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Final Report:

Innovative Solar PV Mini-grid with circular Economy Hub and community empowerment in Hurri Hills, Kenya

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Contents

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- **Please include photos, easy to understand graphics, etc., with this report.**
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1 Summary

Why was this project implemented (Needs in the partner country)?

- In 2017 Kenya was rated 142nd among 189 countries in terms of Human Development Index (UNDP, 2019). Poverty rate estimated to 36,1% in 2015/2016. 44% of Kenyan population does not have access to electricity (KPLC, 2018). Most of the rural population use kerosene or/and candles for lighting and are spending much more money than the grid-connected households. Universal access to modern sources of energy by 2030 (SE4ALL, 2016)
- **1,200 underprivileged people** from Hurri Hills village expressed their need of electricity to eradicate poverty and promote prosperity.
- Rural off-grid market is more mature and growing, but private investors are still hesitant and need effective incentives to promote the electrification of rural areas in Kenya.
- This project is a small pilot project, a showcase, that **needs REPIC grant** (as no economy of scale), to show private investors the reality of this profitability, through an innovative monitoring platform and a containerised solution embedded in the community.
- The findings of this pilot project will help promoting multi-million investments into large scale Solar PV microgrids in rural areas that would impulse the sector, catalyse stakeholders' action and growth, and thus hugely impact on poverty reduction, protecting the environment, promoting education, and improving health of the most vulnerable. This will boost local development, support businesses and the development of entrepreneurs.

What was implemented (project's content)?

- Constructed PV Power plant: 20 kWp Solar PV Mini-grid, in operation since October 2019.
- Location: Hurri Hills, Marsabit County (Lat: 3.376779 N / Long: 37.746045 E), Kenya
- Budget: 351 030 €
- Description: Implementation of an innovative solar photovoltaic mini-grid with circular economy hub and community empowerment activities to eradicate poverty and promote prosperity, and set-up of viable and robust business model answering local needs with a **service approach.** Transfer of **technical knowledge** to the local operator.
- Beneficiaries: local population of the Hurri Hills village, and the surrounding satellite villages population. Currently there are 44 end-users with a connection to the mini-grid.
- Project Developer, owner, and local operator SES Microgrids Kenya limited (**SESMA Kenya** hereafter), counting in 2021 with two employees based in Nairobi, Kenya, and one local operator in Hurri Hills.

How was the project carried out and what objectives have been achieved?

- ✓ Feasibility study.
- ✓ Community engagement.
- ✓ Management scheme and financial model
- ✓ Detailed engineering.
- ✓ Governmental and regulatory approval.
- ✓ Procurement of equipment.
- ✓ Construction and commissioning.
- ✓ Training of local staff.
- ✓ Dissemination of project results (https://www.ruralelec.org/newsletter).
- ✓ Development of a website (https://sesma-energy.com/kenya/).
- ✓ Operation since 2019.

What do you foresee as further actions to be undertaken?

- Extension of distribution line to another 15 households interested in being connected.
- Provision of electricity through other stand-alone solar products to isolated households that are too far away from the distribution lines.
- Installation of meters to all customers.
- Further community training on productive uses and commercial applications of electricity.
- Extend service to other areas that require electricity, such as cold storage, water, clothes washing or printing.

- Liaise with other organizations acting in Hurri Hills to find common areas of work that boost development in Hurri Hill, such as Safaricom, Concern Worldwide, Pacida, Mercy Corps, Caritas or Hafura Project.

2 Starting Point

At the project start, Hurri Hills had **no grid connection** nor access to electricity. At that moment, even Solar Home Systems were not popular products yet, and villagers commonly used kerosene, charcoal, and firewood to get energy, and candles for lighting. Feasibility studies showed that their energy budget represents a large part of their income, **spending in energy a greater share of their income than urban households**, where there is electricity available.

Hurri Hills is a pastoralist community, where the main economic activity is livestock farming. **The lack of electricity prevented them from developing other means of economic development and alternative revenue streams**, reducing their resiliency to natural hazards, such as extreme draughts.

Marsabit County Government appointed Hurri Hills as a suitable location for electrification, as it was not in any existing electrification plan. This reduced the risk for the developer, on one hand for getting political support, and on the other, to eliminate the risk of grid extension of the national grid.

During selection process, Hurri Hills scored higher than other potential villages due to several reasons:

- It is a **compact village** with satellite villages around, making the microgrid solution as the best for electricity access, due to higher density population that other areas.
- It had a **clear commercial centre** with various shops, as mentioned below.
- There were **no other electrified villages** in close proximity, which would result in **migration or visits from the other close-by villages** to consume and develop activities made possible thanks to electrical services.
- It is close to the border with Ethiopia and the road connecting the two countries, bringing high economical potential with **extensive commercial exchange flows**.
- It has a fertile soil, but agriculture is not practiced due to lack of electricity (irrigation).

The following section provides Baseline levels of all indicators used, that can be understood as a starting point of the project.

3 Objectives

Description of the project's original objectives.

OBJECTIVE 1:	**SOCIAL**
Description:	**At least 1.500 people, in Hurri Hills and surroundings, confirm that they have access to electricity through the facility installed, related services, and affordable, reliable, and modern energy appliances matching their needs. They see their life conditions improved in a sustainable way and it led to a reduction of uncontrolled exodus to urban zones and attraction of neighbour inhabitants (SDG1.4, SDG 3.8, SDG 4.4, SDG 5.5, SDG 7.2, SDG 7.B, SDG 7.1, SDG 9.B)**
Indicator 1: Proportion of Hurri Hills population living with access to electrical basic services based on 100% renewable energy share.	
Baseline:	Year 0: 0% (Based on field visits)
Target:	Year 3: >80%
Indicator 2: Achieve productive employment and decent work for all women and men giving them sustainable income opportunities (SDG 8.5). Unemployment rate, by sex and age	
Baseline:	Year 0: youth (15-24 y/o): 61.5 % // women (15+): 50.9 % // men (15+): 38.8 % (Based on World Bank for Kenya (2015))
Target:	Year 10: youth: < 10 % // women: < 10 %// men: < 10 %
Indicator 3: Percentage of inhabitants that report a better autonomy and life quality in education, health services, safety, working conditions, access to information, according to site survey after facility installed	
Baseline:	Year 0: N/A
Target:	Year 3: > 80%

OBJECTIVE 2:	TECHNOLOGICAL
Description:	**The innovation of the technical solution and services is proven with the monitoring platform showing live technical and economical results. Very high-quality electricity access: alternating current (AC), 24 hours/day, 7 days/week, all year long for more than 20 years (98% availability (downtime smaller than 2%)).**
Indicator 1: Prevention of greenhouse and gas emissions. GHG emissions prevented, in tons of CO2 equivalent, over 20 years of operation.	
Baseline:	N/A
Target:	7500 tons of CO2 equivalent
Indicator 2: Number of businesses and workshops installed and using the circular Economy Hub facility and its electrical equipment.	
Baseline:	Year 0: 2
Target:	Year 3: 10
Indicator 3: Standardized, Modular, Containerized attribute of the solution is proven by the rapidity of procurement, transport, installation and commissioning.	
Baseline:	Usually: 8 - 12 months
Target:	5 months

OBJECTIVE 3:	ECONOMIC
Description:	**To show evidence of possible cost reduction up to 30% for OPEX and CAPEX for the scale-up phase. To be able to reduce the grant part of the financing, to make it more attractive and show strong economic results for bigger investments for a scale-up. To collect funds for scale-up phase with precise data from other sites and demand.**
Indicator 1: Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships (SDG 17.16). Partnership between the 5 entities keeps on for other microgrids, improving the swissness part of the project on the replication phase.	
Baseline:	N/A
Target:	15 microgrids with 20% more Swiss know-how and technology components integrated in it.
Indicator 2: A wide range of workshops, webinars, seminars and site visits will be implemented to disseminate the project results in each participating country.	
Baseline:	N/A
Target:	> 3 international conferences to divulgate know-how and feedback of experience on the project, > 5000 visits of the project page website, > 100 Key stakeholders (financers, government, REA, community inhabitants, operators, installers, ...) will have a better knowledge about efficient uses of electricity, rural electrification to incentivize such programs, to implement adaptation, mitigation and technology transfer, and development actions.
Indicator 3: Attraction of investors for the scale-up phase, investment leverage (additional capital raised). Reception of Letter of Intent to finance the scale-up phase.	
Baseline:	N/A
Target:	10 LOI from different entities

4 Project Review

4.1 Project Implementation

How was the project carried out (approach, partner and project's main steps)?

4.1.1 Work Package 1: Development phase

Previous percentage of completion (proposal stage: March 2019): **96%**

Percentage of completion to date: **100%**

Date or estimated date of completion: **N/A**

After a GIS mapping and a site mission in 2016 together with GIZ as a partner, Hurri Hills was cleared by the Rural Electrification & Renewable Energy Corporation (REREC, formerly REA) and a letter of support from the Marsabit County Government was issued, addressing the Ministry of Energy and Petroleum as well.

During the second mission, a user engagement campaign was performed, where the project details and the electricity tariffs were presented to the associations' representatives (women, youth and elders) as well as other interested potential customers, since the whole community was invited. The potential clients were also asked to sign a list of interest to connect to the mini-grid and to select the level of service they would like. A total of 71 signatures were received.

The Kenyan registered company "SES Microgrids Kenya limited (SESMA Kenya)" was fully registered in November 2017 to be able to support financially the project according to taxes regulation and to be abler to employ local people.

4.1.2 Work Package 2: Design of management scheme and financial model

Previous percentage of completion (proposal stage: March 2019): **100%**

Percentage of completion: **100%**

Date or estimated date of completion: **N/A**

Based on first customers' ability to pay, willingness to pay and forecasted demand, a system sizing was performed in early 2018 while the complete engineering design with bill of quantities was done early 2019. The system is a hybrid twenty-kilowatts peak solar system with back-up (only) diesel generator to face continuity of the service during maintenance or equipment replacement. Following these studies, all capital and operational expenditure was assessed and based on these financial elements and the electricity demand, a monthly electricity fee was designed for different user categories. Thereafter, it was presented and approved by the community.

The **management of the mini-grid** is carried out following the structure provided in Figure 1. Figure 2

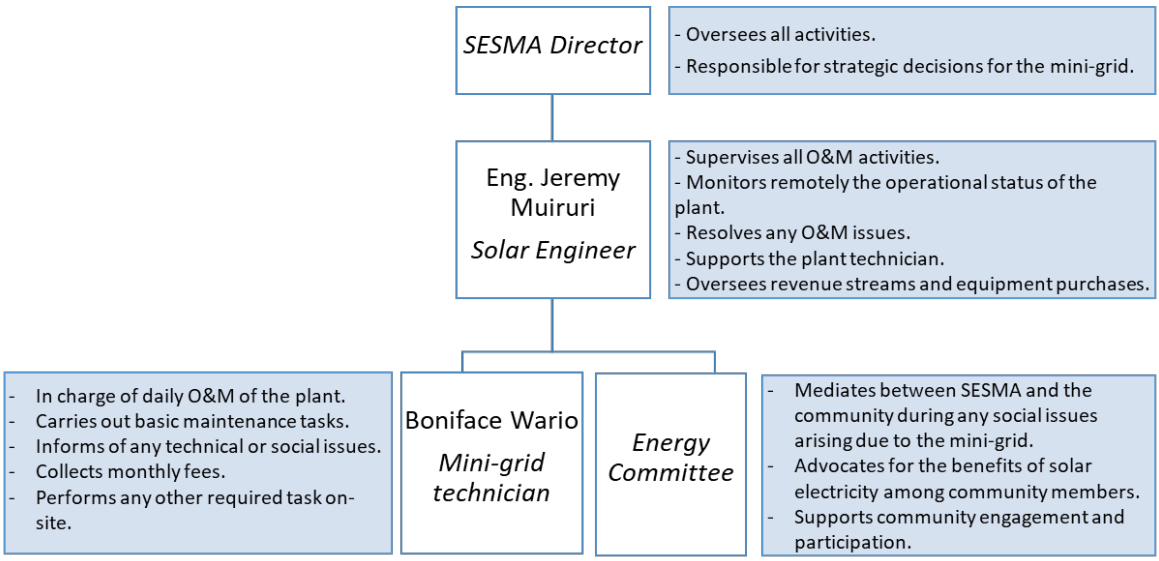

Figure 1. Organigram of the mini-grid management.

4.1.3 Work Package 3: Permitting process

Previous percentage of completion (proposal stage: March 2019): **96%**

Percentage of completion: **100%**

Date or estimated date of completion: **N/A**

The proposed tariff to the community has also been approved by the Energy and Petroleum Regulatory Authority (EPRA, formerly ERC), at 49 KSH/kWh (0.38 EUR/kWh at 24.03.2022 exchange rate). As a requirement for final permit approval by the same authority EPRA, the blue printed layout of the final project design need had to be approved by the Lands, Physical Planning, Energy & Urban Development County Government of Marsabit, which gave the approval.

EPRA is also in charge of providing licence to mini-grid private developers to generate, distribute and sell electricity. After a long process, EPRA awarded licenses in March 2021 for:

- Power generation
- Power distribution and supply.

The licenses are to be renewed annually.

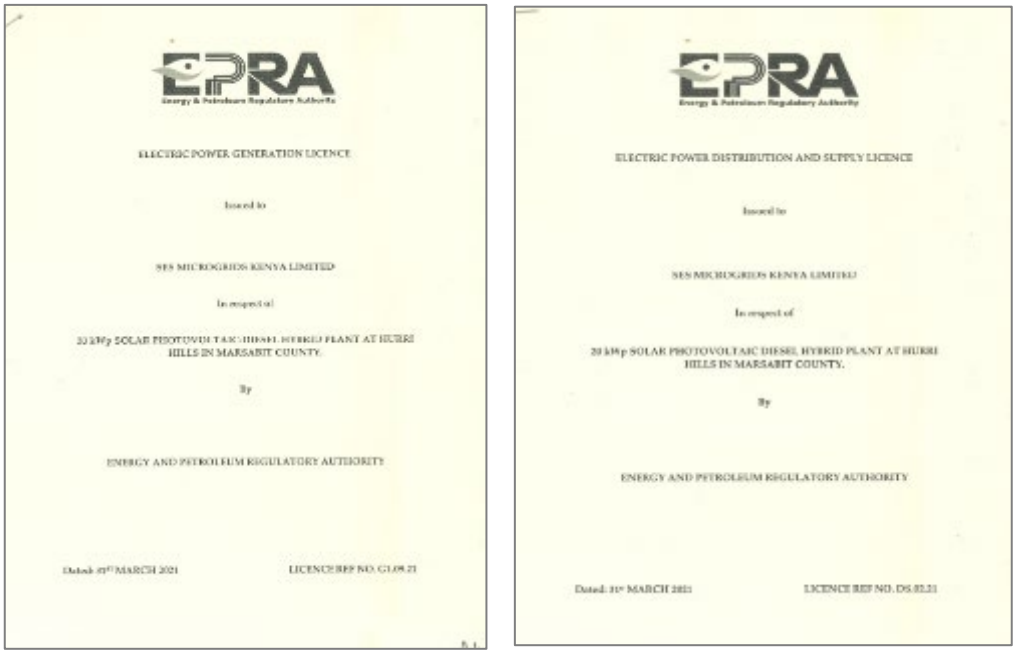

Figure 2. Licenses awarded by EPRA.

4.1.4 Work Package 4: Implementation Phase

Previous percentage of completion: **96%**

Percentage of completion: **96%**

Date or estimated date of completion: **March 2022**

The construction phase was concluded on the 26th of September 2019 after the commissioning and energization of the distribution lines. The implementation phase included:

1. The grid distribution network was completed in July 2019.
2. The cement slab and initial civil works were completed in June 2019 (for drying period reasons and sustainability of the slabs over the time)
3. The container from Barcelona (technical house, cables, inverters, solar panels, structures) was cleared from taxes in Nairobi and arrived on site on September 5th, 2019.
4. The second container from Nairobi (Diesel Generator, batteries, pre-assembled end user boards, tools and consumables) also arrived on site on September 5th, 2019.
5. SES Microgrids project manager (Jeremy Muiruri) was on site.
6. Simultaneous construction of the solar power plant and the technical house were carried out.
7. Grid network technicians arrived on site and connected first round of customers as well as installed the streetlights along the three main roads.
8. Commissioning of the solar hybrid generation plant and energization of the distribution network.
9. First customers received electricity

Figure 4. One of the 3 phases line of the grid network

Figure 5. The cement slab realised

Figure 6. Container from Europe (offload of the containers)

Figure 7. Power Plant

Figure 9. Technical house interior (inverters, charge controllers and meter).

Figure 8. First customers receive electricity service.

Note: This activity is only completed to 96% because only five connections (11% of the connected users) have an energy dispenser (meter). The rest of the energy dispensers are planned to be installed in Q1 2022, completing the activity to 100%. During the implementation of the project, funds allocated to the purchasing of meters were dedicated to human resources, as time dedication needed had been underestimated, particularly for the operation and maintenance supervisory activities, and for administrative and management tasks. It was considered that the installation of

meters was of lower priority and could be postponed, given that the mini-grid fully operates without them and the electricity service is being provided to the same standards.

4.1.5 Work Package 5: Capacity Building

Previous percentage of completion (proposal stage: March 2019): **50%**

Percentage of completion: **98%**

Date or estimated date of completion: **January 2022**

- In June and July 2019, **six selected community members** (two women and four men) based on their technical skill and willingness to participate in the project, completed a T1/T2 training (solar hybrid technical trainings) at Strathmore University in Nairobi. In addition, three of these community-based members were trained on Low Voltage (LV) grid network operations and maintenance. The six technicians participated in the construction of the solar generation power plant and were compensated for their work.
- When the construction finished, one of the trainees (Mr Boniface Wario) was selected to be the **technical operator of the mini-grid**, based on site and employed by SES Microgrids Kenya. The technician is in charge of maintenance and fee collection from customers.
- During the construction of the power plant, different additional training modules were prepared to reinforce the technician skills of the local operator.
- The technician travelled to SESMA offices in Nairobi in October 2021 to receive further training.
    - Technical training: O&M, sequence of operation and as-built drawings, a total of 4 hours of training.
    - Training on data collection surveying tools, to be able to perform satisfaction surveys to end-users, and assessment of potential new connections.
    - **Technical training from inverter manufacturer Studer**. This training was attended by the Technician from Hurri Hills, two staff members from SESMA located in Nairobi and one staff member from TTA.

Figure 10. Training at SES Microgrids Kenya offices in Nairobi.

Note: the 2% pending is capacity building to community members. This is not depending on REPIC contribution. Due to the inability to travel to site during most of 2020 and 2021, the **capacity building to the community members** has been postponed (more details in following sections) to the next visit in January 2022. The training will cover electricity use and demand management, Energy Daily Allowance concept, efficient appliances, productive uses of electricity and commercial initiatives.

4.1.6 Work Package 6: Dissemination, steering and evaluation, scale-up preparation

Previous percentage of completion: **25%**

Percentage of completion: **90%**

Date or estimated date of completion: **N/A**

Dissemination

1. Website. SESMA Kenya has updated their website with information from Hurri Hills mini-grid.
2. ARE's newsletter. Hurri Hills was featured in October 2021 ARE's Newsletter, under the title *Hurri Hills, a Success Story of Entrepreneurship Despite the Pandemic,* which showed success examples of businesses and productive uses in Hurri Hills that have flourished with the mini-grid installation. According to ARE´s statistics, the Newsletter was sent by email to 13,848 people and opened by 2,942 people. Additionally, it was seen by over 700 people on their website (unique page views) and had over 9,500 impressions on social media (of which 888 were directly on the Hurri Hills post on LinkedIn.

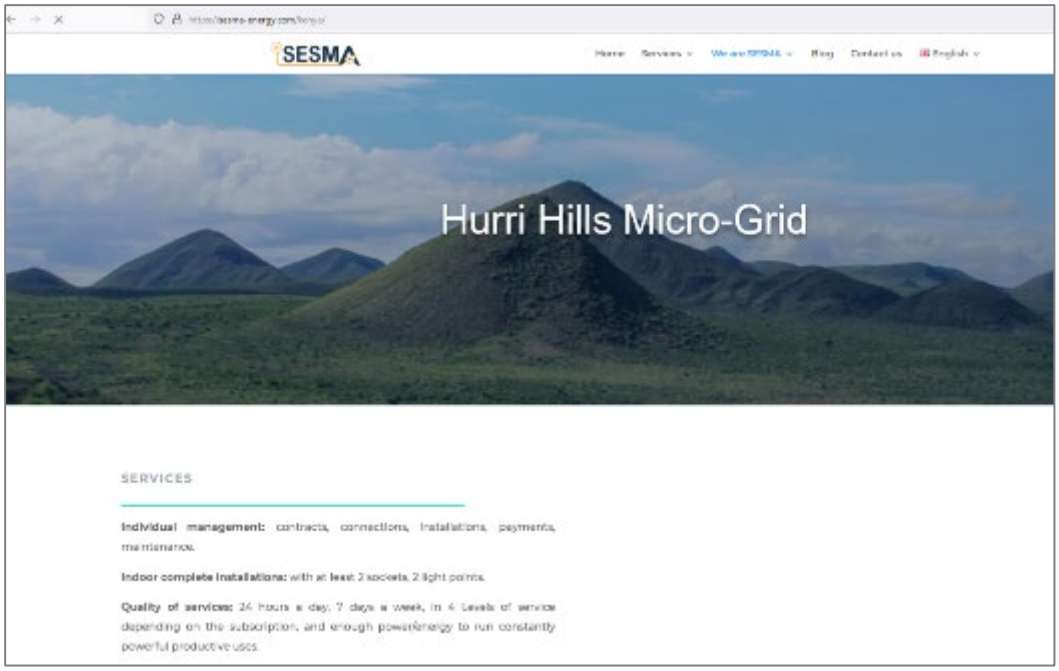

Figure 11. Hurri Hills information on SESMA Kenya website.

Satisfaction surveys.

The local operator has been trained to do satisfaction surveys among the users of the mini-grid, and will carry them out in January 2022. Satisfaction surveys will provide an extremely valuable insight on the performance of the mini-grid at a social level.

Socio-economic impact assessment

SESMA is currently under conversations with the co-donor of the project, GIZ, to coordinate the development of a socio-economic impact assessment.

Scale-up preparation

Initial activities on business development with the objective of securing funding for scale-up have been carried out, but unsuccessfully until the date. Major programmes for off-grid electrification in Kenya focused on engaging the private sector (such as KOSAP) have been more active on stand-alone solutions than in mini-grid development.

Note: The 10% pending is because the dissemination activities have not yet included a presentation at an international conference or meeting, which is planned to happen in 2022.

***

Did the project's main objectives have to be modified during the course of the project? Describe any of the modifications made.

- Meters. During the implementation of the project, funds allocated to the purchasing of meters were dedicated to human resources, as time dedication needed had been underestimated, particularly for the operation and maintenance supervisory activities, and for administrative and management tasks. It was considered that the installation of meters was of lower priority and could be postponed in time, given that the mini-grid fully operates without them and the electricity service is being provided to the same standards.

The post-construction objectives were heavily impacted by Covid-19 pandemic, during 2020 and 2021. In particular, some of the project activities had to modify and/or delay:

- Travelling to site.
    - SESMA Kenya was unable to perform the check-up visits scheduled during 2020 and the beginning of 2021, due to restriction of movement within the country and recommendations to travel only when strictly necessary. Even when travel restrictions were lifted, SESMA Kenya took a safe approach to delay the visits to Hurri Hills, to avoid any risk of transmission of Covid-19 to any village member, which could have fatal repercussions in a population with low access to health services and very strong stigmatization to Covid-19 infection.
    - Additionally, the drought situation in the North of Kenya has also affected the scheduling of a mission to Hurri Hills. The way of living for most of inhabitants in Hurri Hills is based on livestock, which is currently under great risk of death due to lack of water and graze, and selling prices have fallen more than ten times, leaving people with extremely reduced incomes. For this reason, the timing for a visit to Hurri Hills has been postponed from the end of 2021 to the beginning of 2022, with the expectation that the rainy season of November-December 2021 (also expected to be less than normal) will alleviate the economic situation.
    - A mission to Hurri Hills has been planned for January 2022.
- Capacity building activities to the local operator. The training activities for the local operator had to be delayed and modified. Finally, in view that a trip from SESMA to Hurri Hills was strongly delayed, the local technician was invited to SESMA offices in Nairobi, to complete his training.
- Capacity building activities to the community. The capacity building activities to the community, however, had to be postponed until January 2022. SESMA has minimized the impact of the delay by training the operator to do satisfaction surveys. The aim of this is to allow customers to express themselves regarding the current service they receive, and to ask any question they may have.

4.2 Achievements of Objectives and Results

To what extent were the objectives achieved? Which results were achieved?

Objective	**Target**	**Intermediate Result Year 2**
1.1 Proportion of Hurri Hills population living with access to electrical basic services based on 100% renewable energy share.	Year 3: 100%	Year 2: 44 customers connected to the mini-grid / 72 potential customers (61%). Target to be achieved in Year 4.
1.2 Unemployment rate, by sex and age	Year 10: youth: < 10 % // women: < 10 %// men: < 10 %	Year 2: To be measured in surveys to follow.
1.3 Percentage of inhabitants that report a better autonomy and life quality in education, health services, safety, working conditions, access to information, according to site survey after facility installed	Year 3: > 80%	Estimated Year 2: >80% of mini-grid connected users. Safety due to street lighting has already been reported as a major improvement, with crime rates reduced to almost none. Satisfaction surveys will provide more accurate indicator value.

2.1 Prevention of greenhouse and gas emissions. GHG emissions prevented, in tons of CO2 equivalent, over 20 years of operation.	7500 tons of CO2 equivalent in 20 years.	Projection from the mini-grid of Hurri Hills only: 307t[1]
2.2 Number of businesses and workshops installed and using the circular Economy Hub facility and its electrical equipment.	Year 3: 10	Year 2: 8 Target to be achieved in Year 3.
2.3 Standardized, Modular, Containerized attribute of the solution is proven by the rapidity of procurement, transport, installation and commissioning.	5 months	Procurement took longer than expected, but once the container was in Nairobi, it took less than **2 months** to transport, install and commission.
3.1 Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships (SDG 17.16). Partnership between the 5 entities keeps on for other microgrids, improving the swiss component on the replication phase.	15 microgrids with 20% more Swiss know-how and technology components integrated in it.	Year 2: 5 mini-grids in Burundi operated by SESMA with Swiss equipment.
3.2 A wide range of workshops, webinars, seminars and site visits will be implemented to disseminate the project results in each participating country.	> 3 international conferences to divulgate know-how and feedback of experience on the project, > 5000 visits of the project page website, > 100 Key stakeholders	Year 2: ARE's Newsletter The Newsletter was sent to 13,848 people and opened by 2,942 people.
3.3 Attraction of investors for the scale-up phase, investment leverage (additional capital raised). Reception of Letter of Intent to finance the scale-up phase.	10 LOI from different entities	This objective has not been achieved.

Focusing on Objective 3, to show evidence of possible cost reduction up to 30% for OPEX and CAPEX for the scaleTo be able to reduce the grant part of the financing, to make it more attractive and show strong economic results for bigger investments for a scale-up. To collect funds for scale-up phase with precise data from other sites and demand.

Our analysis indicate that CAPEX and OPEX could be reduced close to the 30% objective once the local structure is created and the paths for logistics, local management, local authorities, etc. are open. CAPEX will be also reduced by aggregating projects and scaling up the procurement. However, the tariff approved by the local regulator covers around 20% of the project LCOE. Even by reducing 30% the CAPEX and OPEX, still around 50% of the LCOE should be financed or subsidized by third parties. In this case, the local authorities are regulating the tariff with the aim of subsidizing the infrastructure, which make the projects depending on the local government financial capabilities.

From our perspective, detaching the electrical tariff from the local authorities' approval will help to reduce project dependencies. The local communities are willing to cover the project cost through higher tariffs, but the local government want to run the rural electrification as part of the same pipeline as the national grid. Every project should have a different tariff in order to cover project costs (LCOE) instead of having national tariffs for grid or rural minigrids, based on subsidized models.

[1] This considers only current demand.

4.3 Multiplication / Replication Preparation

What preparatory work was carried out for the multiplication and replication within the project's framework?

- SESMA was able to replicate and apply lessons learnt to **five mini-grids in Burundi** that currently operates (https://sesma-energy.com/burundi/). The mini-grids in Burundi follow a similar philosophy of operation to that of Hurri Hills. In particular, aspects that were replicated or used as a starting point were:
    - **Company registration and operation**. Probably the most beneficial experience from Hurri Hills for the development of the mini-grids in Burundi, was the ability to set up a company in an African country. Setting up SESMA in Kenya provided valuable experience in terms of administrative processes that need to be followed for company registration, setup and operation, but also for the process of license application and approvals.
    - **Management structure**. The management structure has been replicated in each of the mini-grids, particularly at the local level. Community members have been trained to provide day-to-day operation and maintenance activities, and to be in charge of customer management and fee collection. Additionally, an engineer monitors remotely the operation of the mini-grids, and provides troubleshooting when needed.
    - **Containerized solution**. For the five mini-grids of Burundi, the technical design of the powerhouse with all the equipment was replicated and only modified to fit the capacity needs of the new sites.
    - **Modularity**. The design followed a modular approach to increase/decrease capacity of the system in future designs. The experience gained in Hurri Hills was developed one step further and served to optimize the design costs in the mini-grids of Burundi by providing only two designs for two different capacities: 27.5 kWp and 55 kWp.
- SESMA is at the moment exploring additional options for multiplication and replication of the mini-grid installation. At short term, SESMA is in conversations with the Hafura projects to look for options to replicate the system in a location that is accessible for the sewing atelier to be connected. At a longer term, SESMA is looking for opportunities to replicate the work in other villages in underserved counties of Kenya.

4.4 Impact / Sustainability

Which impacts were already noticeable up to the end of the project?

- The major impact that has been reported from the community members is the **reduction in crime almost completely, due to the presence of street lighting**. Due to the geography of Hurri Hills and its green areas, it attracts the presence of visitors all year long, from local authorities, NGOs, and neighbouring villages. Before the mini-grid was built, crime levels were significantly high, and people, especially women, avoided to walk around in darkness after 7pm. Nowadays, crime at night has been reported to happen very seldomly. This will be more accurately recorded through satisfaction interviews scheduled for December 2021.
- **Several businesses reported to get better earnings**, provide improved services, and extended working hours. Both business owners and customers are pleased about this.
- **Children do not have to walk to school in darkness anymore**, as the school has installed lighting on the front wall, that combined with the street lighting, allow children to walk in and out of school in light.
- **Households are used to electricity now.** Even during crises such as the one caused by the draught, people are still willing to dedicate part of their income to the electricity bill, because they value the service they receive.
- **Villagers in Hurri Hills value the quality of service received.** Opposite to what villagers have seen in other mini-grids in the area, the mini-grid in Hurri Hills is not undersized, and is able to provide as much electricity as is required, and still has capacity for major demand growth in the next 5-7 years. Not having blackouts, or energy rationing, is highly valued by the community.
- **Diesel generator is not used**. Up to the date, Hurri Hills is running **100% solar mini-grid.** The generator is only turned on periodically for maintenance purpose.

- **Demand from end-users has quadruplicated in two years** (See Figure 12). The demand per end-user was 190Wh/day in December 2019, and it was 740 Wh/day in October 2021.

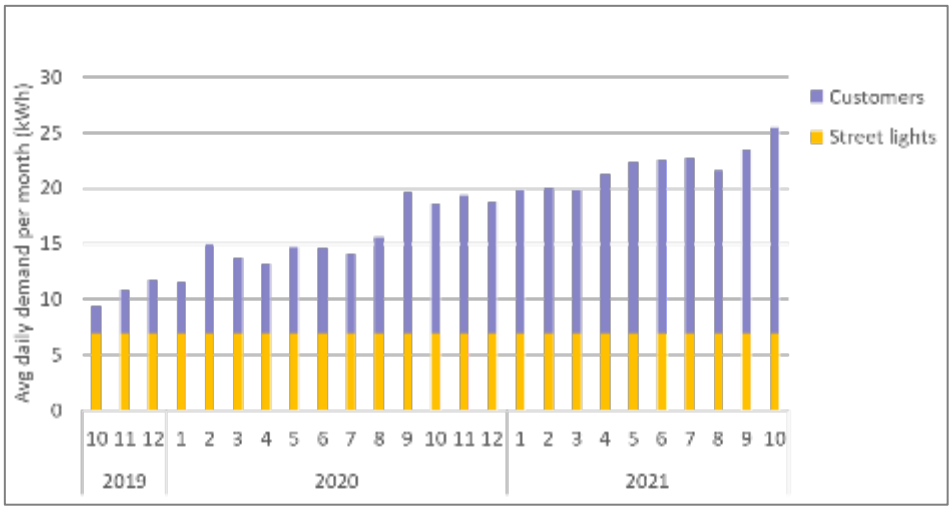

Figure 12. Average daily demand over the past two years.

Please provide qualitative text and quantitative information (in the table below) in the following three main categories, where applicable:

Ecological	**Unit**	**At the REPIC Project's Completion**
Installed renewable energy capacity	[kW]	20
Renewable energy produced	[kWh]/year	10,512[2]
Amount of fossil fuel energy saved	[kWh]/year	5,739[3]
Greenhouse gas reduction	[t CO_2-eq]/year	15.4 t[4]
Newly collected and separated waste	[t]	
Newly recycled waste	[t]	
Economic		
Energy costs (LCOE)	[ct/kWh]	1.737 Euros/kWh 220.827 KSH/kWh (at 24.03.2022 exchange rate)
Triggered third-party funding/investments	[CHF]	
Local private income generated	[CHF]	
Social		
Number of beneficiaries	[Number]	250 direct beneficiaries, plus another 200 indirect beneficiaries.
Number of new jobs	[Number]	3-5
Number of trained personnel	[Number]	5 technical training + community trainings to take place during Jan 2021

[2] Renewable energy produced is the sum of all the daily solar production reported on the studer monitoring for a 1 year peroid.
[3] Considering that there was not generator before, this amount accounts for the fossil fuel energy generation avoided.
[4] This amount accounts for the fossil fuel avoided.

5 Outlook / Further Actions

5.1 Multiplication / Replication

What are the next planned steps?

- **Search for additional funding to replicate in other villages**. SESMA is looking for opportunities to replicate the work in other villages in underserved counties[5] of Kenya, and actively engaged in looking for additional supporting finance.
- **Technical and advisory support to other developers.** SESMA has first-hand experience in the development of business models for mini-grids in Kenya, and the challenges that it involves. SESMA is putting this experience into useful knowledge for other local developers, through consultancy and technical support. In this way, the experience gained through the project can reach a larger impact, and positively influence the mini-grid sector as a whole.
- **Carry out and evaluate satisfaction surveys from connected users**. This feedback is extremely relevant to design further actions on what is going well and what should be improved.
- **Bring electricity to 100% of Hurri Hills inhabitants willing to be connected**. During the connection phase, 44 users decided to be connected. Currently there are another 15 users that have expressed strong interest in being connected (out of the 28 that do not have a connection). Considering that the distribution assets are owned by the County of Marsabit, it is required to raise funds in order to expand the distribution line and install droplines and internal wiring to those customers.
- **Deploy pilot cases for new businesses and additional electricity services**, through the purchase of efficient appliances and productive uses. By installing certain appliances (at the power station or other more suitable locations), such as a printer, washing machine or a fridge, new uses of electricity could be promoted. In a first stage, a community member can be trained to carry out these services and ask for a fee. This will encourage further entrepreneurship in Hurri Hills.
- **Connect the women-run Hafura atelier**. Through the Hafura project, a group of women from Hurri Hills are being trained in sewing and jewellery making. Currently they have 5-7 mechanical sewing machines in their constructed atelier. SESMA is exploring options to collaborate with Hafura so that the sewing machines can be replaced by electrical ones and support the income generating activities being achieved by the project.
- Place a **banner on the gate of the PV plant**, with details of all donors and stakeholders of the project.

Which hurdles need to be overcome in order to have successful multiplication / replication?

- Off-grid regulation in the country should allow for greater flexibility in setting tariffs, in order to attract and accommodate the needs of the private sector to make sustainable business cases.

5.2 Impact / Sustainability

What are the sustainable effects (environmental, socio-economic aspects, CO_2 relevance, resource efficiency, etc.) expected during the multiplication phase, in the medium term?

- By installing the mini-grid in Hurri Hills currently operating with 100% solar energy, an alternative electrification mode based on fossil fuel has been avoided. Similarly, for the five mini-grids in Burundi, the users enjoy clean energy, with minimal operation of the diesel genset.

6 Lessons Learned / Conclusions

What are this project's main findings and conclusions?

- Electrification has a great impact on the social conditions of remote areas, especially security.
- Street lighting has a dramatic effect on the reduction of crime and Gender-Based Violence (GBV).

[5] USAID 2020, Off-grid solar market assessment brief for 14 underserved counties of Kenya (Link).

- Having a sustainable business model for maintenance and operation of mini-grids in remote areas require supporting regulation and economic support (in terms of grants or subsidies) from governmental institutions, and in its defect, from external donors.
- 100% PV mini-grids are possible and can provide quality service.

Which recommendations can be made for similar projects, or within this context?

- Communicate since the beginning of the project with other organisations and agencies working in the area, to study their interest to be connected or alternative ways of collaboration to foster development.
- Understand the regulatory framework and how it is forecasted to evolve.
- Do not overestimate the initial willingness of users to be connected to the mini-grid.
- Put emphasis in the training and support of local members of the community, and create a healthy working relationship by meeting their expectations of communication, training and responsibility transfer.

Interesting observations within the project's context: Which of your personal impressions would you like to share?

- It has been a highly positive experience to work with the local operator of the mini-grid, Mr Boniface Wario. Mr Wario showed high motivation since the beginning to participate in the project, and very quickly understood the potential that the mini-grid could bring to his village. He has diligently performed all the tasks assigned to him, has been eager to learn more, and is making a positive impact on his community. The past visit to SESMA offices in Nairobi was very satisfactory for Mr Wario and also for the SESMA staff that participated.
- In rural areas where the economic activities are dominated by livestock activities, it is more difficult to promote the use of productive uses of electricity. In agricultural-based activities, end-users can be engaged into milling or other food production activities, that are not so relevant in cattle-based economies. Furthermore, promotion of other electricity powered activities that could positively influence the community such as water pumping, is not a priority of the community, that sees the idea of a permanent source of water as a potential threat to their livestock, since it may attract pastoralist population from nearby areas.

7 References

USAID 2020, Off-grid solar market assessment brief for 14 underserved counties of Kenya (Link).

8 Annex

- Article in the ARE newsletter