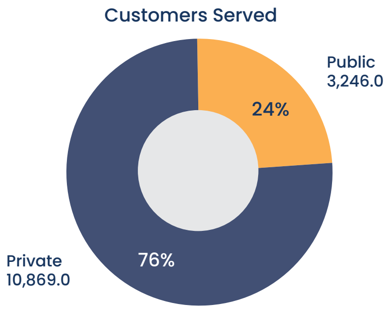


This could indicate that the private sector's engagement in minigrids is less than optimal. Nonetheless, it is important to note that private minigrids across Africa have consistently shown a high service uptime of above 99%.[19] Hence, over time, this could be a better measure of performance between public and private projects.

6.4.2 Customer coverage

Despite the majority of minigrid capacity being public, the private minigrids serve the majority of customers (approx. 76%). This clearly shows that the private sector minigrids cover a significantly larger customer base than public minigrids, indicating either more efficient minigrid sizing or barriers preventing customers from connecting to public minigrids like connection fees being at unaffordable levels for the marginalized communities that comprise poor households.

Figure 12: Customers served - public and private



[19] BAM 2nd Edition.

The capacity per customer gives an indication of how much capacity is required to cover a single customer. It is obtained by dividing the installed capacity (in kW or Watt) by the number of customers. Generally, the lower the capacity per customer, the higher the coverage (and sizing) efficiency. The capacity per customer is calculated using the following equation:

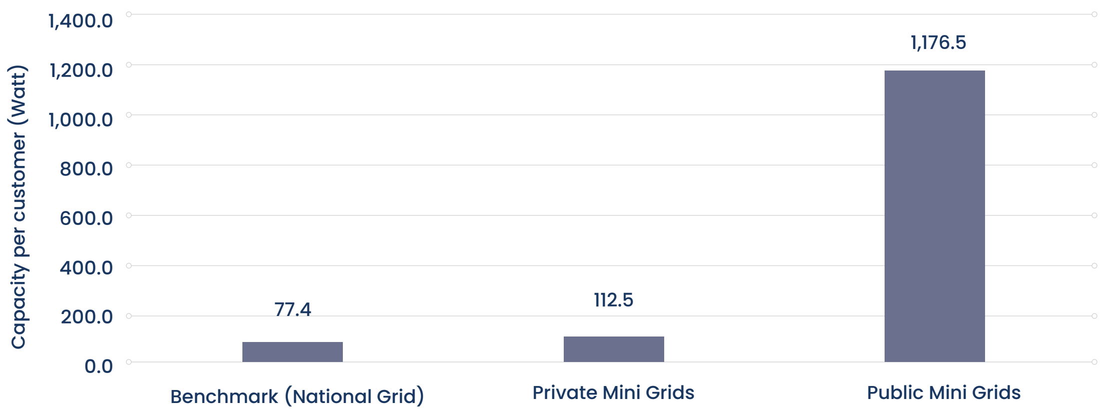
$$Per - customer\ Capacity\ \left(\frac{Watt}{customer}\right) = \frac{Mini - Grid\ Capacity\ (kW) * 1000}{Number\ of\ Customers}$$

For benchmarking, the per capita generation capacity of Kenya's national grid was also calculated as follows:

$$Per - customer\ Capacity\ \left(\frac{Watt}{customer}\right) = \frac{Grid\ Generation\ Capacity\ (kW) * 1000}{Population * Electrification\ Rate\ (\%)}$$

Based on a grid generation capacity of 3,321 MW,[20] a total population of 53.43 million, and an electrification rate of 76%,[21] the per-customer power capacity was 77.4 Watts/customer.[22] The following figure compares the median per-customer capacity (in Watt/customer) for public minigrids, private minigrids, and the national grid.

Figure 13: ***Capacity per customer (in Watt)***



Customer coverage can therefore be inferred from the capacity per customer simply by dividing a reference capacity (e.g., 1 kW) by the capacity per customer to obtain the number of customers covered per kW of capacity. The higher the customers covered per kW, the higher the coverage. The following equation illustrates the calculation of the customer coverage.

$$Coverage\ \left(\frac{customers}{kW\ of\ capacity}\right) = \frac{1\ kW * 1000}{Per - customer\ Capacity\ (\frac{Watt}{customer})}$$

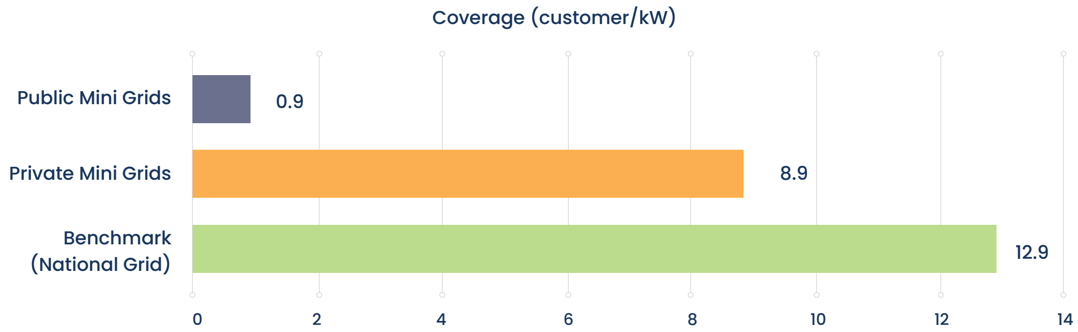
The following bar chart illustrates the coverage of public and private minigrids, compared to the reference coverage (national grid).

[20] International Trade Administration, Kenya – Energy-Electrical Power Systems. U.S. Department of Commerce.

[21] World Bank, Access to electricity (% of population) – Kenya (2024).

[22] For the purpose of this analysis, one customer is assumed to be a single person.

Figure 14: Customers coverage (number of customers per kW)



As can be seen, the coverage of private minigrids is higher than public ones, and is closer to the benchmark (national grid coverage), indicating either a more efficient sizing strategy or fewer barriers to customers' connection than public minigrids.

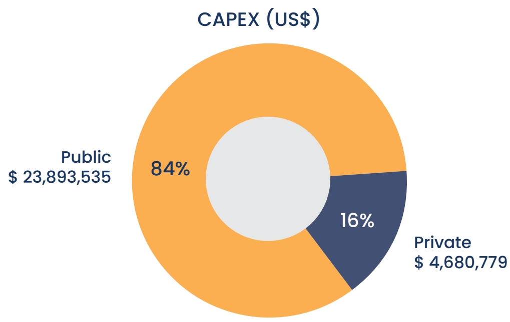
6.4.3 Capital expenditure (CAPEX)

The main items falling under capital expenditure costs are:

- Plant and equipment
- Transportation and logistics
- Construction supervision
- Electrical distribution network
- Testing and commissioning

The total CAPEX investment made in both public and private minigrids amounts to approximately $28.57 million. The majority of investment, about $23.89 million, is in public minigrids, representing about 84% of the total investment, as opposed to $4.68 million in private minigrids, representing the remaining 16%. The following figure illustrates this investment split.

Figure 15: CAPEX investments - public and private minigrids ($)



6.4.4 Operational expenditure (OPEX)

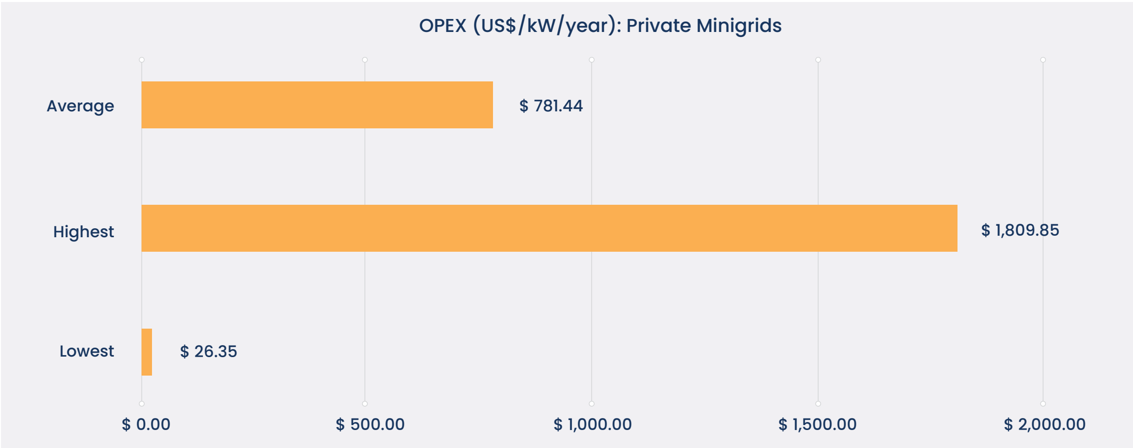
The OPEX comprises the following main items:

- Staff remuneration
- Maintenance (regular and corrective)
- Utilities (water, waste disposal, etc.)
- Miscellaneous costs

Figures 16 and 17 summarize the average, highest and lowest sampled parameters of the specific OPEX data (in $/kW/year) for private and public minigrids.

A: Private minigrids

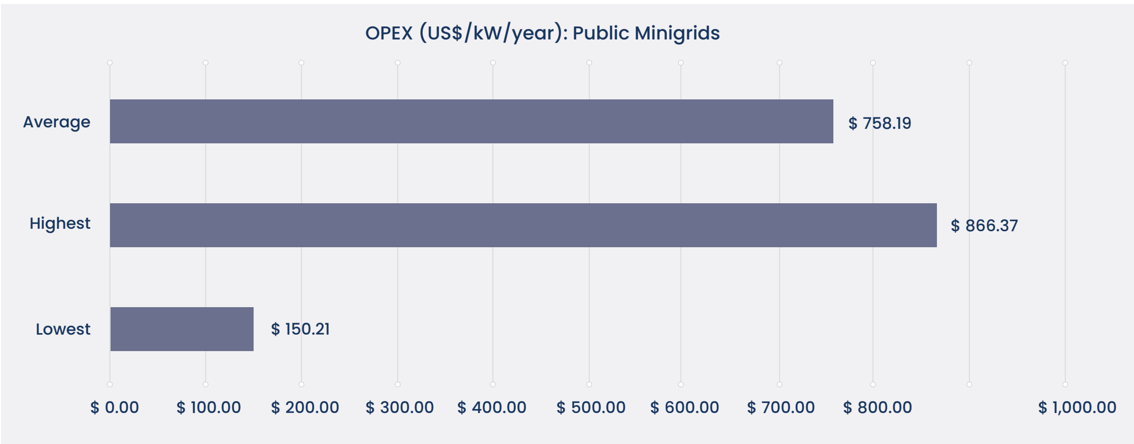
Figure 16: OPEX ($/kW/per year. Private minigrids



From the visual above, private minigrids sampled had the highest and lowest values of $1,809.85 and $26.35, respectively in terms of annual OPEX costs per kW basis. This is a huge spread, given that different developers have varying levels of maturity and internal efficiencies. The average is then about $781.44.

B: Public minigrids

Figure 17: OPEX ($/kW/per year. Public minigrids

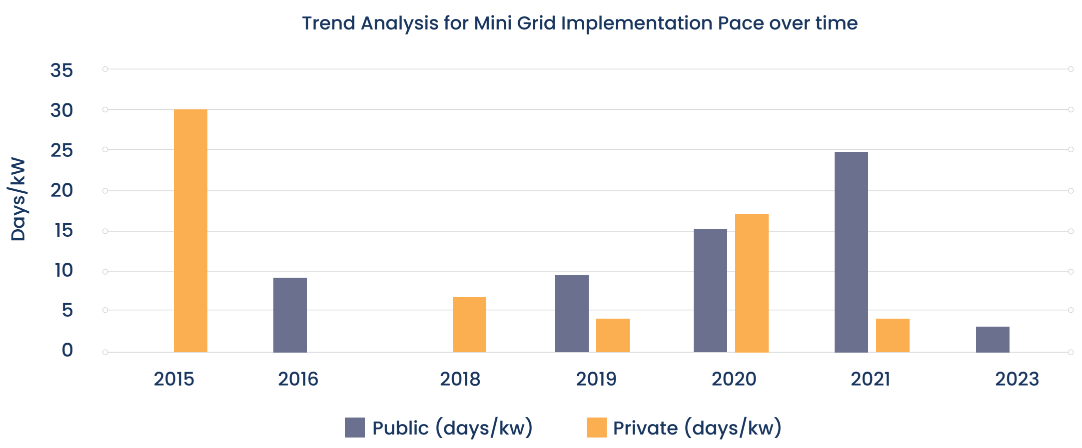


On the other hand, from the visual above, public minigrids sampled had the highest and lowest values of $866.37 and $150.21, respectively, in terms of annual OPEX costs per kW basis. This translates to an average of $758.19, which is skewed by the OPEX of less efficient sites.

6.4.5 Implementation duration (pace)

The collected data included the implementation duration of different sizes of minigrids. To normalize the data, the implementation duration was divided by the size of the plant in kW. Therefore, the analysis is done using the derived metric of implementation days per kW of capacity. In summary, the average duration (in days per kW) of implementing private minigrids is lower than that of public minigrids, indicating a faster pace in private minigrids implementation. However, there is a noticeably higher variation across different private sector project durations, reflecting more uncertainty in procurement time (e.g. uncertain equipment purchasing lead time), which could imply dealing with different suppliers for dissimilar projects.

Figure 18: A trend analysis for minigrid implementation pace over time



Further, Figure 18 above compares how the minigrid implementation pace/timeline has evolved between private and public minigrid projects. Private minigrids in 2015 took an average of 29.73 days/kW compared to 4.08 days/kW to implement in 2021. For public minigrids, there was a steady increase from 2016 to 2021, where it peaked at 24.73 days/kW. It is likely that the 2020 and 2021 periods adversely affected government-run projects due to the Covid-19 pandemic. It probably shows that private minigrid players adapted better to the pandemic aftershocks, at least in terms of procurement, construction, and overall implementation.

Also, during the pandemic, there were efforts by donors like the World Bank to increase liquidity by designing the Covid-19 Energy Access Relief Fund (EARF), which benefited some off-grid companies across the continent.[23] Other advocacy efforts by AMDA and other associations ensured private minigrid operators were categorized as essential services by the government, thus ensuring continuity of project implementation.

[23] World – COVID-19 Energy Access Relief Fund Project: Environmental and Social Review Summary.

Cost Benefit Analysis

Photo Credit: Hydrobox

7. Cost Benefit Analysis: Public vs. Private Minigrids

7.1 Analysis parameters

This chapter analyzes the initial investment costs, connection fees, future management and operational expenses, and reliability to evaluate the cost-effectiveness of producing a unit (kWh) of electricity. It includes an in-depth examination of various financial indicators related to project performance. To conduct the in-depth analysis, the following parameters were employed:

1. Project size – Refers to the capacity of the minigrids measured in kWp.
2. Initial investment cost – This represents the total cost of designing, procuring, and installing the minigrids.
3. Connection fees – Covers the last-mile costs for connecting power to end users.
4. Operations and maintenance cost – Denotes the annual expenses required to maintain the minigrids.

To guide the creation of a structure for a company`s financial future, the assumptions below were applied during the financial modeling:

1. 15% annual capacity factor – This represents the ratio of actual power generation to the maximum possible generation from the minigrids.
2. Battery replacement cost in year 7 – It is assumed that batteries will need to be replaced in the seventh year.
3. Discount rate – A discount rate of 12% was applied.
4. Revenue tariff – A tariff of 0.16 was used for public minigrids and 0.56 for private minigrids.
5. Project life – The lifespan of the project is assumed to be 20 years, which is in line with the typical economic life of electricity generation equipment (solar PV modules) and electricity distribution infrastructure and at the same time in line with the maximum Power Purchase Agreement period of the project given by EPRA.

7.2 Analysis findings

The table below summaries the findings of the cost benefit analysis.

Table 4: Minigrids financial model analysis

Mini-Grids Financial Model - DASHBOARD					
Description	Unit of Measurement		Model-Public	Model Private A	Model Private B
Inputs					
Project Installed Capacity	kWp		1,865.00	875.39	200.06
Annual Capacity Factor	%		15%	15%	15%
Spares Cost at year 7	USD		1,096,477	690,204	215,986
Discount Rate (for DCF)	%		12%	12%	12%
Revenue Tariff	USD/kWh		0.16	0.56	0.56

Annual Units Generation	kWh		2,450,610	1,150,262	262,879
1. Capital Expenditure (CAPEX):	USD		16,042,151	3,546,468	1,488,807
2. Operating Expenditure (OPEX):	USD/year		1,032,743.8	52,303.0	72,678.7
3. Cost per kW Installed:	USD/kWp		8,601.69	4,051.30	7,441.80
4. Cost per kWh Generated: LCOE	USD/kWh		1.32	0.49	1.08
Cost per annum	USD		1,032,744	52,303	72,679
Cost per kWp	USD/kWp		553.75	59.75	363.28
5. Payback Period:	No. of Years		(25.19)	5.99	19.98
6. Internal Rate of Return (IRR):	%		-	16%	-1%
7. Net Present Value (NPV):	USD		(21,081,563)	826,506	(1,030,148)
8. Capacity Utilization Factor (CUF):	%		15%	15%	15%
9. Revenue per kWh:	USD/kWh		0.16	0.56	0.56
10. Subsidy/Grant Dependency:	%age of project cost in subsidy		Yes	Yes	Yes
11. Debt-to-Equity Ratio:	%				
12. Energy Efficiency Ratio (EER):	%				
13. Project Delivery Time:	Months		22	13	13

Based on the financial data from the minigrids financial model, the following analysis covers the Net Present Value (NPV), IRR, project duration, and payback period for three different models: one public model, and two private developers' models, subsequently stated as private minigrid A and private minigrid B.

1. Net present value

For public minigrids, there is a cumulative negative NPV of $21,081,563, indicating that the project would lead to a financial loss over its lifetime.

Private minigrid A has a positive NPV of $826,506, suggesting that the project is expected to generate value over its lifespan and is financially viable.

However, private minigrid B has a negative NPV of $1,030,148, indicating that it would incur a loss over its lifetime. This is typically due to low utilization rates (a factor of low consumption due to low productivity and low aggregate connections). To enhance NPV, the minigrid developer can increase customer connections to increase revenue collections and use more remote monitoring systems to reduce O&M costs. Additionally, the organization can promote the adoption of productive uses of electricity to increase the capacity factor of the system.

2. Internal rate of return

The public minigrids have a negative IRR, indicating that the project is not expected to generate returns at a rate sufficient to cover the cost of capital.

Private minigrid A has an IRR of 16%, suggesting that the project's returns, expressed as a percentage, exceed the discount rate of 12%.

In contrast, Private minigrid B has a negative IRR of 1%, which indicates that the project is not anticipated to yield returns adequate to cover the cost of capital despite having a positive NPV. This suggests that while the project may be viable in terms of total returns, it may fall short of meeting investors' expectations for return rates.

3. Payback period

The public minigrids have a payback period of 25 years, indicating that it will take more than 25 years to recover the initial capital investments.

In contrast, Private minigrid A has a payback period of 6 years, while Private minigrid B has a payback period of 20 years.

4. Duration of project

The public minigrids require nearly 22 months to complete installation and become operational, whereas private minigrids A and B take approximately 13 months.

The public minigrids require nearly 22 months to complete installation and become operational, whereas private minigrids A and B take approximately 13 months.

7.3 Public sector comparator (PSC)

The Public Sector Comparator (PSC) is a metric used by governments to inform decisions related to undertaking a specific project via public procurement. It estimates and compares the hypothetical risk-adjusted cost of a project under two scenarios: if it were owned, financed, and constructed by the public sector; and a case where the project is implemented via a private sector investment and the government procures only the project outcomes.

The most important factors that PSC analysis takes into consideration are the cost of capital, operational efficiency, sensitivity to price escalation, and risk adjustments. In the case of minigrid, the factors considered are:

- The construction cost of the minigrid.
- Profit margin of undertaking the project (Assumed for the public sector).
- Operation and maintenance costs over the project`s useful lifetime (assumed to be 10 years).

The total lifetime cost of the minigrid project is simply the sum of the costs highlighted above (i.e. estimated at $22,912 for public minigrids and $14,0228 for private minigrids). To determine whether it makes sense to undertake the project via private sector investment as opposed to public sector procurement, the 'value for money' is calculated as the lifetime cost of the public sector option minus the lifetime cost of the private sector option. If the value for money is positive, the private sector option is more cost-effective.

The following table illustrates the PSC analysis done for implementing a minigrid.

*Table 5: **Minigrids financial model analysis***

Description	Public	Private
Profit Margin/Risk Premium	0	$2,011
O&M Costs (cumulative over 10 Years, 10% annual escalation)	$13,808	$4,614
Total Lifetime Cost	$22,912	$14,028
Value for Money (difference between lifetime costs of both options)	$8,883	

Based on the above analysis, as value for money is positive, it makes more sense to encourage the participation of the private sector in building minigrids, as opposed to implementing them through public sector procurement.

Conclusion

Photo Credit: Renewvia Energy

8. Conclusion

This analysis provides a clear comparative view of public and private minigrid performance across key dimensions:

- CAPEX Efficiency: From an investment perspective, the public minigrids emerge as the less attractive option financially, characterized by a significantly negative NPV and IRR, along with the longest payback period of over 25 years. On the other hand, private minigrids show a decent IRR of 16%.
- OPEX Efficiency: The operational expenditures of private and public minigrids are closer, with an average of $781.44/kW/year, and $758.19/kW/year for private and public minigrids, respectively. However, given the current budget constraints in the Kenyan government, the operational sustainability of publicly run minigrids carries a high perceived risk.
- Implementation Period: The average implementation durations for public and private minigrids are 10 and 8.85 days per kW installed, respectively. Nonetheless, private minigrid data exhibit a higher variation, reflecting more uncertainty in procurement time. This high variation can disproportionately affect local developers, who typically do not have the liquidity to absorb longer-duration project development cycles.
- Customer Coverage: Customer coverage is significantly better for private minigrids, which cover around nine customers per kW installed, as opposed to only one customer per kW for public minigrids. This insight shows that a dollar of CAPEX subsidy to a private developer achieves a higher impact threshold (i.e. 9X) compared to a similar sized publicly owned minigrid.
- PSC Analysis: A simplified PSC analysis confirms a positive value for money, indicating more effectiveness in implementing minigrids via the private sector as opposed to public sector implementation.

In this analysis, the private sector demonstrates higher cost efficiency, broader customer reach, and more sustainable project economics in minigrid delivery, highlighting its important role in advancing Kenya's electrification goals.

A simplified PSC analysis confirms that investing through the private sector yields better value for money. Going forward, policy and financing frameworks should reflect this efficiency gap and prioritize scalable, private-sector-led solutions.

In this analysis, the private sector demonstrates higher cost efficiency, broader customer reach, and more sustainable project economics in minigrid delivery, highlighting its important role in advancing Kenya's electrification goals.

Key Recommendations

Photo Credit: REREC

9. Key Recommendations

Based on the comparative analysis conducted through this study and the findings thereafter, this research proposes the following collaborative interventions going forward:

- **Refining regulations to improve project implementation timelines:** Minigrid regulations need to be adapted to reflect the decentralized nature of the industry. Portfolio or regional licenses, streamlined and digitized processes, smart and remote monitoring technologies, and regulatory offices equipped to approve hundreds of applications a year. Further, there may be a need to support local developers with fast-tracked approvals for smaller sites to compete with international counterparts.

- **Implementing data-driven government approaches to subsidy funding targeting private minigrids:** From the KNES, $33.1 million in minigrid capital expenditure is required as part of the national electrification strategy, with an annual subsidy element of about $3 million. As the results have shown that private minigrids have a better performance in terms of lower CAPEX, OPEX, and implementation period, as well as higher customer coverage, it would be sustainable to allocate a higher subsidy budget (both supply and demand side (if any) to private minigrid pipeline to leverage on this impact.

  While the government may have its constraints, it certainly has the goodwill of many bilateral and multilateral donors that can support shaping the narrative towards more subsidies for private minigrids. Moreover, such market data from AMDA members can be used to regularly update the amount of public investments needed for both supply side and demand subsidies in future iterations of the KNES report. Given that the KNES report was dated 2018, and the country has not met its universal electrification targets as of 2022, the data feeding into the INEP needs to be updated with current realities (and not of 2018).

Given that the KNES report was dated 2018, and the country has not met its universal electrification targets as of 2022, the data feeding into the INEP needs to be updated with current realities (and not of 2018).

- **Reconstitution of current working groups to absorb other sector players:** More collaborative policy development must be encouraged in future updates to the INEP and KNES. For instance, representation from government agencies, private developers, industry associations like AMDA and Kenya Renewable Energy Association, key minigrid investors and donors, as well as policy think tanks such as the World Resources Institute (WRI) and Strathmore Energy Research Centre (SERC). Involvement of such players in the broader conversation can help in the scaling up of minigrids in the following ways:

  - AMDA, as a champion for data-driven advocacy, can support the government through its access to granular and aggregated data from its Benchmarking Africa Minigrids reports and provide real-time comparison between minigrid cost data between Kenya and other markets.

  - Minigrid Developers (local and foreign) have first-hand knowledge of evolving trends, e.g. technologies, customer needs, and investor expectations. Thus, they can provide an on-the-ground perspective on what works and what does not.

- o WRI has been instrumental in market development in the global south including, Kenya. WRI has developed the Energy Access Explorer, an interactive online platform on energy access across Africa and Asia.[24] Indeed, such tools can be low-cost sources of geospatial and anecdotal data for the government as it updates policy. WRI also works with governments and funds convening sessions and conferences that bring stakeholders together. Other tools include ESMAP's data, Access to Energy Institute (A2EI),[25] and Odyssey, which provide remote monitoring technology for the planning and implementation of off-grid projects.

- o SERC has been supporting some counties to develop county energy plans, thereby giving life to the concept of devolution of energy as per the aspirations of the Kenyan constitutions. Given the need to involve County governments, such partners can act as knowledge nodes between the national and local governments.

Investors and donors provide the capital needed to unlock electrification. The policy must be continuously aligned to meet capital providers' bankability expectations. For instance, given World Bank's ASCENT program is managed in Kenya, the INEP must become attractive for such capital. One way is to incorporate PUE analysis and update population metrics to come up with an up-to-date total addressable market. Other initiatives that could have an impact on the flow of funding into Kenya are CEI Africa (one-stop-shop vehicle offering debt, RBF, and technical assistance into off-grid projects including minigrids) and Mission 300 (a joint initiative by Global Energy Alliance for People and Planet (GEAPP), Rockefeller Foundation, Sustainable Energy for All (SEforALL),[26] the World Bank and African Development Bank (AfDB) to electrify 300 million people by 2030).

- **Explore the potential for enhanced PPP:** While programs like KOSAP and tenders under last-mile connectivity are sighted as successful examples of PPPs between KPLC, REREC, and private developers, it will be more strategic if such partnerships can be explored beyond traditional time-bound build and transfer models. Some of the areas of PPP that can be enhanced include:

  - o Joint project development: In the past, there have been separate top-down and bottom-up approaches to site development between public and private sector players that have led to delayed project implementation. For instance, one developer learned quite late that some of their target minigrid sites under development were selected for the KOSAP initiative. At the time, they were fundraising from private investors. Hence, they had to look for other complementary sites so as not to lose funding. Nonetheless, this process had effectively delayed construction. Exploring joint development efforts can be one way of eliminating such risks. An example is in Nigeria where Kano Electricity Distribution Company (KEDCO), one of the 11 public Distribution Companies (DISCOs) announced opportunities for partnerships with private renewable energy companies to install minigrids in its concession region.[27] KEDCO, in the past, partnered with Konexa, a private company on an energy franchise model.[28]

  - o Network management and O&M partnerships: Private minigrid players have

[24] Energy Access Explorer

[25] Access to Energy

[26] The Rockefeller Foundation, Mission 300.

[27] ESI Africa, Nigeria: DisCo and renewable energy companies to set up solar mini-grids.

[28] Kano DisCo signs MoU with Konexa to deploy renewable energy solutions.

technical teams in remote regions that can be leveraged to support the public minigrids and even the main grid (KPLC) in remote regions where they operate. For instance, private developers' competence can be activated when there is downtime and be quickly deployed to the site for troubleshooting. Some private developers can provide O&M services to public minigrids at a more effective cost than the current OPEX/kW that public minigrids are experiencing, as shown in the data.

- Shared learnings on PUE: Private developers generally have shown more expertise in demand stimulation activities like deploying PUE appliances like home appliances, cold chain infrastructure, electric cook-stoves, milling, e-mobility, egg incubation, and internet services. Such developers can be strategic partners to support the public sector in incorporating a holistic commercial and customer service approach to their projects. Going forward, it may be prudent to update future iterations of the KNES with relevant PUE contexts to enhance the perspective of how minigrid CAPEX and OPEX costs can be optimized when PUE is taken into account.

Going forward, it may be prudent to update future iterations of the KNES with relevant PUE contexts to enhance the perspective of how minigrid CAPEX and OPEX costs can be optimized when PUE is taken into account.

- Bulk procurement partnerships: The CrossBoundary Innovation Lab conducted a research and development prototype around bulk procurement across various private developers. The results showed that developers saved 24% on PVs and 40% on batteries. This was apart from volume discounts, which were additional savings due to logistics.[29] This shows bulk procurement can further de-risk projects by lowering CAPEX costs. Such initiatives can catalyze additional investments into a market. For instance, because of the success of the trial, the GEAPP launched a $10 million Demand Aggregation for Renewable Technologies (DART) platform for developers in Nigeria. Coming back to Kenya, one way to explore bulk procurement is a collaboration between EPCs supporting KOSAP and EPCs and private developers implementing other projects such as those funded by initiatives like CEI Africa, and KKCF.

[29] CrossBoundary, Prototype on bulk procurement – Mini-Grid Innovation Lab.

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Photo Credit: Nal Offgrid Ltd

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11. Annexes

Annex 1: Technical and financial data collection form

This form sought to assess the key inputs, outputs, assumptions, and scenarios for a typical minigrid project to compute the cost and pace comparison aspects between public and private minigrid developers.

No	Information Type	Description	Response
1	Date of minigrid evaluation		
2	Name of Plexus Energy Official		
3	ID/No.		
4	Signature		
5	Tel.		
6	Name of County, minigrid owner/ operator, leader		
7	ID/No.		
8	Signature		
9	Tel.		
10	Name of minigrid		
11	Minigrid No.		
12	Minigrid owner		
13	County		
14	Sub-County		
15	Constituency		
16	Ward		
17	Village		
18	Total number of customers		
19	GPS location		
20	Land area (size and distance from county HQs)		
21	Existing infrastructure (e.g. road, & distance to grid)		
22	Diesel price		
23	Date of construction (commencement)		
24	Name of contractor		

25	Minigrid construction	Describe minigrid configuration	
26	Date of completion and commissioning		
27	Technical design capacity (Plant) and brand	Solar array (kWp)	
		Inverter (kW)	
		Inverter charger (kW)	
		Battery size(kWh/Ah)	
		Generator (kW or KVA)	
		Single Phase or 3-Phase	
28	Distribution network	Network length (Km)	
		Network voltage (V)	
		Actual connected customers	
		Type of metering	
		Tariff model/scheme in use	
29	Energy demand information		
	Solar plant output	Daily/Month (kWh)	
	Customer information	Name	
		Address (GPS coordinates)	
		Type of meter	
		Connection fee paid	
		Tariff category and scheme	
		Daily/monthly consumption (kWh)	
		Monthly expenditure on electricity from minigrid	
		Frequency of power outages	
		Power restoration time	
30	Financial information (By minigrid developer/owner)		
	Financial investment factors	Weighted Average cost of Capital (WACC) if available	
	Investment costs	Cost of solar PV	

		Inverters	
		Inverter chargers	
		Batteries	
		Diesel generator	
		Balance of Plant (BOP)	
		Civil works	
		Connection cost	
		Additional project cost	
	Operation and maintenance costs	Operating costs (technical personnel)	
		Maintenance	
		Cost of diesel fuel	
		Annual cost increase	
		Annual plant maintenance	
		Land lease cost per year	
		Insurance cost per year	
		Security	
		Plant down times monthly/yearly and duration	
31	Other Information	Annual increase of demand (%)	
		Annual degradation of modules (%)	
		Solar PV + Generator OPEX costs share (%)	
		Plant life (Years	
32	Loan (where applicable)	Debt (KSh/USD)	
		Equity (KSh/USD)	
		Cost of debt (%)	
		Corporate Tax (%)	
		Debt Term (Years)	
		Grace period during construction (Years)	
		Discount rate (%)	
33	Approved regulator (EPRA) tariff	Tariff	
		Escalation component of tariff	

Annex 2: KII questionnaire template

The questionnaire below was shared with KIIs and sought to address the information gaps that were needed to meet the objectives of the study:

No	Information Category	Response
A	**Procurement Process**	
1	What was the procurement process followed for the procurement of the minigrid?	
2	Were there any specific regulations/guidelines followed during the procurement process?	
3	How many minigrids were procured and their capacities in kW if they are many? Kindly share a list.	
4	How long did it take from advertisement to award of contract/ contract date of the minigrid?	
5	Did you face any challenges during the procurement process?	
B	**Capital Costs**	
1	What was the total capital cost investment for establishing the minigrid? If several share a list.	
2	Breakdown of capital costs	
	Equipment	
	• Solar PV modules	
	• Inverters	
	• Batteries	
	• Diesel generator	
	• Balance of Plant (BOP)	
	• Distribution network	
	• Additional project cost	
3	Were there any unexpected expenses during the implementation?	
C	**Connection Fees**	
1	How many customers are connected to the minigrid?	
2	What are the connection fees charged to customers for accessing the minigrid?	
3	Are there any subsidies or financial assistance schemes available for customers?	
4	How are connection fees determined, and have they changed over time?	
D	**Implementation Process**	
1	How long did it take for construction of the minigrid to be completed (Contract sign date to commissioning)?	
2	Were there any costs involved, e.g. supervision, commissioning, Give figures.	
3	Were there any challenges faced during the implementation?	
E	**Operations and Maintenance**	
1	Do you operate and maintain the minigrid or you contract out the service?	

2	If O & M is contracted out, is there a Service Level Agreement with the contracted operator?	
3	What is the cost of diesel fuel?	
4	What is the annual plant maintenance cost?	
5	What is the annual cost increase?	
6	In-case of a fault with the system, how long does it take rectify the fault?	
7	What is the annual PV power output reduction due to solar modules degradation and other factors?	
8	What challenges do you face in the operations and maintenance of the minigrid?	
F	**Time Taken**	
1	How long did it take from the initiation of the project to the commissioning of the minigrid?	
2	Were there any delays during the implementation process, and if so, what were the main reasons?	
3	How does the actual implementation time compare to the estimated time?	
G	**Comparison and Lessons Learned**	
1	In your opinion, what are the main advantages of private sector-led minigrid development?	
2	Conversely, what are the main advantages of public sector-led minigrid development?	
3	What are the key lessons learned from your experience in implementing the minigrid project?	
H	**Policy, Legal and Regulatory**	
1	Do you have a policy governing the development of minigrids in the Country?	
2	Is there a legal framework governing the development of minigrids in the Country?	
3	Are there regulations in place for the development and operations of minigrids?	
I	**Additional Comments**	
1	Is there any additional information or insights you would like to share regarding the minigrid project?	

Signatures

Name of Organization...

Interviewee Name..

Signature..

Date..

Plexus Energy Ltd Officer Name..

Signature..

Date..

AMDA

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