UKRI – GCRF SIGMA Project

Sustainability, Inclusiveness and Governance of Mini-grids in Africa

KENYA FIELDWORK REPORT

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SIGMA Fieldwork Report No. 1

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The views expressed in this report are those of the authors and do not necessarily represent the views of the institutions they are affiliated to or the funding agencies.

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ACRONYMS

CBOs	Community Based Organisation
CEP	County Energy Plans
CIDP	County Integrated Development Plan
CSR	Corporate Social Responsibilities
ECOWAS	Economic Community of West African States
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EPRA	Energy Petroleum Regulatory Authority
FGD	Focus Group Discussion
ICFI	International Centre for Frugal innovation
KOSAP	Kenya off Grid Solar Access Programme
KPLC	Kenya Power and Lighting Company
KW	Kilo Watt
MOU	Memorandum of Understanding
NETFUND	National Environment Trust Fund
PMC	Project Management Committee
PUE	Productive Use of Electricity
REA	Rural Electrification Authority
REREC	Rural Electrification and Renewable Energy Corporation
SIGMA	Sustainability Inclusiveness and Governance of Minigrids in Africa

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DEFINITION OF TERMS

Mini grids: A set of small-scale electricity generators interconnected to a distribution network that supplies electricity to a small-localised group of customers

Inclusiveness: providing equal access to opportunities and resources for people who might otherwise be excluded or marginalised

Connected: households, businesses or institutions that have paid and are using the electricity from the mini grid

Unconnected: households that are not using the electricity from the mini grid for their operations

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INTRODUCTION AND BACKGROUND

ICFI-Kenya Hub is part of a consortium implementing a 3-year research project titled "Sustainability, Inclusiveness and Governance of Mini-grids in Africa (SIGMA) funded by UK Research and Innovation-Global Challenge Research Fund. This is a collaborative project involving partners from the United Kingdom (University of Sussex, the Open University and De Montfort University), TaTEDO in Tanzania, International Centre for Energy, Environment and Development in Nigeria and the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) in West Africa. The main objectives of the project are to:

- Develop an evidence base on mini-grid performance in Sub-Saharan Africa;
- Develop a framework to analyse political economy of energy access and sustainability framework of mini grids; and
- Undertake in-depth case studies of mini-grid sustainability, inclusiveness, and governance in for countries of sub-Saharan Africa (Kenya, Tanzania, Senegal, and Nigeria).

ICFI Kenya hub is to provide data for the "Sustainability, Inclusivity and Governance of Mini-grids in Africa" work package taking care of the Kenyan geographical context.

METHODOLOGY

Research design

This study adopted an embedded case study design, where we considered Kenya as a case study, with a focus on several embedded units, which informed the fieldwork exercise.

Research area

The field visits were conducted in the Counties of Kajiado, Siaya, Homa bay, Kisii, Busia, Turkana and Murang'a.

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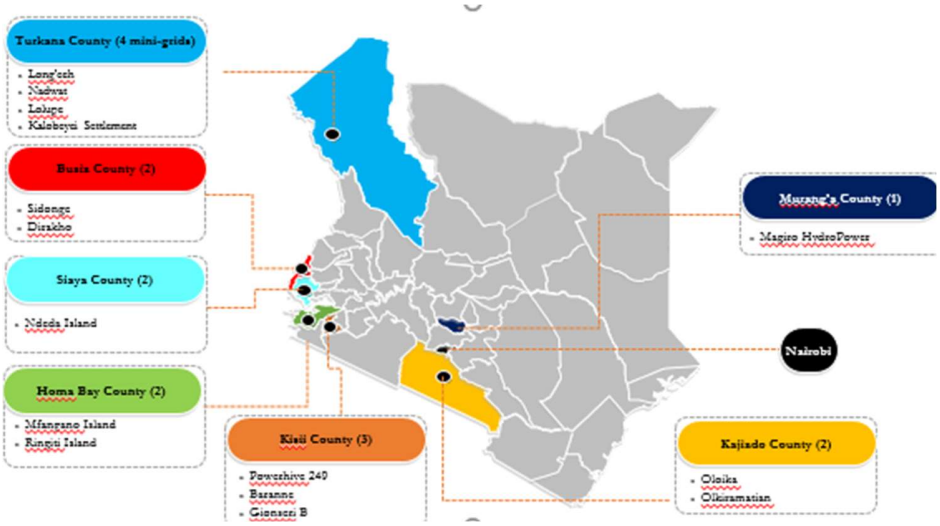

Figure 1: Map of Kenya indicating counties visited for fieldwork

Data collection

To achieve the objectives of the work package, data collection was necessary. A fieldwork protocol was developed outlining the data collection plan as discussed below.

Data collection plan

As per the fieldwork protocol, we targeted to collect data from 20 mini grids across selected counties. The selection of the mini grids was based on the matrix presented in Table 1 according to technology and ownership type.

Table 1: Matrix of targeted mini grids in each country

		Ownership model					
		Publicly owned	Privately owned	Public Private Partnership	Community owned	Other (e.g. faith-based organisation)	TOTAL
Technology	Hydro	1		1	1	2	5
	Solar PV		3		3		6
	Fuel oil	2	2				4
	Geothermal						0
	Biomass		1				1
	Natural gas	1					1

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	Wind		1				1
	Hybrid		2				2
	TOTAL	4	9	1	4	2	20

From these sites, we conducted focus group discussions and interviews with key informants and households. Key informant interviews were conducted with mini grid developers/operators, county government officials in charge of energy, and community leaders such as members from the management committee e.g. chairman and secretary. Users of the mini grids such as households, enterprises and community facilities were interviewed using semi structured questionnaires. We interviewed ten (10) connected and five (5) unconnected households. Five (5) enterprises were also interviewed per minigrid, focusing on different types of business (e.g., general shops, barber shops, salons, posho mills, video halls, guest houses, welding workshops, among others). Community facilities such as schools, health centres, vocational training colleges, community library were also interviewed where possible. Focus group discussions were conducted with the mini grid users. The criteria for conducting the FGDs considered planned mini grid/under development, in an existing mini grid and in a decommissioned/non-operational mini grid.

Questionnaire

We developed semi-structured questionnaires targeting household connected to the mini-grids and those not connected to the mini-grids, productive users such as business enterprises that were connected to the mini-grid and institutions such as schools and health facilities. The aim was to collect their views on their energy use, expenditure, inclusivity and community participation, benefits derived from the connection for those who are connected etc.

The questionnaires development process was iterative. The development of the questionnaires considered different variables including household demographics and income, energy use, energy cost, electricity connection cost, electricity stability, reliability, payment systems, and participation during mini grid development and during operation and communication channels. The software we used was the free version of the *Kobotoolbox* (*survey form building and data storage*) and ODK (*data collection app*). The form building was done in-house and the ODK app was downloaded from Google Play Store and configured to the *Kobotoolbox* server.

Lessons learnt during questionnaire development

The process of developing the survey questionnaires and building them on *kobotoolbox* was smooth except for some few issues. First, the software (*kobotoolbox*) had some technical shortcomings, which created some challenges as we were creating the questionnaire. This platform lacks some advanced options (e.g.) found in other sophisticated software such as SurveyCTO. Secondly, some survey questions were complex in nature therefore developing the survey forms proved to be challenging. To deal with this, the questions were simplified but ensuring the objective of the research was maintained. Third, late changes made to the questionnaires were also a source of delays and paused challenges to the form building process. Furthermore, software problems could lead to system hiccups in the middle of an interview, and it was a challenge moving forward with the interview.

In addition, during the fieldwork, the *kobotoolbox* was to be continuously enhanced and updated in the field and this led to too many changes, which led to some inconsistencies, as some submitted forms were slightly different from the others. Few coding errors and last-minute questionnaire modifications forced these changes. These hiccups led to delays in the start of the actual fieldwork in the field. Another problem faced in the field was the constant need to charge the tablets once they ran out of power. We however solved this challenge by using power banks. Editing the forms once they have been uploaded into the system proved to be a challenging and the problems arise from the platform itself. However, despite these challenges, data collection using the tablets was very much advantageous than using paper questionnaire.

i. Tablets provide much needed anonymity and confidentiality in research.
ii. Using tablets ensured that the data was safe from the possibility of data loss or damage even in the event where the tablet is broken or lost. This is because some tablets were set in such a way that the forms were submitted automatically to the protected server.
iii. They facilitated real-time data storage and access
iv. These tablets were easy and less cumbersome to carry around, and we had no worries of accounting for every questionnaire.
v. Use of tablets also saved us the cost of printing the paper questionnaires.
vi. The use of tablets ensured efficiency in data collection since less time was used while collecting the data compared to writing responses on paper questionnaires.
vii. Programming of questionnaires in *kobotoolbox* can reduce or minimize errors in data collection. For instance, it can allow for setting limits e.g. on age; determine whether a response has to be a numerical or alphabetical, selection of one or multiple options, ensuring all questions are responded to.

Every researcher on the team had good knowledge on use of the tablets and use of *kobotoolbox*.

Recommendations

The advantages of using of electronic data collection systems (tablets in our case) outweighs the disadvantages encountered. We recommend the following:

- Building the questionnaire into the *kobotoolbox* is an arduous and time-consuming task, which should be completed fully before the actual fieldwork begins.
- A more advanced software (*form builder and server*) should be adopted to avoid the recurrence of the technical challenges outlines in the previous section
- Once the actual fieldwork has begun, no changes should be made on the questionnaire, as this proves to be time consuming and leads to inconsistencies.
- It is important to have internet connection during the fieldwork as it is important in ensuring the tablets have internet connection for timely forms downloading and uploading.
- It is important to have a backup source of power for the tablets i.e., extra tablets or power banks as in our case.

Interview guides

We developed interview guides targeting mini grid operators, community leaders and County Energy Department representatives in the respective counties visited. Other key informant interviews conducted were with government agencies such as the Ministry of energy, REREC, mini grid financiers, In addition, we developed an interview guide for use during the FGD sessions in selected sites.

Planning for the key informant interviews

We made prior arrangements before conducting the interviews. After identifying the key informants, we did formal communication through emails and phone calls to request for an interview and book appointments with the respective persons. In most cases, the interviews were successful. In some cases, we received no response and therefore such interviews could not be conducted. For those who accepted our requests, we agreed on an appropriate date of the interview either in person or virtually.

Planning for FGD, how they were conducted, and outcomes in general, lessons

Planning for the focus group discussions (FGD) involved setting up a criterion for the selection of the participants, their mobilisation and eventually conducting the discussion. The criteria followed was: to conduct an FGD in a site with an operating mini-grid, one with a mini-grid under development and one that is decommissioned /non-operational.

The composition of the discussants ensured representation from the different segments in the community with the number ranging from 10-15 discussants. These included males, females, youth, and a community leader. Among the discussants also included members who were either connected or not connected to the mini grid. Mobilisation of the discussants in most cases was done by the mini grid operators. This may have led to a bias in the selection of the discussants against the criteria provided. However, in Mfangano Island and Baranne, the Area Chief did the mobilisation. Generally, the discussions went on smoothly with much of what was intended for the discussion covered.

At the end of the fieldwork, we managed to conduct four FGDs, three of which were in operational sites and one in a decommissioned site. These were conducted in Mfangano island (Homa Bay County), Lolupe (Turkana County), Magiro Hydro mini grid (Murang'a County) and Baranne (Kisii County). However, there was no FGD conducted in a site under development. KUDURA Power East Africa has sites that they intend to install mini grids. However, we could not conduct an FGD in those sites since the officers at KUDURA advised that this would lead to awakening/raising the expectations of the residents since they have been waiting for the project for a long time.

Recommendations

From our observations, it is important to engage a neutral person in the mobilsation of FGD participants where possible to avoid a predetermined scenario or responses.

FIELD VISITS

Planning for field visits

Before the commencement of the actual field visits, we made contact with the point persons at the respective mini grids such as the mini grid developers or operators. We explained the purpose of the study and our intention to visits their mini grid sites and interview their clients. An appropriate date was set. Where the developer was not at their respective mini grid, they provided us with alternative contact persons and their details. Once the dates were confirmed, we developed a fieldwork itinerary that we adopted as a guide to facilitate our travel to and within the respective county. It also

enabled us keep track of activities in the field to ensure that we covered all the activities as planned.

The aim of the field visits was to collect data in the sites where the mini grids are located. This encompassed visiting the mini-grid sites, conducting interviews with the operators, households, businesses/productive users, institutions, local leaders and the county energy departments in the respective counties.

Actual fieldwork

The fieldwork actively began on 2 nd February 2022 as summarised in Table 2.

Table 2: Itinerary of mini grid sites visited during the study

Location	**Date (2022)**	**Name of mini grid/Location**	**Mini grid developer**
Kajiado County	1st & 2nd Februrary	Oloika	University of Southampton
	3rd February	Olkiramatian	Renewvia
	7th February	Kajiado County Energy Department	
Siaya	15th February	Siaya County Energy Department	
	15th & 16th February	Ndeda Island	Renewvia
Homabay	18th February	Mfangano	Kengen/KPLC
	20th February	Ringiti	Renewvia
Kisii	22nd February	Powerhive team and Powerhive chicken slaughterhouse	
	23rd February	Powerhive 249	Powerhive
	23rd February	Kisii County Energy Department	
	24th February	Baranne	Powerhive
	24th February	Gionseri B	Powerhive
Busia	16th March	KUDURA Power East Africa Team	
	16th March	Sidonge	KUDURA Power East Africa
	17th March	Dirakho	KUDURA Power East Africa

	18th March	Busia County Energy Department	
Turkana	21st March	Long'ech	Nal-off grid
	22nd March	Lolupe	Nal-off grid
	22nd March	Nadwat	Nal-off grid
	23rd March	Kalobeyei Settlement	
	24th March	Turkana County Energy Department	
Murang'a	10th-11th May	Magiro Hydro mini grid	Magiro
	11th May	Murang'a County Energy Department	
	11th May		

As illustrated by Table 2, we visited seven (7) counties where we managed to visit 15 mini grids. The mini grids we visited were of varying characteristics (

Table 3) such as the technology, number of connections, generation capacity, ownership, and status of the mini grids at the time of the visit. Collection of data from mini grids with varying characteristics would aid in comparing different mini grids from an economic, technological, technical perspectives, which are important parameters or dimensions for mini grid sustainability.

Table 3: Characteristics of mini grids visited

Mini grid name	**Technology**	**Capacity KW**	**Status**	**Ownership**	**Connections (Households, institutions, businesses)**
Oloika	Solar	13.5	Semi operational	Community	46
Olkiramatian	Solar	6.2	Fully operational	Private	70
Ndeda	Solar & Wind	9,6	Fully operational	Private	400
Ringiti	Solar	20.45	Fully operational	Private	290
Mfangano	Diesel & Solar	520,10	Fully operational	Public	5,000+
Powerhive 249	Solar	60	Fully operational	Private	169

Gionaseri B	Solar	60	Fully operational	Private	374
Baranne	Solar	50	Decommissioned	Private	80 (at the time of decommissioning)
Sidonge	Solar	7.3	Fully operational	Private	220
Dirakho	Solar	30	Fully operational	Private	524
Longech	Solar	45	Semi operational	Private	218
Lolupe	Solar	22	Fully operational	Private	136
Nadwat	Solar	44	Semi operational	Private	180
Kalobeyei settlement	Solar	60 extending to 504	Semi operational	Private	504, expected to serve 2,000+ after expansion work is completed
Magiro	Hydro	70	Fully operational	Private	1,500

We interviewed 110 connected households, 45 unconnected, 53 productive users, 13 institutions, 4 community leaders, 9 site agents/operators and 7 county energy department representatives as summarised in Table 4.

Table 4: Number of interviews or FGD conducted per mini grid

	HH-Connected	**HH-Unconnected**	**PUE**	**Institutions**	**FGD**	**Community Leaders**	**Operator**	**County Energy Department**
Oloika	10	5	5	2		1	1	1
Olkiramatian	10	5	5				1	
Ndeda	10	5	5	2		1	1	1
Ringiti	10	5	5	2			1	1
Mfangano			2	1	1		1	
Powerhive 249	10	5	3				1	1
Gionseri B	10	5	3				1	
Baranne					1		1	
Sidonge	10		5			1		1

Dirakho	10		5	1		1		
Longech	10	5	5	2			1	1
Lolupe					1			
Nadwat	10	5	5					
Kalobeyei Integrated settlement	10	5	5	3				
Magiro hydro					1			1

The productive users of electricity that we interviewed included those who operated general shops, guesthouses, posho mills, welding workshop, barbershop, salons, pubs etc (Table 5). Common PUE across the different mini grids were barbershops, salons, and general shops. The existence of PUE such as welding were not common. In some places such as Ndeda island, a welder would come to the island occasionally when need arises. Establishment of PUE that utilised electricity from the mini grid for processing of gold was due to the availability of the raw material in the localities such as Nadwat and Lolupe. Longech area being a fishing community necessitated the establishment of an ice processing plant for the purpose of fish preservation.

Table 5 : Types of productive users, institutions and community leaders interviewed at mini grid

	Productive users interviewed	**Institutions interviewed**	**Community leaders interviewed**
Oloika	General shop, rental business,	Secondary school, dispensary,	Committee secretary
Olkiramatian	General shop		
Ndeda	Guest house, barber, general shop, betting	Primary school,	Beach Management Unit
Ringiti	Salon, pub	Primary school,	
Mfangano	Welding & fish farm,	School-boarding primary	
Powerhive 249	Posho mill,		

Gionseri B	Hotel, posho mill,		
Baranne			
Sidonge	General shop, barber,		Rtd. Chief
Dirakho		Vocational training school	CBO chair
Longech	Ice processor, salon, barber	Dispensary,	
Lolupe			
Nadwat	Welder/garage, gold processor, salon & cosmetic,		
Kalobeyei settlement	Carpenter/furniture shop, welding,		
Magiro			

We conducted four (4) FGDs (Table 6), which were comprised of representatives of the respective community. The FGDs were composed of men, women, youths and the elderly.

Table 6: FGDs conducted

Site	**MG owner/operator**	**Status**
Baranne	Powerhive	Decommissioned
Lolupe	Nal off Grid	Operational
Mfangano	KPLC	Operational
Magiro	Magiro/Hydroxox	Operational

OBSERVATIONS/FINDINGS

Kajiado County

Kajiado County is located in the former Rift Valley region and borders Narok County to the west, Nakuru County, Kiambu County and Nairobi County to the north, Machakos County, Makueni County and Taita Taveta County to the east and Tanzania to the south constituting one of the counties that share a border with Tanzania. Kajiado County spans an area of 21,292.7 km². Its main tourist attraction is its wildlife.

In Kajiado County, we visited Oloika and Olkiramatian mini grid sites both located in Kajiado West Sub-county. The two mini grids are also owned by Renewvia.

Oloika Mini grid

At Oloika mini-grid (Photo 1), we conducted interviews with the site agent and the secretary general of the committee who informed us that the consultation to start the project was done between the Oloika cooperative society whose membership was drawn from the community and the mini-grid developers i.e., University of Southampton. The mini grid was installed in 2015. Currently, the community through Oloika cooperative society manages the mini grid after the developer handed it over to them.

The mini grid generates electricity from solar energy. The mini grid served 39 households, 1 dispensary, a secondary school and 5 shops. The connection fee was 3,000ksh.

Photo 1: Oloika mini grid. Photo credits: Rosebella Nyumba

The mini grid is currently not functioning optimally occasioned by the rundown of storage batteries that need replacement. The community is yet to be done.

From the interviews conducted, community members stated that at the initial stages when the mini grid was installed the benefits were obvious, and the community was happy with the electrification. Businesses and households had the opportunity to have improved and extended hours of lighting. Shops with refrigerators realised good business due to increased sales. It is important to note that the extremely hot climate creates a conducive environment for sale of refrigerated drinks such as soda and water.

Challenges faced at the mini grid include:

a. Run-down of the battery, therefore, no power storage which also means no electricity at night when it is mostly needed by the households
b. Overload on the system due to too many connections beyond the capacity of the mini grid. Therefore, rationing is done even during the day where some parts of the site do not get electricity even during the day

c. Financial management challenges: the money collected from the community cannot be accounted for.
d. Lack of training for the site agent
e. There is not existing working relationship with the county government. So the mini-grid operator or site agent cannot get the technical assistance needed.

Olkiramatian Mini-Grid

The solar mini grid at Olkiramatian (Photo 2) was developed and installed by Renewvia in 2019. According to the interviews conducted, there were consultations with the local leadership of the community to initiate the process of the mini-grid installation. Afterwards, a consultative meeting enjoined the project developers, the local leadership and the community members. After they reached at a consensus to start the project, the Olkiramatian group ranch leased out land to Renewvia to facilitate the construction of the mini grid. Those who wanted the electricity connection paid 1,000ksh payable to Renewvia. All payments including token purchase are made to Renewvia through a mobile money payment system.

It has a capacity of 6.2KW with a potential to serve 150 households. At the time of the field visit, to the mini grid was already serving 70 households with a reliable and constant 24 hours electricity supply. The mini grid was also serving one private dispensary and other business premises. However, no public facility (such as schools, public hospitals etc.) had been connected.

Photo 2: Olkiramatian mini grid. Photo credit: Abigael Okoko

Challenges

a. Technical challenges. Lack of technician on site. In case there is need for technical assistance, the site agent relays the information to the mini-grid

developer (Renewvia) who then sends a technician. The community, however, states delays since the technician is in the capital city, Nairobi.

b. The mode of payment for the tariff rely on money agents e.g., Mpesa. However, there is only one Mpesa agent who prefers one-way transaction i.e., withdrawal of cash since he gets commission on each withdrawal unlike deposits which do not attract commission from safaricom and therefore lack of enough float to transact the Mpesa agent

County Energy Department of Kajiado County

On 7 th February, we had an interview with the County Director Energy of Kajiado County where we had a discussion around regulatory and policy issues of mini grids in the county.

From the interview, it was noted that the county is not so much involved in matters around mini grids. The Ministry of Energy approves the mini grid projects at the national government level. The county energy department is also not involved in the process of setting tariffs. The county is, however, involved in easing the approval and licensing process for investors such as creating a conducive environment for the investors by linking them up with the community. The county also helps in matters that involve land e.g., knowing where one can put up a mini grid project. In some cases, the County energy office only gets reports/feedback when there is a problem in the community. However, the county has strategies in place to assist the communities where they face challenges by providing technical assistance when it comes to matters involving energy.

Some of the approvals required by investors include approvals by National Environment Management Authority (NEMA), land use approvals i.e., the land should not be a public land, and the project should be located within an area where that kind of development is permitted. Land approvals are done by the ministry of lands and housing at the county level, which includes the change of land use. The county lacks an energy policy. However, the process of developing the energy plans is underway. The County Integrated Development Plan (CIDP) has included mini grids as one of the sources of energy among others in the county. There are plans by the county to electrify all public facilities such as schools and dispensaries. To improve the rate of electrification in Kajiado County, the county is putting in place measures that will encourage independent developers.

Challenges

- There is no budget allocated for electrification of the remote areas.
- The county is not involved in mini grid regulation and approval and feels left out

- The existing channel of communication between the country energy office and the community is through the ward administrators, which the community is not aware of, or not utilising. From the interviews with the community, there hasn't been any working relationship with the County energy department

Siaya County

Siaya County is one of the counties in the former Nyanza Province in the southwest part of Kenya. It is bordered by Busia County to the north, Kakamega County and Vihiga Counties to the northeast and Kisumu County to the southeast. It shares a water border with Homa Bay County, which is located south of Siaya County. In Siaya County, we visited a mini grid in Ndeda Island located in Bondo sub county and also had an interview with the County Director of Energy in Siaya town.

Ndeda Island mini grid

We accessed the Ndeda Island by driving for about 45 minutes on a murram road from Bondo town to Uyawi beach from where we had a boat ride for about 30minutes. The Island has a population of about 4,000+ inhabitants and was served by a primary school and a health facility as the main public facilities.

A hybrid mini grid, (Photo 3) which incorporates both solar, and wind energy systems, which supply the island with electricity, serve the island. The installed capacity of the mini grid is 15 KW (9KW from solar and 6 KW from wind energy). The household interviews were conducted with both connected and unconnected households. Apart from households and businesses, the mini grid also serves the only public primary school and health facility (Photo 4) within the island.

Photo 3: Hybrid Mini grid at Ndeda Island, Photo credit: Abigael Okoko

Photo 4: Institutions served by the mini grid: left to right; health facility and public primary school. Photo credit: Abigael Okoko

County Energy Department of Siaya County

Siaya County has not installed any mini grids. The mini grids found within Siaya county are those developed by the private developers e.g., at Ndeda island there is solar and wind power Mini grid developed by Renewvia & Vesters. There is another one at Sika, Mageta Island by Renewable world. There is an ongoing project at Mageta Island estimated to have a capacity of 700 KW.

At the time of the visit to Siaya County, the Energy department was not properly structured. It has one officer, the department of energy was placed under the public works and roads/transport department, and therefore, activities of the energy department not prioritized compared to the other departments. The energy department was drafting a county energy policy, which was still at the draft stage. Training for the county energy planning was being conducted at the national level after which all counties were expected to have their county energy plans. In the draft

Siaya county energy policy, there was a proposal for the development of an energy Centre in the county.

Regarding the mini grids regulations and operations within Siaya County, the county played a very limited role. The county was not involved in approval or regulation of mini grids or tariff setting. As such, there was a proposal that the county be involved in the process of setting tariffs. There had been complaints by the community served by the mini grids that the cost of the electricity from the mini grids were higher than that of Kenya Power. e.g., when Ndeda mini grid was being set up the tariff was set at 70 Ksh per unit, but after some negotiation and intervention it was reduced to 65ksh per unit.

The challenges faced by county government:

- The Energy Petroleum & Regulatory Authority (EPRA) and the Ministry of Energy set the tariffs and County government is not involved in this process and are only involved as stakeholders.
- The Ministry of Energy at the national level does all the approvals. The county does not play any role. The county is only involved in the change of user done by the ministry of lands at the county offices. However, change of user is a process done for any other project involving land not only those unique to development of mini grids.
- KPLC works in isolation and, therefore, knowing where they are going to extend the grid is a challenge
- Funding is also a challenge, especially from the county government. Projects can run well if there is funding and more so external funding since the internal budgeting process is bureaucratic and takes long.

Challenges faced by stakeholders/investors

- Houses are scattered and, therefore, heavy initial capital investment to put up the necessary infrastructure.

Impacts of the mini grid

The mini grids have contributed to the economic development and change of lifestyle of the residents e.g., there are increased business opportunities, floodlights have been put up therefore more business hours, more security for the community in Ndeda Island

Homa Bay County

Homa Bay County is located in the Southern part of Nyanza, along the southern shores of Lake Victoria. Homa Bay County covers an area of 3,183.3 sq. km with a population of about 1.3 million people. It borders five other Counties: - Migori to the South, Kisii and Nyamira to the East, and Kericho and Kisumu to the Northeast. It is accessible by lake transport, road and air. In Homa bay county, we visited Mfangano Island off-grid power system and Ringiti Island mini grid.

Mfangano Island

Located in Suba West constituency, Mfangano Island is served by a public off-grid system. The off-grid plant is operational and comprises diesel generators with installed capacity of 520KW and 10 Kilowatts Solar PV Cells, battery and inverters.

The mini grid was established in 2009 by Rural Electrification Authority (REA), currently known as Rural Electrification and Renewable Energy Corporation (REREC) and was subsequently handed over to Kenya Power and Lighting Company (KPLC) for transmission, operation and maintenance. The off grid was established on land acquired through the government of Kenya tendering process. It serves 1,500-2,000 clients. However, at the time of the field visit, a current audit had not been done to establish the exact number of clients (households, institutions, businesses etc.) that had been connected to the off grid. The cost of power generation was cited to be too high. The running costs were high, therefore, making it hard to make profits but instead making huge. For instance, they require 0.34l litres of diesel to generate 1KW of energy. At the time of the filed visit, 1 liter of diesel was approximately 160 Kenya shillings and, thus the cost of generating 1KW of energy was 0.34*160= 54shillings. This translates to 200% loss since the tariff charged by KPLC is 22 Ksh per unit.

Previously, the Government of Kenya reimbursed the amount incurred on fuel consumption after receipt of the KPLC invoices. Nowadays, there is no reimbursement from the government since it is expected that KPLC off grid should be self-sufficient/sustaining, hence the reluctance in making reimbursements.

The project has had a massive impact on the community, hence the efforts to make itself sustaining by ensuring its continuity in the future. In a bid to do so, the power plant acquired the 10kw solar system to complement and act as a backup. This is still not sufficient given the high population of the island. Plans were, however, underway to purchase and install a big solar plant and hydrogen Fuel cells. According the key informant, the hydrogen fuel plant is expensive to install, however, it would be cheaper to maintain since it only requires water, and that water is readily available from the nearby Lake Victoria. The Hydrogen cell plant will require 200 liters of water a day, which is readily available from the lake. The future of the off grid lies in moving from fossil fuel to renewable energy, hence the hydrogen cell and solar installation proposal.

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Outcome from Focus Group Discussion at Mfangano Island

We conducted an FGD at Mgangano Island. One of the key points take from this site was that the community had access to the station, and they had personal contact with the officials at the power plant. This made it easier for the community to voice their electricity related problems compared to those served by the main grid or those living on the mainland in Mbita.

From the FGD, the impact that the off-grid system had had on the island were quite apparent. Impacts cited included:

- Emerging of businesses such as welding, photocopying, printing services, barber shops, salons among others therefore contributed to the economic development of the island
- Electrification of institutions such as hospitals, which were thus able to perform their duties more efficiently. Health facilities could laboratory tests, perform nighttime deliveries, refrigerate vaccines, etc., that were a preserve of facilities in the mainland
- Improved performance in the schools since students and pupils could study at night therefore extra study time
- Saved time and money travelling across the lake to do simple tasks such as printing and photocopying

Challenges in Mfangano Island

- Inconsistent tariffs.
- Frequent Power outages
- High connection cost which varied from consumer to consumer depending on the distance from the nearby transformer.

Ringiti Island

Since we were already at Mfangano Island, we took a boat at Mulundu beach and rode for approximately 15 minutes to Ringiti Island on a boat. Renewvia owns the solar mini grid at Ringiti Island (Photo 5 and Photo 6), which has an electricity generation capacity of 20.45KW.

Photo 5: mini grid at Ringiti Island. Photo credit: Rosebella Nyumba

Photo 6: Shores of Lake Victoria at Ringiti Island. Photo credits: Abigael Okoko

At the time of the field visit, the solar mini grid was serving 290 clients, which included households, a primary school, a health facility and business/commercial establishments such as salons, barbershops, general shops and a video hall. During the initial days, the electricity supply was not very reliable. There were frequent outages since the installed capacity was low. Later, the capacity was increased, and the outages reduced. However, towards the end of 2021, some batteries ran out and the island therefore had electricity during the day only. To help solve the matter, some batteries were brought in from the other Renewvia sites such as Ndeda Island to support the mini grid at Ringiti Island. In the meantime, batteries meant for Ringiti Island mini grid were shipped into

the country and they were replaced. The system was now operational with outages experienced occasionally. Residents say that sometimes they experience outages due to bad weather like very cloudy weeks or on rainy days. The electricity voltage was considered stable. Connected households and business establishments use electricity from the mini grid for lighting. However, some connected households still use the home solar systems. They say they already had these systems before the arrival of the mini grid. Unconnected households rely on alternative solar systems/home solar systems such as sunking and solar panda, which are the most common in the island.

Kisii County

Kisii County is a county in the former Nyanza Province in southwestern Kenya. Its capital and largest town is Kisii. The county has a population of approximately 1.3 million people. It borders Nyamira County to the Northeast, Narok County to the South and Homabay and Migori Counties to the West. The county covers an area of approximately 1,317.5 sq. km. The county is inhabited mostly by the Gusii people.

We managed to visit Powerhive and had a chance to meet the Powerhive team at their office in Kisii. We also conduct interviews in two (2) of their mini grids, that is, Powerhive 249 and Gienseri B and conducted an FGD at Baranne. We also visited the Kisii County Energy Department.

Powerhive

We had the opportunity meet and have a discussion with the Powerhive team at their office in Kisii. Powerhive has been in operation since 2012 and started with three (3) pilot mini grids. They got a license to build 100 mini grids in Kisii and Nyamira Counties in 2015. Many of the mini grids in operation came alive in 2016. They had 21 mini grids in operation and five (5) had been decommissioned. At the time of the interview, Powerhive had connected 6060 households to their grids. The mini grid were constructed on land leased from the community members.

Connection fee for electricity started at 3,000Ksh and was currently at 9,980 Ksh. Those who had paid 1,000 ksh were eligible for connection. The rest of the amount was staggered whereby 20% of the consumption fee paid would go into paying the debt. The tariff charged was 70 Ksh per unit for residential, 43 ksh per unit for businesses and 52 Ksh per unit for institutions. The villages also benefited from street lighting installed by Powerhive as part of their CSR program.

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Business models adopted by Powerhive

i. Anchor projects:
    a. **Black Soldier Fly project**: involved insect farming as animal feed (Chicken and swine) using organic waste collected from the nearby municipal markets. This had incorporated the use of heavy electricity consumers such as the grinder, mixer, and drier. They had collaborated with Insectivo on this project.
    b. ***Kuku Poa* project**: Powerhive had put up a chicken processing unit, which engaged in processing of birds in readiness for the market.
ii. Appliance financing: These included financing of appliances such as electric pressure cookers, water-heating kettles, blenders, TV, posho mills, etc. to their clients.
iii. Bundle model. Clients had an option to choose from the different consumption plans that Powerhive had developed. They could purchase daily, weekly or monthly electricity bundles.
iv. Venturing into e-mobility such as electric motorbikes and tuktuks. They already had electric motorbikes, which were being used by their staff.

Challenges faced by Powerhive include:

i. Power theft
ii. Material theft e.g., cables
iii. Political interference in their sites especially during electioneering period
iv. Grid intrusion by KPLC where sometimes the KPLC contractors intrude into the Powerhive grids without Powerhive's knowledge.
v. Dependency syndrome where the community believes that they should be getting the electricity without paying for it
vi. Lack of ownership of the electricity projects by the community, which caused vandalism, and eventual decommissioning of the sites.

However, from their experience over the years they had gained knowledge on community engagement and cite that there had been enhance community unity e.g. in the process of negotiating for wayleaves there must be an agreement between neighbours as the poles are erected from one plot to another.

Powerhive 249

Powerhive 249 is a solar mini grid that was developed by Powerhive. It had an electricity generation capacity of 60KW. At the time of the visit, it serving 169 clients, who included households and productive users. This mini grid by Powerhive had adopted an anchor-client business model, rather than having the households being their primary clients. They adopted this model after the realisation that the demand for electricity by the households was low and building the demand for electricity was quite a slow process. This could therefore not sustain the mini-grids and thus the need for a paradigm shift in their operations. Among the anchor productive users was the Black Soldier Fly (BSF) production facility, which used municipal organic waste as the primary raw material. The process involved crushing the organic waste (Photo 7), and then mixing with blood sourced from the slaughterhouse. This mixture was then used as feed for the BSF larvae. The output from the facility was organic manure and the BSF (Photo 8), which was, used as animal feed especially by chicken/poultry farmers and some pig/swine farmers.

Photo 7: Organic solid waste collected from Kisii Municipal market, Photo credit: Abigael Okoko

Photo 8: BSF in the drier, Photo Credit: Rosebella Nyumba

The electricity from the mini grid at the time of the field visit had not been connected to any of the public facilities within the area. There were electricity connections from the main grid within the area, most of which were alluded to illegal connections.

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Gionseri B

Gionseri B mini grid (Photo 9) was established in 2019 with an installed electricity generation capacity of 60KW and was serving 374 clients with electricity. The main clients were households with some productive users such as posho mills and small shops/a hotel. At the time of the visit, this mini grid had served no schools or institutions. Connected households used the electricity from the mini grid to power the electric appliances, the common use being charging phones, watching TV, and listening to radio. Unconnected households use the home solar systems for charging phones and listening to the radio. Some also take their phones to a neighbour's place or to the nearby shops for charging.

Photo 9: Solar mini grid at Gionseri B, Kisii County Photo credits: Rosebella Nyumba

Baranne minigrid

We conducted a Focus Group Discussion at Baranne Chief's camp. The Baranne mini grid was commissioned in 2013. It operated for 5 years before its decommissioning. It had an installed capacity of 50KW and was connected to 80 clients (households, businesses, and primary school) at the time of its decommissioning. Decommissioning was because of a misunderstanding between the developer/operator and the community. A politician informed the community that there was a memorandum of understanding between Powerhive and the County government of Kisii that prevented extension or arrival of the main grid by Kenya Power & Lighting Company (KPLC) in locations where Powerhive had put up a mini grid. Therefore, the community, with the incitement of local politicians, began a mission to have the mini grid removed, so that

KPLC could extend the electricity grid to Baranne. This led to vandalism of the electricity cables, poles and other equipment installed by Powerhive.

Before the decommissioning, people often complained of power outages, which were occasioned by vandalism and theft, which happened mostly at night when it was raining. Powerhive had to keep doing repairs, replacing wires and poles while on the other hand, the community kept experiencing outages. Due to the frequent outages, people with incubators made losses since eggs in the incubators were going bad and other businesses that relied on electricity would also be interrupted. No accidents were reported during the period the power plant existed.

Those involved in the theft were community members. Increased theft and vandalism necessitated discussions between Powerhive and the community on improving security to curb theft. Community members identified the culprits, but according to them, Powerhive did nothing regarding the theft. However, according to Powerhive, the community members were not willing to become witnesses and it would therefore be a case in futility. Other complaints that arose were the prohibitive cost of electricity and the unspecified period one was required to pay for the staggered connection fee after paying an initial amount of 2,500Ksh connection fee.

After several negotiations between powerhive, the community and the local leaders (chief, assistant chief), it was agreed that the mini grid be decommissioned due to the losses incurred. The decommissioning took place in 2019. Residents complained that ever since the decommissioning of the mini grid, they had suffered a great deal. The national grid had not arrived in this area, they could not charge their phone in their houses and the number of lighting hours has reduced. The hatchery business initiated by Powerhive closed down due to lack of electricity. The nearby primary school, which used electricity from Powerhive to facilitate learning activities, also continued to remain without electricity.

The decommissioning of this site and other sites acted as a learning lesson for both the developer and the communities. i.e.

i) Improved community engagement. Through constant engagement with the community, the community began to own and safeguard the projects in their sites. Communities with electricity witnessed the challenges that those in decommissioned sites were undergoing and therefore wanted to ensure their electricity remains stable. This has reduced cases of vandalism and theft.

ii) Created a demand for electricity whereby disconnected clients wanted reconnection. Some other areas that did not have access to electricity also wanted to be connected to this electricity given its reliability.

County Energy Department of Kisii County

The energy mandate had not been fully devolved to the counties. The department of energy in Kisii County is was at the inception stages. The county had not established any mini-grids but those that were present within the county were those developed by private investors or partners such as Powerhive. Other mini grids that were under development within the county included Nyakwama hydro-Mini grid on River Gucha financed by a Chinese group and SUSEFA mini grid which was was being developed through the assistance of UNDP

Stand-alone solar systems were also in use in the county. The county had adopted the integration solar and main grid electricity to create hybrid systems, which would act as back-ups during outages. These hybrid systems had been developed in hospitals such as Marani and at the level 5 hospital -Kisii teaching and Referral hospital.

Kisii county government did not have an energy policy in place. However, the process of developing the county energy plans (CEP) was underway. The CEP development was still in its rudimentary stages and the county was conducting a stakeholder analysis to map out the potential stakeholders that would work with the county government on this. Mini grids were to be included in the plan. The county was also preparing the County Integrated Development Plan (CIDP), which was to inform the CEP regarding energy planning for the county. The county was also in the process of developing an Energy Act and other affiliated regulations. The energy department was working in collaboration with other departments such as the Legal department to draft the Energy Act. There was also a plan to develop an energy center in the county.

Challenges

- The Kisii County Energy department received minimal allocation, e.g., in 2022, it got 3million Ksh which went into buying transformers
- Energy issues in the county were not prioritized
- Technical challenges limited the uptake of renewable energy technologies such as solar and biogas.

Busia County

Busia is a county in the former Western Province of Kenya. It borders Kakamega County to the east, Bungoma County to the north, Lake Victoria and Siaya County to the south and Busia District, Uganda to the west. The county has about 893,000 people and spans about 1,700 square kilometers making it one of the smallest counties in Kenya. We had a meeting with the KUDURA Power East Africa Ltd team. We then visited Sidonge and Dirakho mini grids. We also had an interview with the Busia County Energy officer.

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Kudura Power East Africa

We had a chance to visit Kudura Power East Africa Ltd from 16 th to 17 th March 2022. The visit included a discussion with the Kudura Power East Africa Ltd team. The discussions revolved around their operations in Busia County, their community engagement model, the regulations around mini grids in the county and the challenges they face in running mini grids.

Kudura Power East Africa targeted communities that did not have access to electricity with the target being 100% connectivity in Busia County. Their entry points into the community included Community Based Organisations (CBOs) and community members who approached KUDURA stating the need for electricity. KUDURA then held consultative meetings with the community before the start of any project. Prior to the installation of electricity, the developer assessed the electricity needs of the households. A project management committee (PMC) would then be formed whose membership came from within the community. The PMC was composed of men, women, youths, the elderly, while observing the 30% gender rule as enshrined in the Kenyan Constitution. The total membership of the PMC should be an odd number. Issues deliberated during the consultative meetings included members' ability to pay and the tariff (although EPRA regulated the tariffs. The PMC were engaged at all stages of the mini grids development, from inception to implementation.

At the time of the field report, KUDURA had 11 operational/active mini grids and had plans to establish 22 more mini grids. Kudura had adopted a tier system of client connection, with the tiers ranging from 1-6 and the charges were as follows:

i. Tier 1 - 3,000Ksh
ii. Tier 2 - 4,500 Ksh
iii. Tier 3 - 6,000 Ksh
iv. Tier 4 - 7,500Ksh
v. Tier 5 - 8,400Ksh
vi. Tier 6 - 10,500Ksh

Therefore, if a client intended to increase their consumption beyond which his/her tier could support, they were required to apply for an upgrade upon which they were required to top-up the connection fee to match the current tier had applied for. The tariff charged was 73ksh for households and 68 Ksh for businesses and institutions. The lower tariff for business was intended to motivate electricity use for productive use.

The tariff setting involved having negotiation meetings with the community and conducting a baseline survey to find out how much the community could pay for the electricity. The amount was then sent to EPRA who would then come to the ground and discuss with the community after which they determined and set the tariff.

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Challenges

a. Regulatory challenges had halted the establishment of the 22 planned mini grids. The regulations require a 15km radius between the grid and the mini grid, which was not easy to achieve in a county like Busia due to its high population density.
b. Bureaucracies' in acquiring approvals. It took a long time for decisions to be made and therefore many delays were experienced.

Strengths

a. Kudura Power East Africa Ltd had a policy on densification of the grid, which ensured 100 % connectivity to the electricity from an installed mini grid in an area.
b. They have a strong community engagement arrangement, which allows community members to be aware of the products of Kudura e.g. the different tiers in place and their respective connection fees, what one needs to do in case they need a higher tier and the tariffs they pay.

Sidonge mini grid

Sidonge mini grid was a pilot project of Kudura Power East Africa Ltd, which started operations in November 2011. It had a capacity of 7.3KW with 220 connections, which included households, five (5) business operations, two (2) churches and a community library (Photo 10).

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Photo 10: Community library powered by Kudura mini grid at Sidonge.

The Sidonge mini grid started with a flat rate payment system. The community members complained about this flat rate payment system since the consumption of electricity varied from one household to another. They said it was not fair for low electricity consumers who paid an equal amount with heavy users. This led to the installation of the prepaid meters, which allowed for payment of electricity consumed. The Kudura team cited this as a successful pilot project, which influenced the replication and upscaling of mini grids to other sites.

Dirakho mini grid

Located in Nambuku Lugala location, Samia Sub County, Funyula constitueny, Busia County, Dirakho mini grid began operations in 2019 with an installed capacity of 30KW. The mini grid has 524 connections, which served 8 churches, 1 institution (Dirakho Vocational Training Centre), 1 posho mill and households within the community.

Dirakho Community based Organisation acted as the entry point for Kudura into the community. The CBO was already in existence and engaged in different programs involving agriculture and education. In a bid to promote education, the CBO members discovered that proper lighting was essential. With this in mind, the CBO approached Kudura and presented their need for lighting. After this initial engagement, follow-up consultative meetings were held and later installation of the mini grid was done. During its installation, community members provided labour such as digging of holes, helping to carry and lay the electricity poles. The connection was done in tiers ranging from tier 1-6 with the cost ranging between 3,000ksh for tier 1 and 8,000ksh for tier 6.

County Energy Department of Busia County

The County Energy Department of Busia implemented its duties in four main arteries:

1. Solar street lighting
2. Renewable energy initiatives (cooking and lighting)
3. Joint projects with REREC
4. Partnership with private investors e.g., Kudura Power East Africa

The Energy Act 2019 mandates the role of licensing mini grids to EPRA. County energy department with collaborated with Kudura and helped them identify unserved areas e.g., in the islands and the hills in Samia where they would install mini grids. The county also engaged in the public participation forums, which Kudura used to engage the community and create awareness. During these forums, community members were informed of the project intentions and their consent sought. After the community has adopted the initiative, a memorandum of understanding (MOU) was drafted,

indicating the roles of each party. The role of the county was normally on land issues and assisting Kudura in identifying the ideal areas for mini grid installation that REREC had not earmarked as areas where they would potentially construct the grid.

Busia county has a matching fund facility which financed energy projects. Through this fund, the county identified areas that needed electricity and would then supplements the budget by REREC for grid extension in Busia County. Through this fund, extension of the grid in the county was expected to go beyond that which had been budgeted for by REREC.

Turkana County

Turkana County is a county in the former Rift Valley Province of Kenya. It is Kenya's largest county by land area and is found in the northwestern most part of Kenya. It is bordered by Uganda to the west; South Sudan and Ethiopia, including the disputed Ilemi Triangle, to the north and northeast; and Lake Turkana to the east. The mini grids visited in Turkana County included Longech, Lolupe, Nadwat and Kalobeyei Integrated Settlement. Another visit was made at the County Energy Department where an interview was conducted with officials in the department.

Longech mini grid

The main economic activity in Longech is fishing done in Lake Turkana. The fish is consumed locally but also dried and sold to external markets. Nal-off Grid developed Longech mini grid, which, was a solar powered system, in 2018.

For one to have been connected, one needed to pay 1,000ksh for registration and 11,000Ksh for connection. Payment of the connection fee was staggered. To settle the debt, 183Ksh was deducted from the customer's purchase of electricity every time they purchased electricity tokens.

At the time of the field visit, the electricity system was not operating optimally due to run down of the batteries causing a lot of dissatisfaction in the community.

Photo 11: Longech mini grid, Turkana County. Photo credit: Abigael Okoko

Challenges

- High tariffs. Households paid 65 ks/unit while businesses paid 53ksh/unit
- High connection costs which clients ended up paying for a prolonged period.
- Unclear repayment period of the staggered connection fee
- Unclear tariffs for the community members.
- Increase in the water levels of Lake Turkana which forced them to move away and start the reconnection process again
- Power outages due to low storage capacity of the batteries
- The area is very sandy, and this necessitated regular clearing since it builds up very fast and if not cleared would cover the mini grid.

Lolupe mini grid

We conducted an FGD in Lolupe, Turkana County. This mini grid was developed by Nal-Off grid in 2018. It took three years before it was operational. The mini grid started by using a diesel generator and later on, a solar system was installed. The mini grid was currently operational and provided electricity for 24 hours.

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Photo 12: Participants at a focus group discussion in Lolupe, Turkana County. Photo credit: Rosebella Nyumba

The mini grid served 136 clients. It was set-up on community land. The community had requested the developer to build 2 classrooms and sink a borehole as part of community social responsibility due to persistent water shortages. However, this had not been done.

Initially when the mini grid started operating, the meters that were installed indicated the number of electricity units purchased but were later changed to those that did not show the units. The participants preferred the initial meters to help them track their electricity consumption.

Challenges

- The community raised concerns over the tariffs charged saying they were high. They had requested for a reduction of the tariff. The developer informed them that for this to happen, one had to prove continuous consumption of electricity for 8 hours.
- The staggered payment system intended to cover the cost of connection was not clear to the clients e.g., the repayment period
- The community stated a communication gap between them and the developer. Many issues, therefore, remained unresolved
- The community had requested the developer to build two (2) classrooms and drill a borehole for them since the area experienced serious water shortages. The promises were not kept. The community had requested for these infrastructural

developments since they had offered community land for the establishment of the mini grid, and it was to be a way of corporate social responsibility (CSR) by the developer. This failure by the developer and their lack of communication with the community resulted in a lot of resentment by the community. The community felt it were better if the mini grid was removed and KPLC tasked to supply electricity to the area.

Nadwat

The mini grid is located in the gold mining areas of Turkana North Sub County. It was developed by Nal-off grid to supply electricity to the residents of Nadwat. It started operation in 2018 and at the time of filed visit, it had 80 connections, including households, institutions such as a health facility and businesses such as welding, mechanic shops, gold crushers (Photo 13), among others.

Photo 13: Gold processing using mini grid electricity in Nadwat, Turkana County. Photo credit: Rosebella Nyumba

The community gave the land where the mini grid sits for free. During its conception, there was an agreement between the community and the developer that they would give the land free, and the developer would then build two (2) classrooms in the neighbouring primary school as a way of giving back to the community. This had not been accomplished. In 2021 the mini grid started to develop challenges due to run down batteries therefore, no storage of energy. The developer had not replaced the batteries despite the numerous complaints by the clients.

Challenges

- Technical challenges: the batteries could no longer store energy for use especially when the sun begun to set or on cloudy days. Residents had therefore, resorted to alternative sources of energy such as the stand alone home solar systems. Business owners lost business opportunities due to lack of electricity.
- Classrooms that were to be built in the neighbouring public primary school as requested by the community had not been constructed.
- Lack of communication between the project developer and the community. Residents claimed the developer had never come back and their complaints went unattended.

Kalobeyei Settlement

The mini grid is located within a refugee integrated settlement zone known as Kalobeyei integrated settlement, in Turkana County. The camp was established in 2016 and in 2019, the mini grid was established. It had an electricity generation capacity of 60KW designed to serve 250 connections. This capacity was exceeded and at the time of the field visit, it was serving more than 500 clients. Due to this stretched capacity, the mini grid was facing challenges in electricity supply. The batteries could not store power for use when the sun went down.

The developer had begun an expansion exercise for the mini grid to 504KW and upon its completion, it was expected to accommodate more than 2,000 client connections which included households, institutions, and commercial users. Households paid a connection fee of 1,000 ksh while commercial users paid 2,000ksh to get connected. The households paid a tariff of 20 ksh/unit while commercial users paid 25 ksh/unit, which compared to other Renewvia sites minimal and was comparable to that of KPLC. The developer subsidized the electricity tariff since it was displaced settlement setting.

Challenges

- Technical challenges: Due to the overstretched capacity of the mini grid, the batteries were not able to store electricity for use in the evening.
- The developer had to disconnect some institutions that were connected to the mini grid as part of managing the electricity supply system with the overstretched capacity.
- Business establishments closed their operations as early as 4 p.m. due to electricity rationing.

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County Energy Department of Turkana County

The energy department of Turkana County had the mandated of overseeing the electrification of institutions, lighting up health facilities especially the vaccines sections, do street lighting in rural and urban centres.

In terms of mini grids, the county department of energy facilitated documentation, facilitated the process of leasing land although in most cases the land was given for free. The county leadership, did not encourage selling of land and helped in the development of a memorandum of understanding between the different parties involved and acquisition the no objection letters. The county was also involved in dispute management aimed at cushioning the developers while also taking care of the interests of the community. .

The development of the Turkana County Energy Plan was at an advanced stage, and it was due for presentation at the County Assembly. Within the county energy plan, there was the provision for cushioning the community from the high electricity tariffs by introducing subsidies, which would be paid by the county government to normalise the rate. There was an allocation of 10million to cushion the communities i.e. the clients in Longech, Nadwat and Lolupe in 2019/2020/2021. However, some laws tied the use of this fund since the mini grids in these locations were of private developers. The political dynamics in fund allocation made it difficult to develop mini grids in the county. The County was a beneficiary of the Kenya off grid Solar Access Project (KOSAP) and 23 mini grids were set for construction in the county through this program. This program aimed at improving the electrification status in the county, which was estimated to be 30%.

Murang'a County

In Murang'a county, we visited Magiro hydro mini grid.

Magiro Hydro mini grid

Magiro mini grid (Photo 14) located in Mathioya constituency, Murang'a County is a hydro mini grid located along river Gondu.

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Photo 14: Magiro hydro mini grid, Murang'a County.

Photo credit. Abigael Okoko

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It started as a local innovation using locally fabricated turbines. The innovation was then discovered by National Environment Trust Fund (NETFUND), which then helped create a link to investors such as Hydrobox, offered trainings and provided incubation of the innovation. Hydrobox has since become Magiro's partner with equal shareholding. For its expansion, Magiro power identified community electricity generation projects, which had collapsed. These community projects were mostly run by CBOs. They entered into an automatically renewable lease agreement of 25-30 years with the CBO. During this period, the community project relinquished all its operation rights to Magiro Hydro mini grid. After reviving the project, the CBO members were connected to the electricity for free. Magiro power as was locally known had developed a system of synchronizing electricity from its three mini grids namely, Kahinduini, Kituku and Kiambogo grids. With a production capacity of 70 KW, 25 KW and 20KW respectively. The mini grids had connected 1,500 clients including households and business. At the time of the field visit, they were in talks with schools and hospitals around the catchment area to connect them with electricity. Interesting in this site was the fact that residents had the privilege of having connections from both KPLC and Magiro; a situation we had not experienced in any other site visited. The grid and mini grid co-existed, a phenomenon that was not common among the other mini grids. The residents only needed to install changeover switches and chose to use either of the two. They, therefore, had an alternative source of electricity if one provider experienced an outage.

The connection fee for households was 15,000ksh. Businesses paid 20,000ksh for single-phase connection and 25,000ksh for a 3-phase connection. For institutions, a quotation had to be done to determine the electricity demand, which then informed the quotation.

Payment of the connection fee was done in phases. A 50% deposit was made, and the rest paid in installments for a period of 6 months on a "*lipa pole-pole*" model. The tariff ranged between 15-25ksh per unit. Magiro hydropower encouraged use of electricity by reducing its costs based on increased consumption, which they monitored from their system. Payment of electricity was through pay bill system or cash for those who were not able to use the cashless system.

Challenges

- The cost of installation was high for many people. However, the introduction of the lipa-pole-pole model enabled the residents get connected.
- Delays in getting approvals and the necessary licenses from the relevant authorities such as the Ministry of Energy, EPRA were common occurrences.
- During drought, low levels of water in the river led to reduced production necessitating rationing.

- Difficult individuals in the community e.g., those who refused to sign way leaves which led to redesigning and rerouting of the lines therefore increased the cost of extending the Magiro grid line.
- Illegal connections in the past before the installation of the smart meters, a situation that was managed by installation of the smart meters.

CROSSCUTTING FINDINGS

Governance

The energy department was not fully decentralised/devolved and therefore counties seemed not clear on their roles in the energy docket. Some counties like Murang'a County did not have the energy department in place. Counties that had the department of energy in place were not involved in mini grids regulation except for administrative tasks such as getting the no objection letters and obtaining clearance at the county land department for the developers. Mini grid developers got all the necessary approvals from the Ministry of Energy and EPRA, therefore, left out the counties. Budgetary constraints were common for all the counties visited and this limited their planning and implementation of energy related activities.

There was lack energy policies in the respective counties. However, progress was being made in some counties (Kajiado, Kisii, Siaya, Busia, Turkana) through the development of the county energy plans (CEP) which were still at the very early stages of their development.

There were regulatory challenges or inconsistences observed. The current regulation requires a 15 km radius between the main grid transformer and a mini grid. However, this posed as a challenge to densely populated areas such as Kisii, Nyamira and Busia Counties and had since curtailed the extension of mini grid development in these densely populated counties. Noticeable were co-existing main grid lines with that of the mini grid in Kisii, Nyamira and Murang'a counties.

Even with the limited allocation on energy, some counties had initiatives in place for increased electrification in their counties. For instance, Busia Couunty has a matching fund/facility that supplemented the electrification budget for Busia County by REREC. Turkana County was also in the process of subsidising the cost of electricity for the residents. They had planned to achieve this through passing a bill in the county assembly that would allow for this expenditure. Once it was was approved, they would subsidise the cost of the electricity by paying a percentage of the cost to the mini grid developer/operator. This was a way of cushioning the vulnerable residents from the high cost of electricity but ensuring that they had access to electricity. The county had also formed collaborations with development partners such as GIZ. The county was also a beneficiary of the government's KOSAP programmes and had mini grids that were set for establishment in the county.

Energy use

The electricity from the mini grids was for lighting and powering of electrical devices. Connected households and businesses could enjoy lighting in the evenings. Households cited being able to charge their mobile phones at the convenience of their homes unlike in the previous days where they would pay for the service or do for days with no means of communication.

Powering of devices for businesses has been a major boost. Salons, barbershops, general shops, welding, carpentry could be done within the localities. Institutions could use printers and photocopiers and save on time and money spent to get the service outside the institutions. Health facilities can do simple procedures, laboratory tests, vaccine storage and attend to nighttime emergencies such as deliveries due to the availability of electricity.

Cost of connection and use

The cost of connecting electricity to the households, institutions and business establishments varied depending on the developer/operator/technology/use. Some developers such as Renewvia and Nal off grid applied a flat rate system while others such as Kudura applied a tier system with the lowest tier being the most basic connection of a switch and a single bulb. If a client felt the need to increase consumption, they were required to formally request for an upgrade to the next tier and the payment for it also upgraded. The payment for these connections were either done as one-off payment or was staggered. Renewvia in most cases charged 1,000ksh for household connection and this payment was done as a one off payment. Nal off grid, Kudura, Powehive and Magiro that had higher rates of connection fees staggered this amount. Different models were applied such as a 50% deposit fee and the rest being cleared in monthly instalments, a deposit of 1,000Ksh and the rest being factored in the purchase of units etc.

The tariffs charged for electricity consumption were high compared to that of the main grid. Charges as high as 78ksh/unit were observed. However, cased of lower tariffs were witnessed e.g., 15-25ksh/unit. A case of electricity subsidisation was encountered in the case of Kalobeyei settlement camp as a way of social/economic protection of the already vulnerable group. Interestingly, Powerhive and Kudura had a higher tariff for the household consumers compared to business unlike the rest that had a higher tariff for the business/productive users. This was an incentive to encourage productive use of electricity.

Many of the mini grids had adopted the metering system for electricity consumption. Some started with the flat rate system (E.g., Magiro and Kudura Power East Africa) but because it became unsustainable for either the developer or the clients, they changed to the metered system. All mini grids visited had a prepaid metering system and mobile money was the predominant payment method. Few cases of cash payments were witnessed (Oloika, Magiro-by the old who could use the mobile

money Apps). In Oloika where cash was used, cases of mismanagement of funds was reported. The mini grid had worn out batteries which had not been replaced.

Technical sustainability

Across the different mini grids, some technical challenges were witnessed. For instance, solar mini grids needed replacement of the batteries. Some mini grids however experienced dlay in replacing the batteries and therefore the electricity storage was not efficient. This led to black outs and losses by businesses.

LESSONS LEARNT & LIMITATIONS

Planning

- Our fieldwork plan cut across various counties. The fieldwork was planned in a way that a single trip bundled up several sites e.g., Busia/Turkana, Siaya/Homabay/Kisii. This was efficient but also presented a challenge in organising for interviews with the operators and the county energy representatives bearing in mind different activities for the various counties
- Getting some of the contacts was an uphill task and led to delays in visiting a site e.g., Central Kenya mini grids proved to be the hardest to organise yet they are the nearest from Nairobi.
- Insecurity challenges in some parts of the country especially Northern Kenya forcing cancellation of the planned trip or exclusion of the region from the list of proposed sites.

Actual fieldwork

- Time/Seasonal challenges: conducting an interview during the planting season (e.g., in Kisii) caused some delay.
- In the islands, a respondent could accept an interview, but because the boat would be leaving in some minutes, they ended up hurrying up because the boats had a schedule.
- Long travel hours due to the remoteness of most of the mini grids was a challenge and caused fatigue.
- Long waiting hours for interviews especially at the county energy department.
- Long distance between one interview site and the next (for instance between the mini grid site and the county offices). This led to some inefficiencies since we had to all attend the same interview especially those with the county energy department. However, this was also beneficial to the team since all had a feel of the happenings on the regulatory/policy scenario in the county on matters energy and mini grids.

- Language barrier in some cases though not predominant. This necessitated translation, though done at the local level.
- Delays in getting an interview especially with county officials.
- Not getting the right person to interview due to non-establishment of the energy department at the county government level
- Data acquisition challenges: getting data on the capital and operating costs of the mini grids was not possible and therefore filling in the DEA form was a challenge.
- Technological: data collection using tablet is limiting depending on how the coding of a question is done (one may want to take a point but no provision for it).

Next steps

(What next after the fieldwork e.g., new project ideas (e.g., the participation one, etc.).

- Doing transcription of the interviews
- Doing analysis of the data
- Writing of reports, web articles and peer reviewed journal articles
- Develop new project ideas on the energy sector.

APPENDICES

Research permit

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Household questionnaire ***Household questions (final).docx***

Productive user's questionnaire ***Organizations and Productive User questions (final).docx***

FGD guide: ***Focus Group Discussion Questions for Customers (final).docx***

Community leaders guide: ***Community leaders interview guide.docx***

County government guide ***Government departments (final).docx***

DEA form: ***DEA and SE4ALL Emission analysis tool data collection guide.docx***

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