

people&power

STORIES OF DECENTRALIZED RENEWABLE ENERGY PRACTITIONERS IN KENYA

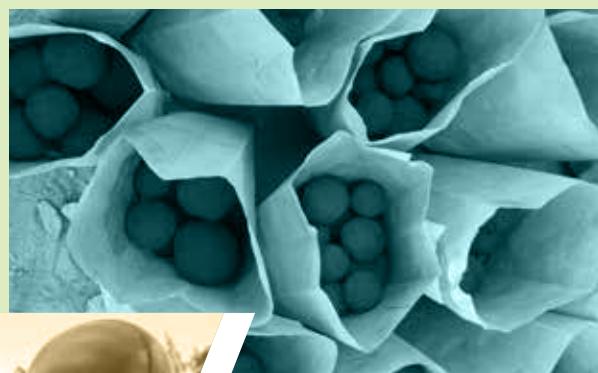


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Foreword

The “*People and Power: Stories of Decentralized Renewable Energy Entrepreneurs in Kenya*” is a publication that documents stories of different Renewable Energy projects in Kenya. The stories provide insight into how decentralized renewable energy is empowering people across the country, especially rural areas where there is high reliance on biomass energy sources due to lack of grid connections. The publication documents 10 successful RE case studies spread across the country on how communities, civil society and specific individuals have used decentralized renewable energy to energize and empower their lives, the struggles they have faced and the lessons they can share. It further interrogates how successful uptake of decentralized renewable has provided social empowerment to the people and improved the livelihoods of the said communities.

Even though the number of people with access to electricity in Kenya has risen annually in the recent past, power supply is still not reliable to many Kenyans. Only about 30% of the population has access to electricity. In rural areas, especially in the sparsely populated northern part of Kenya, less than 5% of households are connected to the grid. Power outages are common due to excess to demand and inadequate transmission and distribution technologies. The vast majority of Kenya's energy consumption (about 68%) is still covered by biomass, which primarily used for cooking. In rural areas, more than 90% of households are using this form of energy. Given Kenya's abundant renewable energy sources, the

potential to scale up renewable energy technologies is high.

There is a huge potential for green technologies in Kenya and such technologies are increasingly becoming competitive thanks to innovation and economies of scale. Soon these forms of energy will phase out the more polluting conventional sources of energy like fossil fuels. The use of renewable energy can potentially bridge the energy supply gap in the country, support electrification of the remote rural areas not connected to the national grid and help meet the climate change mitigation targets. Moreover, it can also reduce dependence on hydroelectric supply which is highly affected by climate change induced water scarcity. The use of renewable energy sources can also play a key role in strengthening climate change adaptation opportunities for the rural poor through the provision of energy services for irrigation and refrigeration and diversification of rural economies through other productive uses of energy. Good examples are highlighted in this publication.

The HBS continue to engage like minded organisations to find such sustainable solutions to energy, and to engage both private and policy makers to address barriers slowing down the uptake of RE in Kenya.

Enjoy the read

Ulf Terlinden
Director, Heinrich Boell Stiftung, Nairobi



The vast majority of Kenya's energy consumption (about 68%) is still covered by biomass, which primarily used for cooking. In rural areas, more than 90% of households are using this form of energy.



Executive Summary

Case Count of Decentralised Renewable Energy Projects in Kenya 2017 is a selection of small-scale, decentralized renewable energy (RE) systems in Kenya in 2017. The study highlights 11 unique renewable energy cases dealing with different technologies that include solar photovoltaics (PV), small hydro, biogas, briquettes and clean cookstoves. The technologies are applied across a range of uses from, basic household energy use, institutional uses, commercial uses and irrigation. These cases provide an insight into how renewable energy is empowering people across the country especially in areas not covered by the national grid. This study examines four main elements of the concerned projects namely: social ownership and local governance; access to technology, skills, and services; access to finance and operation/business model.

The information was collated through interviews with the project management and staff between November 2017 and January 2018. The study attempts to trace how and why the projects were conceptualized, how they were implemented and are being currently run. To assess the impact of the initiatives, project sites were also visited and some key beneficiaries interviewed.

Most of the highlighted projects deal with solar PV technology. These projects are: Talek Power Solar PV Mini-grid in Narok County that provides electricity to residents of Talek Centre through a mini-grid; Makueni County Solar Energy Cooperative Society in Makueni County that supplies electricity to the residents of Kitonyoni Centre through a mini-grid; Basecamp Eco lodges in Narok County that uses solar PV and water heating systems to meet their energy needs in the ecologically sensitive Mara Ecosystem; Gaitheri Secondary School Solar Roof Project in Muranga County where a secondary school adopted solar roofing tiles to cushion them from the frequent power outages and high electricity costs; Ikitisaiya Energy CBO that provides charging services for solar lanterns and mobile phones to the residents of Ikitisaiya in Kitui County; Sunculture, a solar irrigation technology company working with small-holder farmers to improve agricultural productivity in the entire country, and; Women in Sustainable Energy and Entrepreneurship

(WISEe), a women energy cooperative that promotes women in solar energy installation and entrepreneurship in the entire country through capacity building and networking.

Each of the other highlighted projects deal with a specific RE technology either for electricity or household/institutional cooking energy provision. These projects are: Takamoto that supplies biogas technologies for domestic and institutional use and operates in many parts of the country; Magiro Mini Hydro-Power Company that supplies hydro-electric power to the residents of Mihuti Village in Murang'a County through a mini-grid; Sanivation that produces charcoal briquettes from human waste collected through their sanitation project in Karagita, Nakuru County, and Wisdom Innovations that designs, produces and distributes biomass gasifier stoves that are cleaner and more efficient compared to conventional three-stone stoves.

In terms of ownership, the projects can be divided into three broad categories.

These categories are:

- 1) **Community owned projects**, which are owned and managed by the community through either a co-operative society or a community-based organization. The projects in this category are Makueni Energy Co-operative society, Ikitisaiya Energy CBO, WISEe and Gaitheri Secondary School Solar Roof Project.
- 2) **Private companies** which are owned and managed by an individual or a group of individuals. The projects under this category are Magiro Mini Hydro Company Ltd, Takamoto, Wisdom Innovations, Basecamp, Sunculture and Sanivation.
- 3) **County government owned projects** through a registered energy company where Talek Power Solar Mini-grid projects falls.

These cases provide an insight into how renewable energy is empowering people across the country especially in areas not covered by the national grid.

Many of the projects in the first category were initiated by and have received financial support from donors. They are managed by a leadership organ elected through an Annual General Meeting (AGM). However, they all have a sustainability model that stresses on inclusivity, replicability, prudent management of resources and a self-sustaining business venture.

The projects in the second category were mostly initiated through personal injection of capital though they have received donor funding and grants for various activities like Research and Development (R&D), market development or scaling-up. These projects are able to attract donor funding due to their social impact.

The final category, which has only one example, was initiated through donor funding but was then handed over to the county government. The project is run by a limited company that is owned by the Narok County Government on behalf of the people of Narok County.

All the outlined cases have created and continue to create a positive impact in the lives of beneficiaries in different ways through provision of sustainable energy solutions. Across the locations visited, health, economic, social, security and environmental benefits were enumerated as shown in the report. This was accomplished with a few challenges that were encountered either during the project initiation or operation phase. The challenges can be broadly summarized as:

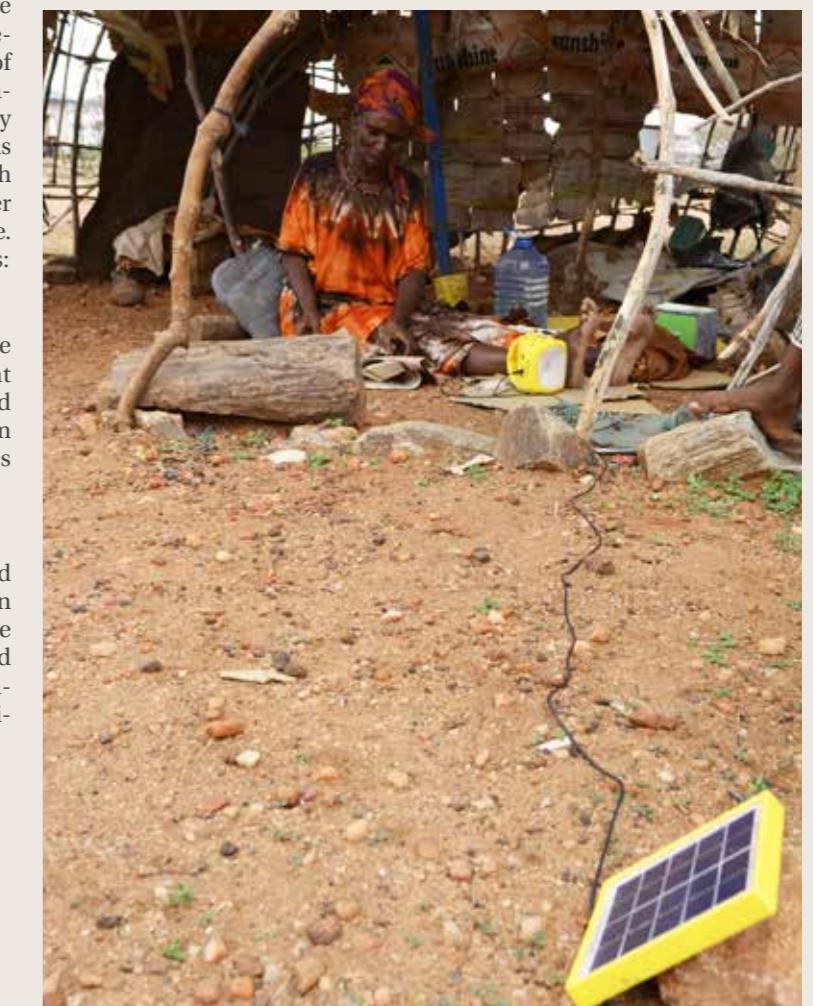


Markets - These include lack of awareness on new products by potential clients. This was addressed through innovative marketing and product awareness drives by the respective projects.



Community mobilization - this was experienced by many of the community-owned projects during the initiation phase. Community mobilization forums were used to sensitize people on the importance of the projects and why they should be a part of it.

The diverse profiles of the selected projects, based on technology, ownership, business model and scale of operations means the lessons learned are quite unique and interesting to a broad audience from policy makers, investors, promoters and financiers



Woman charging her solar torch

Introduction

Case Count of Decentralised Renewable Energy Projects in Kenya 2017 is a selection of case studies of small-scale, decentralized renewable energy systems in Kenya in 2017. The study aims at providing an insight into how renewable energy is empowering people across the country especially in areas not covered by the national grid. The study examines four main elements of the concerned projects namely: social ownership and local governance; access to technology, skills, and services; access to finance and operation/business model.

Each case study captures the journey project developers travelled to get where they are; an overview of the technical aspects of the projects; the business and energy model; the partnerships that they have developed on the way; and lessons learned for the future. The strength of these stories lies in their diversity in terms of technology, model of operation, geography and socio-economic characteristics of the beneficiaries. The case studies highlight the key energy gaps that the projects were designed to fill, the challenges the projects faced and the success stories associated with the project.

As the stories emerge, three main questions form a common thread through all the case studies:

- **Social ownership and local governance:** Who owns runs and regulates?
- **Accessing technology, knowledge, services and training:** How do they know what to do?
- **Accessing finance and achieving economic stability:** How is everything being paid for?

The case studies present personal histories of the proponents, and their innovative thinking and tenacity to see things through despite the odds. They set an example to the rest of the country's innovators and entrepreneurs by spearheading the challenge of addressing key gaps in local energy services provision that can bring lasting transformation in the lives of the rural and peri-urban population of Kenya ■■■



The strength of these stories lies in their diversity in terms of technology, model of operation, geography and socio-economic characteristics of the beneficiaries.



Case Study 1: Takamoto Balloon Biogas

Affordable biogas systems for small scale dairy farmers in kenya

Background

In Kenya around 70% of the population relies on biomass (firewood, charcoal, agricultural residue) for their cooking needs. Despite efforts to address the situation, biomass is still an unsustainable source for household and institutional energy. Biogas provides a sustainable alternative for parts of the country that embrace livestock farming, particularly dairy farming. The technology has been around since the early 80s with mixed levels of success due to various reasons including high cost and lack of technical capacity among others. In the last decade, however, significant progress has been made in building local capacity, quality installations and standardization, with the Kenya Biogas Programme KBP playing an important role in ensuring installation of quality biogas systems in the country. KBP estimates that around 400 Biogas systems are installed annually in Kenya. High initial installation cost of biogas continues to be a deterrent to many potential users. For example, a fixed dome system typically costs around KES 75,000.00 (USD 750) while a plastic floating drum system costs over KES 210,000.00 (USD 2,100). Takamoto Biogas is an interesting example of how one company is using innovative and socially inclusive technological and financial approaches to carve its niche in this sector.

KBP estimates that around **400** Biogas systems are installed annually in Kenya. High initial installation cost of biogas continues to be a deterrent to many potential users.



Takamoto Biogas was conceptualised in 2011, with the objective to provide affordable, reliable, energy to small scale dairy farmers in Kenya. Takamoto was coined from two Kiswahili words 'Taka' means waste and 'moto' which means 'fire' or 'fuel'. The Founder and Managing Director Kyle Schutter conducted research on biogas in Kenya, Uganda, Rwanda, Ghana and the USA, before setting up Takamoto. He has received various awards for his work including the Enjuba Young Entrepreneur Award; the Heinberg Social Innovation award; special recognition from the Sankalp Africa Summit, 2014 and took second place in the William James Business Plan competition.

Takamoto Balloon Biogas Technology

The Takamoto technology comprises of a unique 10 cubic metre (m³) Balloon Bag Digester, which was selected after a series of trials, in close consultation with dairy farmers. Various designs including the conventional, concrete fixed dome and metallic floating drum systems, typically installed in Kenya, had been trialled before settling on this technology. The Balloon Digester is a prefabricated hollow rubber bag which is robust, lightweight, flexible and easy to install. System installation normally takes one day. It is pre-filled with cow dung and water and produces biogas within a week. The gas produced provides 6-8 hours of cooking on a single burner stove - more than adequate for the average Kenyan household of 6. According to Takamoto, these systems, which are imported from China, last longer, are cheaper and easier to maintain compared to other locally manufactured options such as the Plastic Floating Drum Bio digesters currently in the market. The current regulatory framework allows tax-free importation of Biogas Digesters and appliances which makes it possible to supply the technology to the farmers at an affordable price. While they still continue servicing conventional systems installed earlier, Takamoto currently promotes the Balloon system, which has proved very successful in the field.

A typical system comprises of one 10m³ digester, 1 double-burner cooker, sufficient piping for the entire system, installation labour and on-site training on operation and maintenance. The company also stocks a range of



related appliances such as kitchen gas burners; de-sulphurisers (which remove bad odour, and are replaceable every 2 years) and instant water heaters. In addition they sell chicken brooders which are in high demand by small scale farmers and other biogas system installers. These items are sold directly and are self-installed by end-users under clear written and spoken instructions. They generate good income for the company especially during periods when there are fewer full system installations.

Governance, Business Model and Partnerships

Takamoto is registered as a private business in Kenya and is run by a Board of Directors. It currently employs 12 Kenyans, 25% of whom are female. Its head office is in Githunguri town in Kiambu County, and they also have a warehouse in Karatina, Nyeri County. Takamoto is the only company in the country that offers biogas systems directly on credit. Initially they offered two options for payment by customers namely: (i) Cash and (ii) Lease-to-own.

Trials with the Pay As You Go(PAYG) model-a popular business model that is proving successful for Solar Electric Home Systems in Kenya-where customers only paid for using biogas as a service and did not own the system, showed that it was expensive and not sustainable due to various reasons. The reasons included the high cost of purchasing remote monitoring equipment as well as costs of attending to customer calls and monitoring site visits. This made the PAYG model unsustainable and it was abandoned after one year. Takamoto currently focuses on the Lease-to-own model which is working well. To support sales the company engages 7 sales agents, each with a monthly target of 6 systems, which they sell on a commission basis. Once the sale is made, the customer is assigned a unique account number that enables Takamoto to track the operational and financial status of the installation. System costs can vary due to the associated additional transport, labour and other site costs.

Under the Lease-to-own arrangement, the repayment period varies from 1-3 years depending on ability-to-pay. A Kiambu customer, for example, will pay a total of KES 112,200 or around

Margaret Wango of Takamoto Biogas shows a typical balloon biogas digester at a small farm in Githunguri, Kiambu County

The gas produced provides **6-8 hours of cooking on a single burner stove**

- more than adequate for the average Kenyan household of 6.

USD 1,122.00 (1 USD = 100 KES) for one system, by making an initial payment of KES 15,000 (USD 150), followed by monthly instalments of KES 2,700 (USD 27) over the next three 3 years, after which he or she fully owns the system. After clearing the payments, the customer fully owns the system but continues to receive support when needed. In the event that the customer defaults in payments, Takamoto, as a last resort and after having engaged with the customer, is able to repossess the digester due to its portability. This action would have been more difficult or almost impossible with the conventional fixed dome and floating drum biogas systems. The lease-to-own model is only available to customer groups where a cluster of systems have been installed or in Kiambu and neighbouring counties because of ease of follow-up in case of default. The cash-up-front customers pay KES 70,000 or USD 700 for a complete system. In this case, the customers pay a down payment of KES 20,000 (USD 200) and clear the balance immediately after the system is installed.

In both cases, following a commissioning period of 2 weeks after installation, the customer receives a commissioning certificate and enters into a written agreement with Takamoto specifying their terms of engagement. In tandem with the installation, Takamoto provides end-user training on operation and basic maintenance, a simple easy-to-follow instruction manual, and free after-sales service for one year. The cash-up-front model applies to individual, non-clustered customers from remoter areas of the country, where Takamoto has less presence.

Being a small company working in a wide area, Takamoto uses several innovative approaches to attract and maintain customers. For example, they have an internship programme where fresh graduates are trained and then attached to customers in specific areas over a three-month period, to work closely with the farmers, support them in biogas system operations as well as guide them on efficient farming techniques. This proves to be a cost-effective way of keeping in touch with clients and providing additional value to them, thus enhancing customer satisfaction. On the operations side, and with a strong drive to go paperless, all Takamoto records/transactions are maintained electronically. A customised online software application manages all customer data including financial transactions, repairs and maintenance with ease then sends automatic alerts to the office during various stages of installation.

A key driving factor in increasing sales has been Takamoto's successful partnership with a num-



ber of local Savings and Credit Cooperative Societies (SACCOs) and Micro-Finance Institutions (MFIs). These include the Githunguri Dairy SACCO, K-Unity SACCO and Juhudi Kilimo SACCO. These institutions provide access to a larger customer base; pay Takamoto up-front for systems bought by their members and relieve Takamoto of the burden of chasing defaulters.

Another contributing factor to success has been Takamoto's partnership with the Kenya Biogas Programme (KBP), the lead agency recognised by the Ministry of Energy, which oversees the sector nationally. KBP provides technical support to biogas entrepreneurs and offers them a marketing platform by creating awareness and linking them up with potential clients. KBP conducts regular customer satisfaction surveys across the country, grading biogas suppliers as Yellow (>84% satisfaction level); Green (51%-75%) and Red (<50%), and also provides feedback to suppliers on improvements that can be made.

Thanks to US based partnerships with KIVA - an online lending platform that connects online lenders to entrepreneurs across the globe – and AECF (the African Enterprise Challenge Fund) - a private sector fund that provides catalytic funding to renewable energy enterprises in Sub-Saharan Africa, Takamoto does not rely on donor support for its operations.

KBP conducts regular customer satisfaction surveys across the country, **grading biogas suppliers as Yellow (>84% satisfaction level); Green (51%-75%) and Red (<50%)**, and also provides feedback to suppliers on improvements that can be made.

Challenges and lessons learned

Notwithstanding the above, the business is not without challenges. Kenya's biogas sector is largely self-regulated and whereas a specific energy license for biogas is not required, the company pays for a number of licenses annually to run the business (this applies to similar businesses in Kenya). The licenses include a business permit; branding licenses; storage licenses – all costing around KES 13,000 per year, as well as signage permits costing KES 2,900 per sign per



Takamoto pays a fee every time their branded vehicle is parked in a different county

year. Coupled with that, under the devolved governance structure, Takamoto pays for a separate branding license in every county they operate, mainly for parking their branded vehicle in the county. The Annual Branding license fees vary between counties. Currently, it is KES 10,000 in Nyeri, Nakuru and Eldoret while in Narok and Bomet the fee is KES 5,000. In 2017 alone, Takamoto paid around KES 60,000 for various licenses to county governments.

'For ease of doing business, to avoid duplication, and double payment, branding licenses should be handled differently, perhaps at the National level' suggests Benson Otieno, Takamoto's Operations Manager.

Another key challenge has been the high rate of defaulters, which currently stands at 47%.

'Sometimes, death in the family has affected payment, for example, the husband dies and his widow does not have an alternative or adequate source of income to continue paying monthly instalments. In other cases, the dairy cow which produces the milk for income dies, thus interrupting payments. Although this is not common, it is a sad situation and we have to be sensitive and handle the issue with care' says Margaret Wango, the Marketing Officer, also in charge of customer service. To address the issue of defaulters, Takamoto is trying to expand partnerships with SACCOs and MFIs as they are better equipped to take on the task of debt collection. However, the financial gap created by defaulters is often off-set by income from sales of the biogas accessories mentioned above.



Grace Njatha feeding her floating drum biogas digester at her Githunguri farm in Kiambu

Impact and Future Plans

The environmental, economic and social, benefits of biogas use are quite a number, according to Benson and Margaret. They include:

'More trees are conserved that would either be pruned or cut down for firewood and charcoal. In fact, 12 trees are saved per system. A system is also able to save about 4.5 tons of CO₂ equivalent methane emissions that would have been released to the atmosphere had the cow dung been left to decompose in the open; Farmers save on cost of buying chemical fertilizers by using high quality slurry produced by the biogas plant; Households spend less on purchase charcoal and LPG for their cooking needs; Less time is spent by women and children in collecting firewood; Cooking with biogas as it is clean, quick, efficient and convenient; Biogas cooking can be done on two or three burner stoves, compared to the popular 5 kg Meko LPG cylinder and its integrated single-burner stove; In the field, we have even noticed an increase in self-esteem amongst their customers.' Grace Njatha, a small-scale dairy farmer in Githunguri, and one of Takamoto's earlier customers, installed her 10 m³ floating drum system in 2013 and says:

'I previously used firewood, charcoal and LPG (Liquefied Petroleum Gas) for my cooking needs, which was quite expensive. I now rely solely on biogas for all my family's cooking and hot water needs. Since my biogas system was installed, I have done away with charcoal completely, and only use LPG and firewood to cook large quantities of food when hosting visitors. I try and avoid any impurities when mixing the cow dung and water for feeding my digester, as I know this will result in low output. I have also realised that

feeding my system daily with one drum-full of cow dung and water, ensures good gas production. The system is very economical as I already have a lot of cow dung; water is readily available and only need labour which is affordable, to feed my system. You can't sleep hungry when you have biogas,' she adds happily.

To date, over 450 Takamoto biogas systems have been installed for small-scale dairy farmers (majority), self-help groups, children's orphanages; government institutions and community hospitals in over 24 of the 47 counties of Kenya. These include Kiambu, Meru, Nyeri, Muranga, Embu, Machakos, Makueni, Laikipia, Nyandarua, Isiolo, Kajiado, Nakuru, Bomet, Kericho, Kisii, Kisumu, Nandi, Uasin Gishu, Kakamega, Trans Nzoia, Elgeyo Marakwet, Kitui, Samburu and Tharaka Nithi. Kiambu County leads with around 200 systems, followed by Meru and Nyeri, each with over 30 installed systems. 320 of the 450 are balloon systems, of which 2 have been sold in South Sudan, awaiting installation.

Takamoto is now planning to increase its sales target from 42 to 70 systems per month. They want to diversify the balloon digester volume to include 4 m³, 6 m³, 10 m³ and 30 m³ digesters to suit the needs of different customers. In addition, they are considering installation of fixed dome systems for institutional customers. They also plan to open shop in the capital city of Nairobi, with a view to expanding their customer base to include supplying other biogas companies with biogas fittings. As they do this, they intend to continue to proudly uphold the highest 'Yellow' Kenya Biogas Programme grade to ensure a high quality, affordable product and highest levels of customer satisfaction across the country ■■■

To date, over 450 Takamoto biogas systems have been installed for small-scale dairy farmers (majority), self-help groups, children's orphanages; government institutions and community hospitals in over 24 of the 47 counties of Kenya.

Case Study 2: Magiro Mini Hydro Ltd

Electricity access and entrepreneurship

Background

Small hydro is a decentralised renewable energy technology that provides electricity locally to rural communities where the very high cost of extending the grid by government is prohibitive. This is in great contrast to large full-scale hydro schemes which produce large amounts of electricity that can be transmitted and distributed to towns, cities, countries and even regions. In Kenya the estimated small hydro potential is 3,000MW of which only about 10% is currently harnessed. It is nationally classified into three:

- Pico (< 5kW)
- Micro (5-100kW)
- Mini (100-1000kW)
- Small (1000-3000kW).

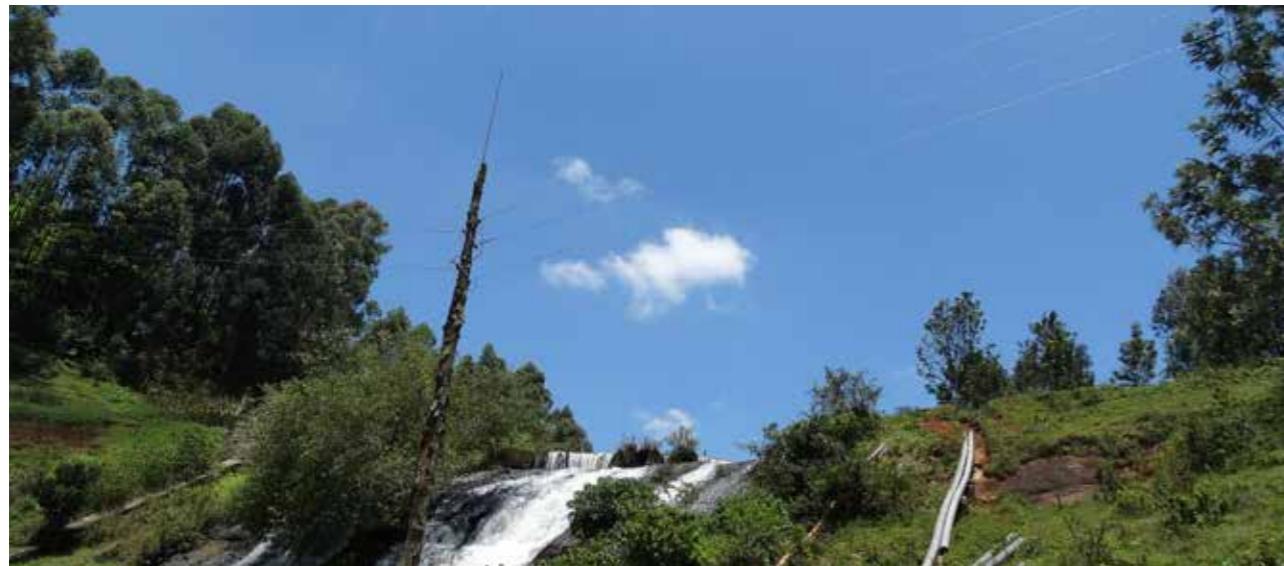
Most small hydro schemes are run-of-the-river, meaning that they do not stop the river flow, but instead divert part of the flow into a channel or pipe and then through a turbine to generate electricity. This electricity which can then be distributed to households, businesses and community centres provide household energy needs such as lighting, mobile phone charging, radio, TV as well as powering equipment such as chicken incubators, brooders, chaff cutters and water pumps for irrigation. At the community level, electricity access can greatly boost the local economy by providing power not only at the household level but also for productive

end use for small business, as well as facilitating the provision of community services such as education, health, water, and communication, among others.

With adequate, financial, regulatory and technical support, such schemes can be easily implemented in Kenya because they are environmentally friendly, can be designed locally with locally fabricated or available components and successfully managed locally. The Magiro Mini Hydro scheme in Muranga is an example of how a young entrepreneur with limited knowledge and resources and driven by a strong passion to make a difference in his life, is turning his dream of providing electricity to his community into a reality.

Technology

When there were not enough kerosene lanterns at home to enable 12 year-old John Magiro Wangare of Gikoe Village in Mathioya sub-county of Muranga County to study at night, he decided to look for an alternative. Rather than reading by the poor light from the kitchen fire, he began using the small bicycle dynamo light on his brother's bicycle. He soon abandoned the cumbersome task of reading his book while peddling the bicycle, and invested in a car alternator, which he later ended up replacing with a petrol generator for KES 3,500 (USD 35) using borrowed funds. Excitedly, he was now able to connect electricity to his home without



With adequate, financial, regulatory and technical support, such schemes can be easily implemented in Kenya because they are environmentally friendly,

*John Magiro Wangare,
Mini hydro Entrepreneur*

external help. However, KES 80 (USD 0.8) per litre of petrol daily proved to be expensive and so he looked around for an alternative 'fuel-less' option to generate his electricity and found it in the running waters of River Ngondo, a tributary of the Mathioya River, about 1 km away from his home. Using KES 6,000 (USD 60) from the sale of rabbits and goats which he reared on a small-scale basis, John, with little technical knowledge, took apart his generator and using bicycle parts and a home-made turbine, set it up to run as micro hydro plant. The owner of the farm where his small powerhouse was located gave him space for free. Soon, John began generating his own electricity from hydro power. He earlier on started charging his neighbours mobile phones and now connected electricity to their homes. Neighbours set aside initial fears and scepticism and happily joined his project and more and more customers wanted to be connected to his grid. Recognising a good business opportunity, John began selling electrical power to his community, with the objective of transforming the lives of his community from within.

Governance, Business Model and Partnerships

Word about this self-taught young inventor spread wide and attracted the attention of Netfund (National Environment Trust Fund) a government-led fund that supports scaling up

and incubation of green grassroots initiatives in Kenya. In 2014, John was placed first in the individual category of the Netfund Green Innovation Award and received business training as well as mentorship and coaching from Daystar University, which also helped him refine his technology. His Netfund award included seed funding to install a 30kVA generator, turbine, control system, pressure pipe, stabilizer, power line cables, a transformer and posts, which he used to increase his customer base. Netfund supported him to register his company and negotiated with NEMA (National Environment Management Authority) for permission to use water from River Ngondo. The Netfund incubation programme also provided additional funding from the Pollution Project of the East African Hub Grant and in 2016 where John was also given the opportunity to pitch his project to over 50 investors at the Netfund investors Forum. Netfund is currently supporting approvals for his power company from the Energy Regulatory Commission (ERC). The Magiro Mini Hydro Company Ltd. was duly registered in 2013 and currently has 4 employees, 3 male and 1 female. John operates his business from his home and has personally trained all his employees who are Form Four high school leavers. In addition, he has trained and continues to train many other youth who visit him regularly to learn more about his scheme.

Depending on the premises which could be an individual homestead, office, a small business



John Magiro inside his powerhouse explaining how the scheme works

Magiro charges a connection fee ranging from **KES 10,000- 23,000 (USD 100-230)**, which customers have the option of paying a KES 5000 (USD 50) deposit and the balance in 3 monthly instalments.

Challenges and Lessons learned

The scheme has had its share of challenges. Some of them include:



During the initial stages, **theft** of poles and overhead electrical wires posed a temporary set-back to the project.



Poles currently used for the overhead wires to distribute electricity are obtained from trees cut locally, and need replacement often as **they do not last long** because they are not treated.



There are those who **default on monthly payment** and following them up takes up valuable time and effort. The number of defaulters currently is around 10 households comprising 4% of all customers. Magiro gets around this by asking for a 3-month payment in advance before reconnecting a customer who has defaulted.



A few distant customers around 20 km away, experience **low voltage** - 170V instead of the expected 240V, which the scheme will need to address.

The Magiro mini hydroelectric project was the international 2016 SAG-SEED award winner (an award founded by UNEP, UNDP and IUCN), having been selected as 'an exceptional eco-inclusive start-up enterprise'.

or community centre, wiring costs KES 9,000-13,000 (USD 90-130). Magiro charges a connection fee ranging KES 10,000- 23,000 (USD 100-230), which customers have the option of paying a KES 5000 (USD 50) deposit and the balance in 3 monthly instalments. When connecting a customer, he educates them on safe use of electricity and advises them on how to conserve energy and not to exceed their agreed electricity allocation of 2 to 3.5 kWh per month. Customers pay their monthly bills through their mobile phones, which is very convenient.

Impact and Future Plans

The Magiro mini hydroelectric project was the international 2016 SAG-SEED award winner (an award founded by UNEP, UNDP and IUCN), having been selected as 'an exceptional eco-inclusive start-up enterprise'. John Magiro has also recently won the WWF Regional Office for Africa (ROA) youth runners-up award for 'creating his own hydropower plant in Kenya and his ability to bring the community together for sustainable development'. His project has been widely covered in the local and international media, including the Daily Nation, Business Daily and Taifa Leo newspapers and, more recently, Al-Jazeera.

Today his 250kW small hydro scheme provides electricity to around 250 customers comprising farmers, teachers, business people and others in neighbouring areas including Gikoe, Mihuti, Kirimahiga, Kiiru, Gitugi, Ileke and Gikuuni in the sub-county of Mathioya. Beneficiaries are now using electricity in their homes, have power to run chaff cutters and water pumps. There is now improved security as the scheme has installed street lights for free. One of Magiro's customers and neighbour, Shem Chege Muthuma, a small scale tea, coffee and dairy farmer has this to say:

I was one of the pioneer customers of the project and connected my home in 2010. At that time, the nearest power line was at Njumbi, some 3 km away, and Kenya Power wanted me to pay KES 500,000 (USD 5,000) to connect to the grid, which I would never be able to afford. Since connecting to Magiro, I no longer use kerosene for lighting and my young family can now see and read in comfort and security. I have bought a television set and a music system with powerful speakers, and am now planning to buy an electric chaff cutter to help make it easier for me to chop Napier grass for my cows. I pay KES 200 (USD 2) every month, which I can comfortably afford. I studied electrical installation briefly when I was a student, and sometimes help John out in attending to any issues, when he is not around. The electricity is very reliable and I am very proud of it!

However, John has bigger plans. He wants to improve his grid infrastructure by replacing existing electricity poles with treated ones and to



expand coverage to a radius of 50 km and reach about 10,000 households. He has several other business ideas like improving access to water in his community. Currently, households pay KES 500.00 monthly to the county government for water - he would like to set up a business to supply water at competitive cost. He wants to sell water pumps to farmers for small-scale irrigation, that he would then maintain; he also wants to set up 2 or 3 maize mills to provide grain milling services.

John is now looking at opening up an office in Gikoe market which will provide him with better frontage. The Magiro Mini Hydro Scheme is a clear example of a grassroots entrepreneurial spirit that has ignited a rural population in Kenya by enabling access to affordable, reliable and clean electricity.



Magiro Power

provides electricity to around 250 customers comprising farmers, teachers, business people and others in neighbouring areas including Gikoe, Mihuti, Kirimahiga, Kiiru, Gitugi, Ileke and Gikuuni in the sub-county of Mathioya.

Case Study 3: Wisdom Innovations

Building sustainability around clean cooking



Background

High reliance on biomass for household and institutional cooking results in the depletion of forests and health complications, among other negative effects. In Kenya, a wide range of stakeholders including government, donor agencies, non-governmental organisations, *'jua kali'* artisans, private companies, research organisations, and finance institutions have played a key role to address this and define the Improved Cookstoves (ICS) sector as it stands today. The large variety of ICS technologies, fuels, and business models developed over the years provide good learning opportunities for project developers and researchers as well as potential investors and entrepreneurs, especially under the current devolved government dispensation.



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port with Nathan Puffer, a US citizen whose wife was a teacher at his school. Years later in 2010, they reconnected with the idea of developing an improved rural biomass cookstove that would make household cooking easy, clean, efficient and affordable. With Nathan's engineering skills and Dan's business acumen, the Wisdom Gasifier Stove was born. Dan resigned from his full time job as an IT administrator with a private company in Nairobi, to focus on the stove business and together, they set up a small manufacturing workshop in Dan's home area of North Kinangop in Nyandarua County.

Technology

The Wisdom stove is a TLUD (Top Lift Upward Draft) gasifier biomass cookstove using natural draft technology which is one of the most efficient ways of burning biomass. Using a few small sticks of firewood, the stove burns the wood, converting the smoke into a synthetic gas which burns with minimal emissions and a

clean flame, allowing efficient cooking. As the wood burns, it is converted to charcoal through a thermal process called pyrolysis. The user thus produces charcoal while cooking with firewood. The charcoal continues to burn in the stove, which provides heat for extended cooking, or can be saved for future use.

The stove is fabricated by hand using local materials with present production capacity of 150 stoves per month. The first prototype 10 stoves were given out to households for piloting for free. Since then, the stove has undergone several design modifications based upon feedback from end-users, before arriving at the current design.

Governance, Business Model and Partnerships

In Kenya, the company was registered as Wisdom Innovations Ltd., with Dan as its Managing Director, while in the US it was registered as an NGO, with Nathan in the lead, each complementing the other with different business models. Both entrepreneurs used their own funds to start up the business, with Dan providing the land on which their workshop is built. Dan started marketing the stove through demonstrations in the nearby market centres, growing his customer base slowly but steadily. In 2012 he was joined by his partner Amos Nene, who has extensive experience in working with women groups and consumer financing. Currently, Wisdom has a total of 7 employees - 5 male, 2 female and another contracted female. In addition, they have trained 5 strategically based sales people who work on a commission basis. The company has sold stoves all over the country, but decided to focus in 4 specific counties - Nakuru, Nyandarua, Narok and Kiambu in line with their current production capacity.

Says Dan excitedly,

"We are targeting the 3.5 million Kenyan households who use biomass for household cooking and do not have access to Improved Cookstoves. We are aiming to increase our current production from 150 to 375 stoves per month very soon by doubling the number of sales personnel and outsourcing certain workshop operations such as metal cutting and folding. By serialising our stoves, we are able to keep track of every stove sold."

The Wisdom TLUD gasifier stove retails at KES 3,500.00 (USD 35) and is exempt from Value Added Tax (VAT) – a ruling made by govern-



We are targeting the 3.5 million Kenyan households who use biomass for household cooking and do not have access to Improved Cookstoves.

ment in June 2016 that has facilitated the ICS sector to grow. The company uses two business models; direct sales and low-cost credit. Because the Wisdom Stove works quite differently from many other improved Cookstoves available in the market, the company recognises the need for behavioural change by end-users, who are usually the women. Constant consumer awareness and training is their priority and they take pride in maintaining continuity with all their customers. As a result most of their sales are through referrals from satisfied end-users.

Their operations have attracted the interest of other agencies and in 2015, Global Alliance for Clean Cookstoves (GACC) provided a grant to help them set up a distribution network, branding, packaging and accounting systems. In 2016, they received support from Winrock International, an international NGO, which provided them with 6-month funding with which they were able to experiment with different types of consumer financing. They learned that due to a growing numbers of Micro-Finance Institutions (MFIs) seeking relationships with savings groups, many savings groups were taking

advantage and being manipulative, by hopping from one MFI to another, taking multiple loans. Using a new approach, Wisdom has targeted women groups that were not affiliated to MFIs. In order to qualify, the women groups needed to be legally registered; meet regularly and demonstrate good internal organisation and financial discipline. In this project, stoves were given on credit at 3% interest, payable over 6 months, which they later reduced to 3 months. They experienced a default rate of 3.5% and worked closely with the local area chief to repossess stoves from the defaulters.

Wisdom has established strong partnerships with many organisations such as:



Kenya Forest Service, which provides a good platform at KFS events, including annual national and county level agricultural shows.



SNV, the Netherlands Development Organization, an NGO, helped in stove testing at the Kenya Industrial Research and Development Institute (KIRDI) and also provided market support.



Wisdom Innovations is a member of and also participates in Working Groups of the **Clean Cookstoves Association of Kenya (CCAK)**. CCAK is a national organization that coordinates stakeholder activities through partnership building, policy advocacy, public awareness creation and capacity building in the sector.

Their latest partnership with the Kenya Climate Innovation Centre (KCIC) provides among others, technical support, market platforms, networking opportunities, training and mentorship, as well as an office space in Nairobi.

Challenges and Lessons learned

"We prefer selling directly to the women because making a successful sale to a man will not work as he does not always transfer the teaching effectively to his wife," says Dan. He adds, "Without gender sensitivity, selling or maintaining our stoves can be quite a challenge. We have found that if one woman's stove does not work, she will tell her group members first and unless we are in regular contact, we might never know. Continued follow-up is important in order for us to succeed".

While most of their sales are direct, Wisdom also links up with Micro Finance Institutions

(MFIs) to get access to more consumers, which the MFI can manage directly. This model has had mixed levels of success. One MFI they teamed up in 2015-2016 brought almost instant results in the beginning with all stoves being sold out in a month. Unfortunately, the MFI would not let Wisdom contact these customers directly to gauge end-user feedback and this resulted in poor after-sales support. To make matters worse, the MFI delayed payment to Wisdom, even after all the stoves had been sold. The two organisations parted ways soon after. However, Wisdom continues to work with other MFIs through other programmes such as the DFID/GIZ funded Results Based Finance (RBF) programme, which channels Cookstoves financing through selected MFIs.

Wisdom also teamed up with a Savings and Credit Cooperative Society (SACCO), a partnership that led to some level of success. However, this relationship also ended when it was found that the SACCO was not carrying out a key component of sales – stove demonstrations – which resulted in lack of understanding by end-users on how to use the stove correctly.

Impact and Future Plans

To date, 3,700 Wisdom TLUD gasifier Cookstoves have been sold, mostly through direct customer sales. Wisdom Innovations won several awards for their technology including an award at the 2014 Agricultural Society of Kenya show for Best Energy Innovation. They now have a good market base and are also partnering with briquette producers to provide a complete stove/fuel solution. They intend to continue with the current business model of selling directly and providing consumer finance. In the coming year, however, they are looking to double their sales staff to 10, who will now get a basic monthly stipend in addition to commission on sales. In addition, they are looking to set up strategic distribution points in the current counties of operations, each with a full-time field officer, for better customer support. These points will also serve as a repair centre in the area.

Setting their sights to 2019, the company plans to build a new, bigger manufacturing facility in Kikuyu town, on the Southern Bypass Highway, just off Waiyaki Way, for greater visibility and market access, with a production capacity of 2,500 stoves per month. As they expand, they will consider setting up distributorships and stocking their stoves in supermarkets. According to Dan, their current partnership with KCIC is aligned to secure debt financing for the company, which will bring transformational change in a very short period of time ■■■



Without gender sensitivity, selling or maintaining our stoves can be quite a challenge. We have found that if one woman's stove does not work, she will tell her group members first and unless we are in regular contact, we might never know. Continued follow-up is important in order for us to succeed".

Dan Waithaka
Founder xyxyxt a voluntati

Case Study 4: Talek Solar Pv Hybrid Minigrid

Bringing reliable and clean grid power to the people of Talek in Narok



The 40kWp Solar Array that supplies the Solar PV hybrid mini-grid in Talek

Background

Talek Solar PV Hybrid Project supplies grid power to Talek urban centre in Talek Location of Narok West Sub-County, Narok County, in the outskirts of the Maasai Mara Game Reserve. Talek centre has a population of about 3,000 people living in 400 households. Like many rural centres in Narok County, Talek centre is not covered by the national grid. This means that before Talek Solar PV Hybrid Minigrid, energy access for lighting and powering electronic equipment for domestic use and business was a big challenge. In addition, charging mobile phones for communication with the outside world was only possible through solar home systems and was quite expensive.

Through discussions between the local community leadership, the county government and the German Development Cooperation in Kenya (GIZ and Welthungerhilfe) in 2014, it was agreed that a solar hybrid mini-grid was the best way of bringing clean energy to the people. The project had the following main objectives:

- To provide electricity access to the community.
- To improve the livelihoods of the people in the area.
- To provide an effective solution that was compatible with conserving the environment.

To implement the project, Talek Power Company was registered by the County Government of Narok in 2014. Welthungerhilfe was involved in community mobilization while GIZ financed the project, supported the registration process and conducted capacity building seminars. The county government of Narok donated the land on which the project is built and supported formation of the power company. The project was built by a German company Energybau Solar Power GMBH in collaboration with a Kenyan company Go Solar Systems LTD. It was commissioned in 2015 and handed over to the County government. For the overall management and maintenance of the system, PowerGen, a Kenyan renewable energy company

that specialises in micro-grid development, operations and maintenance, was contracted by the county government.

The project was set up to provide clean power access to the community with the aim of boosting the economic capacity of the local community by enabling them to engage in electricity-dependent income generating activities like welding, barber shops and hair salons. In addition, people would be able to conduct their business even late at night thus increasing their earnings and enabling access by customers to goods and services. It also provided an environmentally friendly power source to residents of Talek whose economy revolves around sustainable eco-tourism.

Technology

Talek Solar PV Hybrid Project is a 50kW system, consisting of a 40kWp of solar array, a 12kVA diesel generator, a 3,210Ah battery bank and a 2.5 km low-voltage 3-phase distribution network. Clients are billed through mobile money, using a Standard Transfer Specification (STS)-compliant prepayment system through prepaid vouchers. Currently, the company has made 181 connections of which 100 are to business premises and 81 to households within Talek centre. Most of the household consumers work in the tourism sector, especially in the hospitality industry.

Business clients include shops, bars, restaurants, wood workshops, welding workshops, a cyber

café, barber shops, hair salons, a health centre and a video hall.

Governance and Business model

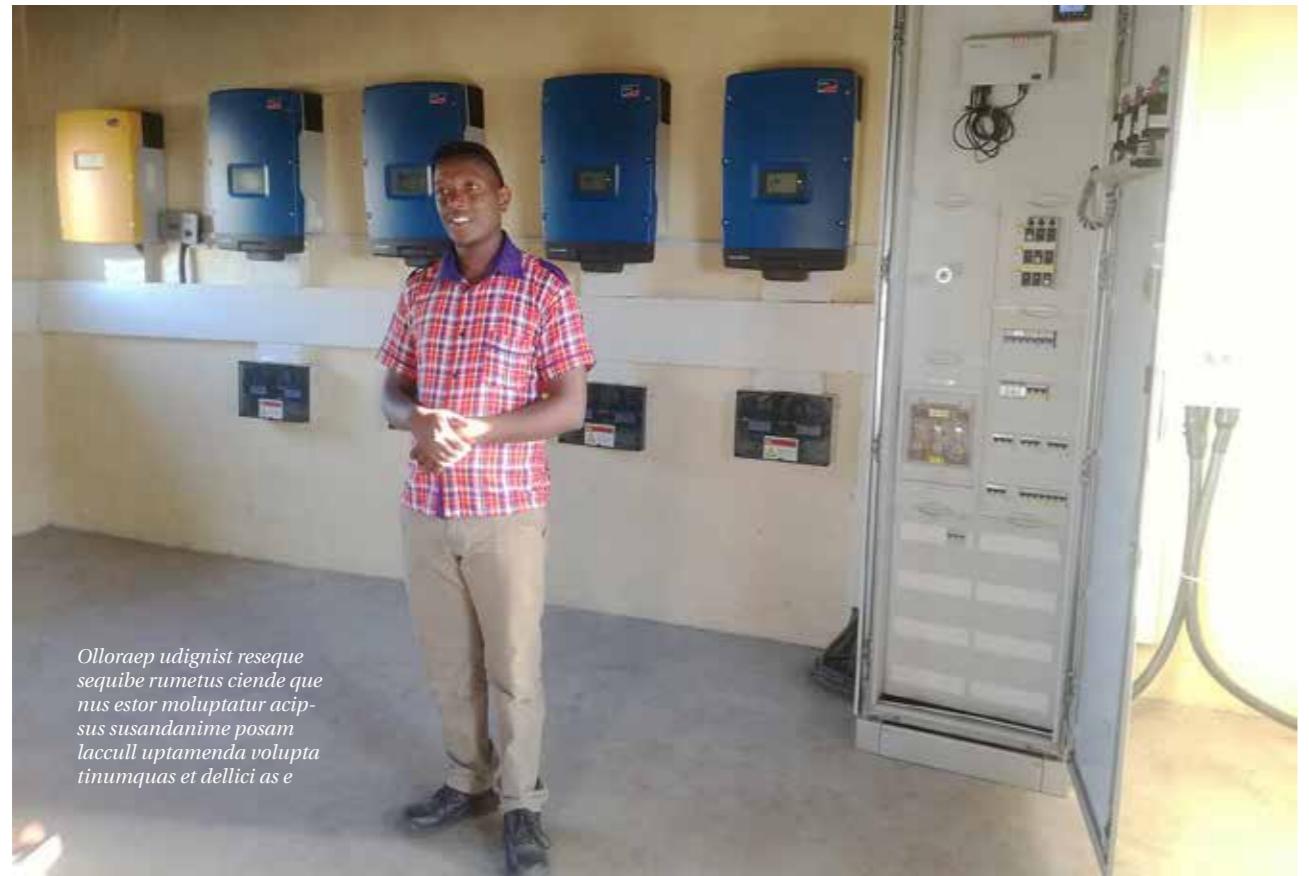
When a client wishes to be connected with power, they apply formally by filling a form. The expected maximum consumption is assessed based on the projected peak load when all the electronic gadgets are connected. This is used to set the customer power consumption threshold. The client's premises wiring is then evaluated to establish if it meets the required standard. If compliant, the client is advised to pay a connection fee of KES 13,000 (USD130) for single phase connection and KES 23,000 (USD230) for 3-phase connections, the latter being for large power consumers like welders. Power is then connected and a prepaid meter installed at the premises. Schools in the area have not been connected to the mini-grid as they have already been supplied with power through another government programme.

Through the prepaid power purchase system, a client buys their units of power in advance. The first 20 kWh of power costs KES 70 shillings per unit while any unit above 20 kWh costs KES 86.00. The customer then pays a standing charge of KES 100 per month and 16% VAT. For customers using 20 kWh and 50 kWh of electricity per month, their respective power bill is as shown in the table below:

Clients are billed through mobile money, using a Standard Transfer Specification (STS)-compliant prepayment system through prepaid vouchers. Currently, the company has made **181 connections of which 100 are to business premises and 81 to households** within Talek centre.

Item	20KWh consumer		50KWh consumer		Comment
	Unit cost (KES)	Total cost (KES)	Unit cost (KES)	Total cost (KES)	
Standing charge	100	100	100	100	Paid monthly
Power cost up-to 20KWh	70	1400	70	1400	Tariff applicable for the first 20 units to ease power burden on small consumers
Power cost for units above 20KWh	-	-	86	1720	Power tariff applicable for any units above 20KWh
Sub-total		1500		3220	
16% VAT		240		515	
Total Payable bill		1740		3735	

Table: Power costs for a typical 20KWh and 50KWh consumer from Talek Power Company



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Purchasing power through the prepaid system ensures that there is no possibility of default by the clients and reduces the need to read the power meter every month for billing. This has reduced the company's operating expenses as they have only employed 2 staff members who act as caretakers and watchmen and one temporary technical staff Benson Gitonga, who is contracted when there is need for minor repairs and maintenance. Benson is a local electrician who worked closely with the installation team during the setting up of the mini-grid and has been fully trained to operate and maintain the system. PowerGen has installed a remote monitoring system that enables them monitor generation, consumption and operation of the mini-grid remotely from their offices in Nairobi and Benson provides an important service by being the focal person on the ground, including taking visitors around the installation.

Challenges and Lessons learned

Talek power company model has been hailed as a good model for powering remote areas using renewable energy mini-grids. Indeed, GIZ, through the German Climate Technology Initiative, has used the case to develop a manual on how to register a mini-grid energy service company in Kenya (for more information, visit their website: <https://www.giz.de/en/worldwide/25332.html>).



However, providing power to a previously unserved community has now given rise to several challenges. Some of these challenges are:

Power demand currently outstrips supply with the company being forced to suspend new connections since November 2017. Already, 5 clients who have applied for connection have been put on-hold. According to Benson Gitonga, there are plans to double the capacity of the power generation facility so as to cater for the high demand, and possibly to extend the grid to the neighbouring villages.



High cost of electricity connection and tariffs which means many poor households which would like to get connected cannot afford the connection and high tariffs. According to Benson, some of the people in Talek already complain that the tariffs are too high compared to the KPLC national grid and that they would prefer paying comparable rates.



During **cloudy weather**, the power output from solar is reduced, despite the battery bank, thus necessitating the use of the diesel generator which increases the cost of generation for the company.

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Due to the rise in demand, however, even full power from solar during good sunshine periods is not able to meet the current energy requirements, which again calls for reliance on the generator. Unfortunately, the generator has not been operational for the last 6 months and this has led rationing of power. During rationing, electricity supply is limited to between 6am to midnight. This has affected businesses that were now used to operating on a 24 hour-basis, forcing them to invest in their own diesel-powered generators or solar home systems as back-up. The health centre is also affected, and health services are impacted during periods of no power

Security lights have created the added advantage of keeping wild animals at bay. Unfortunately, a leopard recently attacked a homestead in the centre and ate a goat in the wee hours of the morning. According to Amos Kipeen, Programs Manager at Basecamp Foundation in Talek, this can be attributed to the recently introduced power rationing.

The Power Company has dealt with the challenge of demand by not connecting any new customers- no additional connections have been made since November 2017 and there are at least 5 pending applications. There are on-going discussions within Narok County government around how to address these challenges.

Impact and Future Plans

Despite all the challenges, the Talek Power Project has been lauded by area residents for transforming the society's economy, social interaction and environment in various ways. Although the solar hybrid mini-grid extends over 2.5km, around 15,000 people from Talek and the surrounding areas within a radius of 30 km now benefit from the project.

According to Benson Gitonga, *"Residents have been able to expand their businesses and establish new businesses generating employment and increased incomes in the area. For example, the area now boasts of 6 welding shops, a cyber café and several barber shops and hair salons on a single-phase connection which we relate to the availability of a stable power. Two petrol stations and one welding business are on the 3-phase connection, and a third petrol station is up-coming. Business owners have been able to increase their operating hours to around 10 pm, while some night clubs operate 24 hours. This has increased the overall income for the proprietors while widening the window for accessing goods and services for the people. Power connection has given rise to new job opportunities associated with power connection and house wiring."*



Socially, people can interact more frequently through the use of mobile phones and in entertainment places like churches and video halls which are able to operate even at night. More people are able to walk about in the evenings due to improved lighting."

Power is also credited with increased information access through watching television and videos and accessing internet through cyber cafes and mobile phones. The local x-ray machine now operates comfortably, providing a vital service for which people would otherwise have to travel long distances to Narok town, over 100 km away, or even to Nairobi. In addition, ICT related services like use of computers, printing, photocopying and scanning are now readily available to the people of Talek.

Finally, the economy of Talek is heavily dependent on tourism with many of the residents working in the many hospitality facilities serving tourists visiting the Maasai Mara Game reserve. As such, the residents are proud that use of electricity from solar has reduced the pressure on harvesting firewood for domestic lighting for some of the households. In addition, this has also reduced the use of kerosene and diesel (in generators) and consequently the associated harmful emissions that negatively impact on the health of the residents and their environment.

Connection to power has also reduced the human-wildlife conflict in Talek as the security lights installed by the people keep off wild animals at night. According to Amos Kipeen, "Before the power arrived, there were many reported cases of wild animals attacking people and livestock in the centre. Since the power was connected, the cases have reduced. When there is power through-out the night, such attacks are very rare." This 50-kW pilot plant has been installed and supplies solar power to a rural business centre. The regulatory authority has licensed the project to generate and distribute electricity. It is being used to test an operating model that can be upscaled; at the same time, it is assessing the economic viability of privately run mini-grids. Future plans for this area include discussions not only around expansion of the existing system to cater for growing demands, but also about replicating the success of this model to other trading centres in Narok County.

Case Study 5: Makueni County Solar Energy Cooperative Society

An energy cooperative brings energy access to a rural trading centre

Background

Kitonyoni is a small market centre in Kitonyoni sub-location, Makueni County. The market centre has a population of about 1,000 people while Kitonyoni sub-location has a population of about 7,000 people. The average household size is estimated to be 10, though it is about 6 within the market centre and as high as 15 outside the centre.

The market centre is off-grid which, according to Makueni County Solar Energy Cooperative Chairman Joseph Muindi, has denied the people of the centre any meaningful development for a long time. Things changed when researchers from University of Southampton visited the village to conduct a socio-economic research on electrification and business. During consultative forums organised by the Energy for Development (e4D) Network of University of Southampton, the people of Kitonyoni were able to state their needs, aspirations and goals. Through e4D in collaboration with the county and national government, a business and community model to electrify the market centre was developed in June 2012.

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The main objective of the project was to boost the economic status of the Kitonyoni Community through solar electricity. The e4D network comprises engineers, social scientists, business and finance experts, and has several partners within it. The e4D implements rural electrification projects as learning entities to support energy access geared to improve the living standard of the poor and provide pathways to growth in rural Africa.

Ownership, Governance and the Business Model.

The Makueni County Solar Energy Cooperative Society business model is based on the e4D community energy model where the community is required to contribute towards development of the project and later become responsible for its operation and maintenance. To implement the project, an energy cooperative society was formed and registered with the Ministry of Cooperative Development and Marketing. This became the main vehicle through which income was raised to meet the required capital contribution. To become a member, one is required to pay a non-refundable fee of KES 300 (USD 3). However, this does not entitle one to be a shareholder of the solar energy cooperative until they bought a minimum of 30 shares which cost KES 100 (USD 1) per share. Membership fee is mandatory for one to be connected to power.

Once the cooperative was formed, the county government of Makueni donated the land where the Kitonyoni project was built, while the University of Southampton in collaboration with e4D engineers, local contractors and villagers assembled the plant in a record one week in September 2012. The power plant is a 13.5 kWp solar photovoltaic plant comprising of 56 solar PV modules mounted on a canopy erected over a cargo freight container, while the battery bank and the rest of the power control systems are installed inside the container. The power generated is distributed through a mini-grid to consumers within the confines of the market centre. The system has a back-up generator which, according to the cooperative chairman, is rarely used since the system rarely develops any problems.

The project targeted to benefit about 3,000 people within and around Kitonyoni through access to services like mobile phone charging, television viewing, refrigeration and lighting. Currently, the cooperative has made 60 connections comprising 45 small businesses and 15 households within the market centre. The local school and health center have also been connected and, according to Richard Wambua, the vice chairman of the cooperative, this has led to great improvement in their service delivery. The businesses connected include bars, eateries, hair salons, barber shops, a video hall, a photocopy and printing shop and mobile phone charging kiosks. The health center and local administration chief's camp were connected for free, but they pay for their electricity consumption.

The Cooperative currently has 3 main income streams:

- Membership
- Selling Shares and
- Selling electricity.

Membership is open to any member of the community within Kitonyoni. An ordinary member of the cooperative can participate in general activities of the cooperative which include:

- Table-banking (a group funding strategy where members of a particular group meet once every month, place their savings, loan repayments and other contributions on the table then borrow immediately either as long term or short-term loans to one or a number of interested members)
- savings and credit facility
- Connection to power and other general Services.

Currently, the cooperative has 204 ordinary members of which about 75% are men and 25% women. When one buys the cooperative shares, they become bona fide members of the cooperative and by extension the owners of the mini-grid scheme. These members are the main decision makers and managers of the power plant. The cooperative has a total of 80 bonafide members of which 25% are women.

For one to become an ordinary member, they are required to pay KES 500 (USD 5) registration fee. The ordinary member is required to make monthly savings of at least KES 300 and save for at least a period of 6 months in order to qualify for a loan facility. When one meets these criteria, they can apply for a loan of up to three times their savings which is charged an interest of 3.5% per month at a maximum repayment period of six months. The loan has to be voluntarily guaranteed by other members to minimise the risk of default. Many members utilise this loan facility to make investments, pay school fees or cater for any emergencies.

For one to become a bonafide member or shareholder, they are required to pay a registration fee of KES 500 (USD 5) and buy a minimum of 30 shares valued at KES 100 (USD 1) each. It is from these shareholders that 2 committees are formed to run the cooperative. These are the Management committee which is tasked with the day-to-day running of the cooperative, and the Supervisory committee which plays an oversight role. Membership to both committees is voluntary.

A member of the cooperative wishing to be connected to power fills an application form. Their house wiring (the cost of which is borne by the member) is evaluated to ensure it is of the right standard after which they are required to pay a KES 12,000 (USD 120) connection fee.

The project targeted to benefit about **3,000 people** within and around Kitonyoni through access to services like mobile phone charging, television viewing, refrigeration and lighting. Currently, the cooperative has made **60 connections** comprising **45 small businesses** and **15 households** within the market centre.

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The connection fee can be paid as a one-off or by paying a deposit of KES 3,000 (USD 30) followed by 18 monthly instalments of KES 500 (USD 5). Connection to electricity is done soon after the initial connection fee or a deposit. The customer also has to buy the electrical cables that extend the mini-grid line to their premises. Initially, the cooperative charged a standard connection fee of KES 17,000 (USD 170) for this but had a challenge when some facilities were farther away from the nearest point of extension, which made extension very expensive. It was therefore decided that the client should buy their own cable and the cost of actual connection brought down by KES 5,000 (USD50).

Every premise has two power meters: a prepaid meter through which consumers load their prepaid power tokens, and a monitoring meter through which the cooperative monitors consumption. According to Chairman Joseph Muindi, the monitoring meter is very important as it discourages illegal power connections by unscrupulous customers. A unit of electricity currently costs KES 75 (USD 0.75), a reduction of over 60% from the initial cost of KES 200 (USD 2) when the project was started in 2012. The prices were progressively brought down to match the consumers purchasing capacity. Income from sale of electricity is meant for day-to-day running of the facility, including general repair and maintenance. 80% of this income is deposited into a management bank account from where it is withdrawn to meet the cooperative expenses like wages and maintenance bills. The remaining 20% is deposited into a separate reserve bank account where it saved to cater for future expenses, for example, replacing expensive batteries. University of Southampton is the custodian of the reserve account. This reserve fund has never been used since the system has never needed battery replacement or any large-scale repairs.

Besides selling power, the cooperative initiated other income generating activities that also brought some much-needed services to the residents of Kitonyoni. The cooperative harvested water from the solar canopy and stored it in two 10,000-liter tanks.

The Rural Electrification Authority (REA) has extended the national grid to the market centre but they are yet to power it. The cooperative society management reported that there was prior understanding between the Kenyan government, through the Ministry of Energy, REA, and the University of Southampton that the grid will not be extended to the market centre for a period of 15 years from the day of the project inception to avoid negatively impacting on the solar power mini grid investment.

Besides selling power, the cooperative initiated other income generating activities that also brought some much-needed services to the residents of Kitonyoni. The cooperative harvested water from the solar canopy and stored it in two 10,000-liter tanks. The water was sold to the residents at a cost of KES 10 (USD 0.1) per 20 litre jerry can. As the area is semi-arid and has no access to piped clean water, this helped ease the water problem while earning some income for the cooperative.

The cooperative was also initially selling solar batteries and solar lanterns and offering charging services to the same. However, this was discontinued, after their stock was depleted. The cooperative also leases out their diesel-powered back-up generator at a fee. The project has two employees, a female clerk who is in charge of daily operations and record keeping and a watchman. In addition, the Cooperative regularly sub-contracts local electricians for their electrical repair and installation work.

The Co-operative also charges a small fee from the many visitors they receive to off-set time spent in showing them around. Like any other cooperative society in Kenya, their accounts are audited annually and the results published for all the members to review. The cooperative engages a government auditor from the Ministry of Cooperative Development and Marketing once a year. This has created transparency within the society and contributes to overall project governance.

Challenges and Lessons Learned

Being a donor funded initiative, the energy cooperative was initially challenged to convince the residents to pay for electricity. According to Chairman Joseph Muindi some people protested that since the facility was donated to them, they should not pay for the electricity. It took a lot of awareness creation to convince potential beneficiaries that even though the facility was donated; the cooperative would still need to cater for operational expenses and maintenance of the facility hence the need for generating regular

income from people for the service. After intensive public awareness creation, the residents' perception was changed, and they agreed to pay for the electricity. The process of registering the Cooperative also took a very long time, "...the Ministry of Cooperative Development and Marketing should consider making this less cumbersome in future", reported the chairman.



During set-up, the cooperative initially used post-paid meters which brought about several challenges. One was the requirement for physical meter reading to enable billing. This **increased the cooperative's operating expenses**. The second was the high rate of default on monthly bills. These challenges were addressed by installing prepaid meters in the customer premises.



The **cost of electricity** which currently stands at KES 75.00 per unit was reported to be very high by Beatrice Mulinge, a hair salon operator in Kitonyoni. The cooperative chairman however reported that they have progressively brought down the cost and hope that it can go as low as KES 40 -50 in the future. They hope such an initiative will increase the number of clients as currently they estimate they are only using around 40% capacity.



Another challenge reported by the cooperative management in the initial period was **illegal connections** from poles or within the customer premises. This challenge was addressed through increased vigilance and through the installation of an additional monitoring meter. Readings from both meters must tally, which helps ensure that clients are paying the correct amounts for the electricity they consume.



Currently, the mini-grid has additional capacity to supply more people with power, but the cooperative does not have the **funds to expand** the distribution network, due to the high capital cost of poles, overhead cable and related infrastructure. The cooperative is already in talks with University of Southampton to see if they can get any assistance in expanding the grid to the households up to 1km from the market centre, with a target to connect 100 additional households. In addition, they have initiated discussions with the Rural Electrification Authority (REA) to grant them permission to mount their distribution cables on the national grid poles to areas where national grid is passing through.



Another project related challenge reported is the **bursting of the water tanks during the heavy short rains in September**. This has cut off water supply to the residents and reduced income to the cooperative. According to the chairman, Joseph Muindi, the cooperative is currently liaising with the county government to get a replacement tank.

Impact and Future Plans

Provision of power to the rural areas through a community energy cooperative is an innovative idea that was developed by the e4D through the University of Southampton. Indeed, the success of the model in Kitonyoni, which was the first to be implemented, has been replicated in six other sites- 2 in Kajiado County in Kenya, 1 in Cameroon and 2 in Uganda. In the cooperative leadership and members' observation, the project has totally transformed the economy of the small market centre. Households now have access to clean energy for lighting, eliminating the use of kerosene tin-lamps that were initially being used. This has reduced indoor air pollution and the residents now enjoy good quality lighting for their daily household chores and for socialising in the evenings. The local health centre and school have also been connected to power and this has seen a great improvement in service delivery. For example, the performance of the local primary school is said to have improved because the children are able to study for longer hours. Health centre physicians are able to serve people in the evening while before they did not operate after darkness or used torches when attending to emergencies. The health centre is also able to store vaccines that require refrigeration which was not possible before.

The biggest impact of electricity access in Kitonyoni is the general economic development of a vibrant market centre. The cooperative vice chairman Richard Wambua reported:

"Before power connection, the centre had only one bar, two eateries, one hair salon and a handful of shops. After the initiation of the project, the centre now boasts of four bars, ten hotels, two butcheries, five hair salons, three barber shops, a video hall, and one photocopy and printing shop. Increase in investment opportunities and demand of business premises has also seen the cost of land rise over six-fold with a 40ft by 80 ft plot initially costing KES 60,000 (USD 600) but now goes for KES 400,000 (USD 4,000)".

Beatrice Mulinge, the hair salon proprietor, reported that her income has more than doubled since she got power.

She is now able to work after dark and offers additional services like blow-drying. Electricity access has also created many employment opportunities in an area which had few income-generating activities.

Amos Mutuku, a worker in one of the barber shops in the market centre stated that he was jobless until the barber shop was set-up and attributes this opportunity to access to electricity in the centre, adding,

“... It is due to availability of electricity that the owner of the barber shop, who resides in Nairobi, decided to start this business giving me a chance to earn a living, while before I was idle and jobless”.

Other benefits brought by the cooperative society include access to credit, access to water harvested from the solar canopy, access to information through watching television at home or in the video hall, access to ICT services (copy typing, printing and photocopying services), access to mobile phone charging leading to ease in communication, general security improvement through installed security lights, increased community interaction and socialising after dark especially in churches, bars and the video hall.

Going forward, the cooperative has several projects that they hope to implement when they accumulate enough funds. Among them is expansion of the current grid to households within 1km radius from the centre. As they do not have enough funds for the expansion, they are in discussion with University of Southampton to see if the expansion could be funded. In addition, they have initiated discussions with REA to grant them permission to mount their distribution cables on the national grid poles to areas where national grid is passing through. The expansion, they hope, will enable them to effectively use the entire capacity of the mini-grid, bring down tariffs and also increase their income.

The cooperative also plans to work in collaboration with the county government to drill a borehole, install an overhead water tank and build a solar-powered water kiosk for selling water in the centre. This, they believe, will address the problem of water shortage in the market centre. Other notable projects the cooperative society wants to start are: a mobile money transfer shop, a battery charging shop, a

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welding shop and a posho (maize) mill. They are also planning to approach Safaricom to provide internet services to the centre. To supplement income from sale of electricity, they also intend to buy tents and chairs, which they can hire out during special occasions.

For now, the Cooperative is successfully managing the project and income from sale of electricity pays for all their operational costs. They have not experienced any black-outs or any major technical issues since installation. Engineers from the University of Southampton are in constant touch and pay regular monitoring visits. In the Chairman's words “Kitonyoni never goes off, unlike Kenya Power.” Moreover, the cooperative has been able to finance all its operations through prudent management of financial resources and the management is confident they can finance any future high-cost maintenance activities should the need arise.

Makueni County Solar Energy Cooperative is a unique project that has been used as a pilot by the University of Southampton and the e4D network to test the cooperative model for electrifying rural market centres. A wide range of partners have been involved in the project including Ministry of Energy (MOE), the Rural Electrification Agency (REA), Ministry of Industrialisation and Enterprise Development, Energy for Impact (formerly GVEP International), Chloride Exide, Makueni County Government, African Institute for Development Policy, Alliance for Rural Electrification (international), East African Energy Technology Development Network, EUREC agency (Europe), International Energy Agency, Jomo Kenyatta University, Norwegian Agency for Development, University of Nairobi, Utilicom Ltd. (UK), The World Bank, the Research Councils UK, and the Department for International Development (DFID).

Already, the lessons learnt have played a key role in shaping the projects that have been established later in Kenya, Uganda and Cameroon. Several local institutions of higher learning among them University of Nairobi and Jomo Kenyatta University of Agriculture and Technology have visited the site to learn more about the model and have recognised the project as a success story. The cooperative was also recognised by the Makueni county government during the 2015 Ushirika Day as the third best run cooperative society in the county ■■■



Case Study 6: Ikisaya Energy CBO Solar Charging Station

Solar power charging station for off-grid communities in rural kitui

Background

Ikisaya is a small rural market centre in Malanani location, Mutitu Sub-county, Kitui County. It is representative of Kenya's arid and semi-arid lands (ASAL) which constitutes 88% of the country and are inhabited by 25% of the national population. Ikisaya is one of the six villages that make up Ikisaya sub-location with the others being Kyanzou, Mwalikanzi, Ndovoini, Ngiluni, Ngovoni and Kalwa. Ikisaya sub-location has a population of approximately 3,000 people living in 377 households. For many years, the entire sub location was not covered by the national grid and the main source of energy for lighting was kerosene, firewood and dry cell torches. Consequently, the market centre did not have any electricity dependent services like mobile phone charging, typing, printing and photocopying services. The transport infrastructure is very poor and there are very few public transport vehicles connecting the centre to Mwingi Town. Without electricity and no readily available means of transport, people had to walk to Endau 10 km away, the nearest centre that had electricity, to charge mobile phone or to make photocopies when required.

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Governance and Business model

The village energy centre model developed by the Solar Transitions team aims at providing affordable basic lighting and electricity services to off-grid communities through an approach where all the services are found under one roof. This is best implemented through a CBO to ensure community ownership and acceptance. The Ikisaya Energy Group CBO was registered in May 2011 with the help of the Solar Transitions team to implement the energy centre model in Ikisaya. For one to join the Energy CBO, they have to be residents of Ikisaya sub-location, pay a registration fee of KES 50 (USD 0.5) and an annual subscription fee of KES 10 (USD 0.1).

In 2011, two researchers from university of Oslo in Norway, namely Tanja Winther and Kirsten Ulsrud initiated the energy centre through a research project named "Village scale solar systems for development: Transfer of social and technological innovations between India and Kenya", short named 'Solar Transitions'. The project was funded by the Research Council of Norway and aimed at evaluating sustainable models for off-grid community solar energy to foster social and economic development and adaptation to climate change. To actualise this, the Solar Transitions team developed the Village Energy Centre Model where affordable basic lighting and electricity services are provided to off-grid communities through one centre proximate to the community. The project team comprised of researchers, engineers and solar energy entrepreneurs from various organisations across several countries. These included Camco (Kenya), TERI (India), IFZ (Austria), University of Oslo (Norway), ACTS (Kenya), University of Life Sciences (Norway), Sweco, and individual experts from Kenya. The centre is managed by the local community through a Community Based Organisation (CBO) and designed to operate on financial principle to achieve sustainability. A key consideration was to ensure that the services provided were affordable and accessible by taking into account local dynamics, including settlement pattern; population density; ability to pay and gender among others.

The CBO members attended sensitisation workshops on how to set up and manage a CBO and the benefits of using solar energy, organised by the Solar Transitions team. On the other hand, the energy centre staff received a week-long training on operating and maintaining the power system, handling and charging devices and general management of the centre.

The Ikisaya Energy Centre has four rooms with each room intended for different uses. These are:

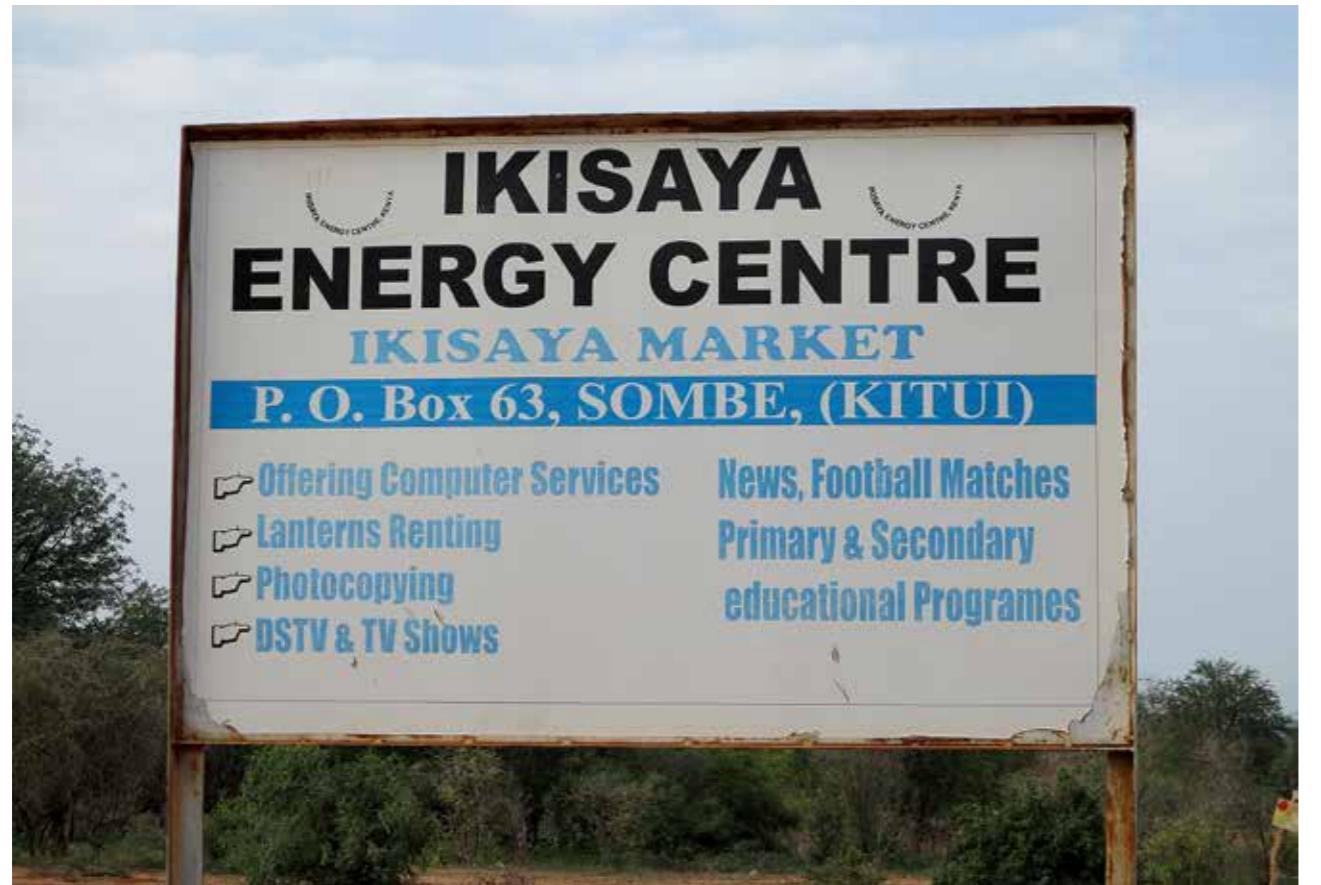
- A multi-purpose room with a TV and DVD-player for news and video shows
- An IT-room with a computer and a multifunction printer
- A management room with batteries and control units that also works as the manager's office and
- A 'charging room' that offers charging services for solar lanterns and mobile phones.

A small room that acts as a barber shop was later added after the residents requested for barber services in 2012. A 2.16 kW solar photovoltaic (PV) array is mounted on the roof of the centre

and connected to the battery bank in the management room. The solar technology was chosen because of the abundance of the solar resource in the area. The centre was set up with grant funding at a cost of 43,000 Euros of which 11,000 Euros was used for putting up the building and 32,000 Euros for the PV system, furniture and other appliances.

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Service	Cost (KES)	Remarks
Rental of portable solar lanterns	Deposit: 200 Renting: 20	Recharging done every second day and the lanterns can be used for 4-6 hours per day.
Mobile phone charging	Charging: 20	Charging takes about 4 hours
Computer services	Typing: 30 per page Printing: 20 per page Photocopying: 10 per page Scanning: 15 per page Laptop charging: 320 for a full charge	Photocopying identity cards costs KES 15
TV/ video viewing	News: 5 per view Movie: 10 per show Football: 20 per match	DSTV service (usually for screening football) was discontinued because it is too expensive.
Hire of multipurpose room	Half day hire: 500 Half day hire without electricity: 250 Full day hire: 1000 Evening hire (6-9pm): 500 School rate (half day): 200	Charges depend on duration and use of electricity
Barber shop service	Adult haircut: 30 Children's haircut: 15-20	Charges for a child's haircut depends on style and age
Sale of Solar lanterns and SHS (Solar Home Systems)	3500-5500 for solar lanterns. About 15,000 for SHS	



The centre pays the Kitui County Government for annual business permits, as required by law. Each room providing a service requires a separate permit costing KES 1,200, namely the Charging room (for lantern and mobile phone charging); the Computer room (IT services) and the TV room (entertainment and meetings), totalling to KES 3,600 per annum. In 2015, however, these rates were even higher at KES 2,500, KES 3,000 and KES 3,000 respectively and only recently lowered by the county government, presumably to encourage more rural business in the county. The beneficiaries are farmers (majority), teachers and some civil servants.

Ikisaya Energy Centre has about 68 members who rent lanterns on a regular basis while about 15 phones are charged per day. The centre has a capacity to charge about 200 solar lanterns and 60 mobile phones per day but is only renting out about 40 lanterns and charging about 15 phones per day meaning it is operating way below its capacity. Together, the lantern renting, and mobile charging services generate over 70% of the centre's revenue making these the most important services for the people. In addition, the centre has a retail outlet from where interested clients can buy solar lanterns. A lantern costs between KES 3,500 and 5,500 and for those who cannot afford to make one-time payment, they are allowed to pay a deposit of KES 2000 and clear the balance in three months. The centre reported that about 30 people have bought lanterns so far. Some of the solar lanterns brands sold and rented at the centre are Sunking, Marathoner

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and Teri. However, according to Monica Winnie, the centre manager, the Marathoner is most preferred by the clients because it is sturdier, water proof and has a mobile phone charging port.

The energy centre has established a network of Agents in neighbouring villages, some as far as 20 km away, which do not have electricity so as to extend its reach. Agents are mostly local small business owners and are identified through a vetting process. After receiving training at the main energy centre, the Agents receive systems comprising one 50Wp solar module, a junction box/charging unit and at least 10 lanterns. Using this system, they offer lantern charging and mobile phone charging services to around 178 households per month. The agents have a turnover of between KES 520-820 per month from the lantern and phone charging business of which they receive 30% commission while the rest is remitted to the Ikisaya energy centre. Currently, the centre supports 9 agents with 6 of them in Endau/Malalani Ward, two in Mutitu/Kaiku Ward and one in Zombe/ Mwirikia Ward. The charging room business permits for each of the agents of KES 1200 is paid by the CBO while the agents pay for their own annual business permits. Collectively, these agencies contribute about 50% of the lantern and mobile phone charging revenue for the Ikisaya Energy CBO. The management committee pays regular visits to all the agents to assess performance and to encourage them and to address any challenges that they may be facing.

For one to qualify to rent a solar lantern, they are required to pay the CBO membership fee of KES 50 (USD 0.5) and a non-refundable deposit of KES 200 (USD 2). The deposit caters for minor repairs in case of damage. All other services (mobile phone charging, TV shows and IT services) are open to all members of the community. Majority of the lantern rental clients are women, including those who are registered members.

Schools occasionally provide good income of around KES 20,000 -30,000 to the centre particularly during exam time, for typing and printing of exam papers. The recently added barber services are very popular, particularly during school opening times, where the centre can receive up to 20 customers in a day, compared to 8-10 customers on a busy day.

It is estimated that the energy centre, on average, generates about KES 50,000 per month of which around KES 44,000 is used on operations and general maintenance (salaries, transport, consumables, agents commission) while the rest is saved in a separate battery maintenance and replacement fund which is managed by the board. The solar batteries at the centre have an estimated life span of 2-3 years.

Challenges and Lessons Learned

The centre faced several challenges, most of which they have been able to address and learned several lessons over time:



In the beginning there was **general lack of know-how** about the lantern operation and maintenance among residents. This was addressed through sensitization and training through community workshops and open-days organised at the centre.



Residents did not understand the importance of returning their lanterns for recharging on the second day, even though the lanterns were not fully discharged from previous use. Again, this was addressed through the sensitization and training. However, those that did not abide were fined KES 10 (USD 0.1) for every extra late day.



Clients **defaulted on their instalments** for purchase of solar lanterns and this facility was withdrawn.



Energy Centre staff had to **undergo re-training** after the initial start-up training, in order to completely understand the system and processes.

Current challenges that the centre is trying to deal with include:



The current **drought** which has affected resources, leading to reduced business



Transport is expensive and makes monitoring of agents difficult. For example, a visit to the farthest agent in Kavala, costs KES 2,000 (USD 20) by motor bike, which is more than twice the monthly turnover for an agent. The energy centre management sets aside one day to visit several centres to reduce this monitoring cost, by sharing it among the agencies.

In 2015, the national grid was extended to the centre, but the transformer blew up the same year and has not yet been repaired. Interestingly, the energy centre management is not worried about any negative impact grid electricity will have on their business. Instead, the energy centre management takes access to grid electricity positively, saying it will bring more development to the market centre and will only minimally affect their business since many of the households using their services live much further out from the main grid network, and are unlikely to get connected.

There were also reports that some people were using the solar lanterns for lighting, when producing charcoal at night in the surrounding woodlands, leading to an increase in environmental degradation. The centre manager however, feels that the number engaged in this vice is not big enough to warrant condemnation of solar technology, since the benefits are much greater.

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Impact and Future Plans

Ikisaya Energy Centre has brought energy services to a remote community unserved by the national grid. The Energy Centre delivery model works well in the rural setting as it fosters community ownership with acceptability. Indeed, a group of Ikisaya residents fondly referred to the energy centre as "our centre" showing great sense of pride and ownership.

Since its inception, the centre has enabled the residents to switch from using kerosene tin lamps which, besides providing very poor-quality light, emit poisonous fumes posing a health hazard to the users. Use of solar lanterns has also translated to savings in households. Residents who would normally spend an average of KES 25 (USD 0.25) on kerosene for lighting (1 litre of kerosene costs KES 100 (USD 1)) and is used for 4 days, now spend KES 10 per day (KES 20 for two days) for a rented solar lantern. This translates to 60% saving for lighting. Savings are higher for those who also use the solar lanterns to charge their mobile phones, because this saves time and money spent on travelling long distances to access phone charging services. The centre has also created employment for the local youth in a rural area where employment opportunities are scarce.

The energy centre has also led to on time and transport for IT services such as typing, printing, and photocopying. Mathews Mwanza the centre accountant-cum- technician reported that people had to walk about 10km to Endau to access photocopying and typing services. At times, people had to travel to Nuu, a return journey of 33 km which would cost KES 1,500 by motor bike. The time and money saved can be invested in other household or income generating activities.

The use of solar lanterns has generally improved the overall grades of the two local Ikisaya and Ndovoini Primary schools (with 392 and 180 pupils respectively) with reports indicating an increase in the mean grade of around 170-marks before the energy centre came up, to a steady increase to 262 marks in 2017. The improvement has come about because the school is now able to use the video hall for pupils to watch educational materials, while parents are able to rent lanterns for their children to use in their evening studies.

Rose Ndila, a client since 2012, who has school-going children had this to say, "*I have two Marathoner lanterns, one for my kiosk and one for home, which I use daily between 7 pm and midnight. My children can comfortably study in the evening using the solar lantern and this has led to improvement of their grades in school*". She also remembers when they had to walk 10 km to Endau to

charge their mobile phones before the centre was started "... we would spend a whole day walking to Endau, charging the phones and coming back. We therefore could only charge our mobile phones twice a month which meant that we were not able to communicate well much of the time. The energy centre has changed all this and now we are able to use the phone whenever we need to". In addition, Rose Ndila stated that using the lantern portrays an improvement in status especially when one has visitors.

Syengo Mulika, an elderly Ikisaya resident talks about his lantern with pride. "*I use it in my house for lighting and phone charging until 10 p.m., and then hang it outside my front door for security before going to sleep. I adjust my lantern settings from 'low' when inside my house, to 'high' for increased brightness when it is outside. It lights up the compound where my goats sleep. Even though it goes off at midnight, the lantern does a good job of keeping away hyenas and snakes and any intruders. My lantern is my watchman.*" he adds proudly.

The energy centre is a hub of social activity extending into the night. It serves as a meeting point for the community to get regular updates on national events on TV, for example, to watch the recent National elections; watch movies and to attend social events such as dances and celebrations. It can also be credited with stimulating the pico-solar industry in the area with many people getting to learn about solar power and buy equipment. The centre holds regular Barazas – community meetings to get more customers to take advantage of their energy services. This has generally improved the understanding about solar and the well-being of the people. Two solar powered mobile charging businesses have come up in the market centre, spurred on by the energy centres success, thus creating more income generating opportunities and more people now own mobile phones.

The centre plans to expand their reach by opening more agencies in numerous other villages that do not have grid power. This will in turn improve the living standards of the people and spur economic growth as has been the case in Ikisaya. In addition, they plan to drill a borehole in future to supply water to the market centre and surrounding villages as the area is not supplied by municipal water. Currently, the residents' villages have to travel long distances by foot, bicycles and donkeys to access water, a process that is both time consuming and tedious. They hope grid electricity will be extended there soon so that they can exploit it for this purpose. Other projects the centre management would like to diversify to when they get access to grid electricity are a welding and metal fabrication shop and to use it to power their TV/cinema hall



Rose Ndila,
Ikisaya resident,
no longer walks
10km to Endau to
charge her mobile
phone



Syengo Mulika
hangs his lantern
outside for extra
security against
wild animals and
intruders



Monicah Winnie charg-
ing solar lanterns at the
Ikisaya Energy Centre

Case Study 7: Sanivation

Sustainable charcoal briquettes

Background

Sanivation is a social enterprise dedicated to improving the overall dignity, health, and environment of urbanizing communities in East Africa through delivering clean, safe, and efficient sanitation services. Naivasha town currently struggles with vastly inadequate sanitation, with the majority of the population using shared pit latrines and usually sharing one toilet between 20 and 80 people. Having worked in Naivasha since 2012, the Sanivation team realized the need to provide an alternative solution to the use of standard outdoor pit latrines in the area, which often leave residents (particularly women and the disabled) feeling unsafe and uncomfortable, especially at night.

Sanivation was conceptualised around 2014 by US based co-founders Andrew Foote and Emily Woods. In September 2015, with funding from various international partners including The

Centre for Disease Control (CDC), National Geographic and Chivas Regal – (a global fund that supports next generation start-up businesses) it was set up at Sanctuary Farm, Naivasha. Sanivation combines two waste streams - human excrement and charcoal dust and recycles them into a clean cooking fuel in the form of briquettes, for which there is a ready market. This systemic approach and elevates it into a sustainable business while providing safe, hygienic and efficient sanitation services to residents in the surrounding area, and access to an affordable, alternative household cooking fuel.

Sanivation works closely with several other organisations, including the Nakuru County Government, UNHCR, the University of Nairobi and the University of Eldoret, the latter two providing briquettes testing services. Additional partners include Halcyon incubator, University of California, Berkeley, ASME, SPRING, Growth Africa, GVEP International and KCIC.

Technology

The 'Blue Box' is a portable, durable, plastic, sitting toilet supplied to low-income peri-urban communities who would otherwise use external shared pit latrines that are often unhygienic and unsafe, particularly for women, children, the elderly and the disabled. The Blue Box is kept comfortably inside the house and offers privacy, dignity and safety to the user. It is emptied twice a week by trained Sanivation staff using *Tuk Tuks* – three wheeler vehicles commonly used for short distance travel in Kenya. The human waste is then taken to their processing plant, where it is treated to ensure that all harmful pathogens are neutralized. Testing is done at their fully equipped on-site lab, which was set up with the support of the CDC.

Charcoal dust is the residue produced through the handling of charcoal as it moves along the value chain of the lucrative charcoal trade in Kenya. Sanivation purchases charcoal dust from specific suppliers in Naivasha and Nairobi. Treated human waste is then combined with charcoal dust using a locally made centrifugal briquetting machine and recycled into 'Fireball' fuel briquettes. Moist fireballs are then transferred on to open drying trays where they are sun-dried and then packed into bags of various sizes, ready for sale. They provide a cleaner alternative to charcoal, which is the key cooking fuel in low income urban and peri-urban households of Kenya.



Makaa ya Jamii Sanivation briquettes in 0.8 kg bags ready for delivery



The Sanivation Centrifugal Briquetting Machine



Paul Manda, Sanivation Energy Production Manager, demonstrates the Blue Box

Governance and Business Model

Sanivation is registered as a private company in Kenya and pays various fees to the Nakuru County Government to legally operate, including an annual business permit, a NEMA license; a KEBS certification fee, and road licenses and vehicle insurance for their Truck and the two *Tuk Tuks* used to service the Blue Box. It currently has 15 employees- 9 male and 6 female- including 4 retail sales agents. Sales Agents get a basic monthly salary and receive a bonus whenever they exceed their target of thirty 0.8 kg bags of briquettes per day.

Beneficiaries of the Blue Box are identified by Sanivation Sales Agents and although they are installed for free, the home owner signs an agreement with Sanivation to abide with the written instructions on how to use the Blue Box, and to pay a basic monthly service fee of KES 200 (USD 2) for the human waste to be collected twice a week. Payments are made by cash

or through mobile money platforms especially Mpesa and households pay regularly. The location of all Blue Boxes is established using GPS coordinates and moving a Blue Box from one house to another is allowed with prior consultation.

Sanivation briquettes are sold under a variety of labels, and packaged and delivered appropriately to suit different markets. For example, the smaller 0.8 kg pack, sold as 'Makaa ya Jamii' (in Swahili this means 'charcoal for the family') in the nearby small town of Karagita, addresses the needs of households, retail shops, road-side hotels and food vendors. This is usually sold by two female door-to-door Sales Agents. On the other hand, the Sanivation truck delivers briquettes the 'Eco Flame' labelled briquettes to more discerning customers in Naivasha town such as small hotels and restaurants. 'Eco Flame' is also sold directly to poultry farmers, supermarkets and other high end customers such as restaurants and hotels in Nairobi - including a large scale distributor in the informal settlement of Kibera. For large consumers the briquettes are sold in 50 kg sacks under the 'Everburn' label to tourist camps in Narok County and others such as the Kenya Wildlife Services Training Institute, which regularly purchases five sacks over regular periods.

Fireball Briquettes are priced as shown below:

Label	Size	Packaging	Price KES	Remarks
Makaa ya Jamii	0.8kg	Small brown bag with simple label	25.00	USD 2.50 (Main customers are households) Wholesale price is KES 20 or USD 2
Eco Flame	4 kg	Medium sized brown bag with attractive color design and wording	400.00	USD 4.00 (customers include restaurants and hotels)
Everburn	50 kg	Large white printed sacks	1,500.00	USD 15 (customers include KWS, hotels, Tourist Camps and other large scale users)



Sanivation Tuk Tuks that service the Blue Boxes in Karagita

Another outlet for the briquettes is in Northern Kenya where Sanivation licenses their model to refugee camps to help them meet the demand for rapidly and locally deployable sanitation services. They work with implementing partners to design, build, and train local staff and refugees on operating improved sanitation services that meet the demands of camp residents. Income from briquettes helps sustain the household sanitation service, since the KES 200 monthly fee alone would not be able to cover costs of that service.

Their monthly target production of 10 tonnes of briquettes was achieved in 2016, and in a special Christmas marketing campaign, they offered special reduced prices which resulted in booming sales. In 2017, however, they are selling 15 tonnes a month and demand has now exceeded supply.

Challenges and Lessons learned

There have been a lot of learnt lessons along the Sanivation journey, described in the examples below:



In the piloting phase there was continuous monitoring to receive in-depth qualitative information about users' experiences which helped provide inputs to the final design and improvements to the technology and the process. The team was in constant touch with the users to receive feedback on



any challenges and make necessary adjustments. The main reasons expressed for the interest in private household sanitation were safety at night, convenience of not sharing, comfort of sitting, and ease of use for people with limited mobility. Many of the women, especially the elderly, were afraid to use the latrine at night for **fear of being attacked or raped**.

The initial monthly household service fee was set at KES 600 (USD 6) which proved **very expensive** for the users. It was then reduced to the present KES 200, which made a big difference in uptake.



There were also issues with the **quality of the chardust**, the main ones being embedded impurities or large particles, which affected production. This was resolved by working with specific suppliers to provide the required quality in the right quantity.



During the dry months, they are able to achieve full production capacity, unlike **during the wetter months when open drying of the briquettes is slower**. Unexpected heavy rains in May, June, October and November 2017 resulted in much slower drying.



Production was drastically affected by **fluctuations in grid electricity** from Kenya Power. In December 2017, the plant went 6 days without power due to a technical hitch which was later sorted out. However, there was drop in annual overall production of around 20% compared to the targeted annual production of 120 tonnes.



The initial plan was to use flower waste, in addition to chardust, from nearby flower farms. However, the **cost of carbonizing flower waste was found to be too high** and so the focus shifted to chardust which is readily available.



Sales in Kibera were affected in the last half of 2017 due to the **national elections**, dropping to 30%.



Rainy weather conditions affect **mud roads** and sometimes delay Tuk Tuk sanitation services to households.



Sanivation Eco flame briquettes ready for dispatch to hotels and restaurants

Impact and Future Plans

The reliable, user-focused, and vertically integrated sanitation services offered by Sanivation address the full sanitation value chain and allow families living in peri-urban areas around Naivasha to live a modern and healthy life. To date, 130 households are benefiting from sanitation services.

Studies conducted by Sanivation show a reduction in the number of people suffering from diseases related to improper human waste disposal. Their clients can place their toilets in any room in their home providing privacy and convenience while minimizing the abuse or injury that women and children can face when using a shared pit latrine. In addition the sanitation service provides a hygienic place to use the bathroom and removes infectious waste from communities, helping to reduce diarrheal disease.

Sanivation briquettes burn for 1 hour 45 min longer than charcoal, and are thus more economical to use. Nelly Karanja, a Sanivation Sales Agent in Karagita, says that regular demonstration and continuous awareness creation has helped overcome the initial reluctance by clients to purchase and use the fireball briquettes.

She adds happily: "*I am now famous for selling Makaa ya Jamii in Karagita and have made a lot of friends here.*"

The same sentiment is expressed by fellow Sales Agent Agnes Mwikali, who works with Nelly. Every week they receive 250, 0.8 kg bags of *Makaa ya Jamii* at the Sanivation shop in Karagita, which also displays the Blue Box, and move from door-to-door selling the briquettes.

Key environmental benefits of the sanitation service provided by Sanivation include the prevention of contamination of local water sources, including Lake Naivasha. Charcoal production in Kenya is done from highly unsustainable resources using inefficient conversion technolo-

gies which result in depletion of trees, especially in the arid and semi-arid areas of the country. Sanivation Energy's Production Officer Paul Manda says, "One tonne of Eco Flame Briquettes saves 88 trees."

Sanivation has developed a low-infrastructure, systems-based approach with scale and replication in mind. They have recently signed a Memorandum of Understanding (MOU) with the Nakuru County Government, to work with Naivawass, the Naivasha Water, Sewerage and Sanitation Company, the body responsible for sewerage and sanitation in Naivasha sub-county. Under this MOU, Naivawass will provide the space in Naivasha on which Sanivation will invest in a plant to manufacture extruded briquettes. Extruded briquettes will be made using saw dust and targeted to address the cooking and heating needs in institutions. Sewage trucks in Naivasha will now discharge human waste to the plant instead of taking it for standard waste treatment, where the liquid part of treated sewage is normally discharged into Lake Naivasha and the solid residue is dried in open beds in Naivasha town. The new Sanivation plant is expected to become operational in 2018 and will employ 10 people.

Sanivation has received several awards and has been cited in various US based journals for their work. They have plans for expansion to increase coverage by adding new branches and refugee camps throughout East Africa and serve over 1 million people by 2020

Studies conducted by Sanivation show a reduction in the number of people suffering from diseases related to improper human waste disposal.

Case Study 8: Solar Approaches For Tourism In A Wildlife Conservation Area

Basecamp Maasai Mara solar projects



Background

Basecamp Explorer Maasai Mara is a Gold Rated Eco Camp situated on the banks of the Talek River, bordering the world famous Maasai Mara National Reserve. Founded in 1998 by Svein Wilhelmsen, it is a part of the Basecamp Explorer Group – a tourism company that operates in 5 destinations on three continents across the globe in a responsible, enlightened way. The camp sits on a 22-acre piece of land along River Talek. It comprises of 12 spacious self-contained tents each with a thatched roof, private outdoor shower and bio/dry toilet, standing on a platform that faces the river, giving a unique view of the reserve and its wildlife. Basecamp Maasai Mara practices sustainable tourism that promotes conservation and fosters community development by providing income generating opportunities locally.

Basecamp Foundation Kenya is a non-profit tourism based organization started by the Base camp Explorer in 2009 to work with the host communities and partner organizations in tourism destinations to create sustainable destinations in developing countries. The foundation aims at creating a forum for host communities to demonstrate positive impacts of tourism on the natural, social and economic environment. According to Amos Kipeen the programs manager,



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the foundation's work is defined by four core values : Empowerment, Energy (Green Energy), Entrepreneurship and Environment. This is being done through:

- Care for the community through health and water infrastructure support
- Empowering the community to use their culture for economic benefit
- Supporting community conservancies and local conservation initiatives
- Supporting climate change mitigation initiatives, and
- Building the capacity of the community through education.

The Foundation champions community development in a responsible, informed way, without compromising on sustainable natural resource management or the protection of wildlife.

Provision of energy to a facility like Basecamp Maasai Mara in an ecologically sensitive area not covered by the national grid is a big challenge. Because use of fossil fuels like diesel and firewood has negative environmental impact, Basecamp had to look for environmentally friendly and renewable energy technologies to provide electricity, water heating and cooking services to the Eco Camp. The camp management settled on solar PV for provision of electricity and solar water heaters for provision of hot water. This decision was informed by the fact that Talek area has abundant solar resource throughout the year. Besides using renewable energy technology for its own use, Basecamp also initiated projects to build the capacity of the local community to install and maintain solar PV home systems and to run small solar businesses in the area.

Technology

The first solar hybrid system in the Eco Camp was set up in 1998, starting with an 11kW solar PV (photovoltaic) array, coupled 2 Victron Inverters with a small generator that was mostly used for lighting and for charging light-duty appliances like mobile phones. The system has since been upgraded to 17kW with a 10KVA back-up generator. The old inefficient lights have also been replaced with energy efficient LED bulbs. The current system serves all the increased power needs of the camp including charging camera batteries, hair drying, and shaving. The system also supplies all the communication needs of the camp.



A Basecamp employee cleaning the solar PV array at Basecamp Explorer Maasai Mara

Use of solar energy does not stop with provision of electricity. The camp has 8 ground-mounted, 250 litres (6 units) and 300 litres (2 units) Suntech solar water heating systems to heat water for the bathroom- showers and other camp uses. This has eliminated the use of scarce firewood thus reducing pressure on the woodlands. The camp has also installed a solar parabolic cooker in their kitchen as a demonstration to the local community on efficient energy technologies.

As the area does not have piped municipal water supply, the camp has drilled a 150m borehole and uses a 1kW solar pumping system, comprising of a Lorenz submersible pump powered by eight Suntech 135-watt solar modules, which pumps water to 2 overhead tanks of 15,000 litre capacity and one 50,000 litres groundwater tank. The surrounding community is allowed to fetch water from the camp for their domestic use and to charge their mobile phones from the camp's solar system.

The Foundation has also built an eco-friendly Mara Leadership School which is powered by a 9-kW solar PV system, comprising 30 solar modules of 300 watts each and a 2,225 AH battery bank comprising twelve 2V Sunlight deep cycle batteries. The system provides the school building with electricity for lighting around 35 LED 5watt energy efficient bulbs; operating teaching aids; as well as charging radio batteries and mobile phones for school staff. The Mara Girls Leadership School has been set up in partnership with the Stomme Foundation, the Wangari Maathai Foundation and several other donors. It supports needy Maasai Girls through a sponsorship programme, where disadvantaged girls acquire education plus life skills and entrepreneurship training.

Basecamp Foundation's Solar Mamas project

One notable capacity building initiative by the foundation was to support five local Maasai women to train in solar installation and solar lanterns assembly in an international, widely publicised project at the Barefoot College in India in 2011. These "Solar Mamas" were grandmothers selected from the villages surrounding the Mara Naboisho conservancy who upon return, were expected to support in the Foundation's community energy access and empowerment initiatives in the area. In this unique partnership, Base Camp Foundation was responsible for identifying and mobilising the trainees and facilitated their travel, upkeep and escorts. They ensured equal representation from different villages in the area. Barefoot College on the other hand hosted them and facilitated their training. One of the Solar Mamas, Lasoi Sengeny from Aitong, vividly remembers her training experience:

"...The training was very interesting because we did not understand English, while the trainers used both English and Hindi and we picked up several Hindi words. The training was very hands-on, and we would communicate in sign language. We were given an illustrated manual and also made our own drawings which were easier to understand".

Upon their return, the Solar Mamas were contracted by Basecamp for one year, to install subsidised Solar Home Systems (SHS) supplied by Barefoot College in homes around the Naboisho Conservancy. Customers were required to pay KES 10,000 (USD 100) for a complete system.



In total, the five Solar Mamas installed around 75 systems targeting about 300 SHS. The SHS systems were hailed for bringing clean lighting and mobile phone charging solutions to the people. The solar lights also improved security in homesteads leading to fewer attacks by wild animals, thus reducing human-wildlife conflict in the area.

When the Basecamp contract ended, the Solar Mamas were contracted in 2012, by a solar company that operates in Kenya, Pakistan and Myanmar. The Solar Mamas acted as sales agent and installation technicians and were paid on commission. Solar Mama Lasoi Sengeny proudly reported *"Business was very good; I sold the solar products as far as Transmara, 70 km away"*.

Customers would pay the company directly through their mobile phones. Sadly, 8 months after engaging the Solar Mamas, the company stopped operations in the Mara region and their hard-earned commission was never paid. In total the Solar Mamas installed more (than 150 SHS for the company.) They also earned KES 500 maintaining these systems for their customers. However, these services are no longer required as customers were trained to maintain their systems. The Solar mamas have not engaged in solar installations since then, due to lack of market information and capital. They all now earn income in other ways. Some work in the hospitality facilities within the Mara region, others sell vegetables in the local market while others make beadwork items under the BaseCamp Maasai Brand beadwork project and are reported to earn up to KES 20,000 (USD 200) per month.

Despite the earlier disappointment with the solar company, Lasoi Sengeny is still passionate about

solar and stated that she is ready to work with any other company or organisation under better structured terms. Through this experience, she has also learned to appreciate the difference between good and poor quality equipment and insists on the importance of using good quality products that will not disappoint clients. Lasoi Sengeny however does not regret the past experience and is happy to have travelled to India for training. She feels that this experience should act as a motivation for young girls to become solar engineers and hopes that one of her daughters, who is very enthusiastic about solar, will get a chance to follow in her footsteps. Moreover, she is happy that she played a small but important part in bringing clean energy to her community.

Impact and Future Plans

By looking at the bigger picture, Basecamp Maasai Mara has positively impacted on the environment and the lives of the local population in a variety of ways.

Through an afforestation program started in 2000, over 80,000 trees have been planted, which have helped reforest the ecosystem that was severely degraded before the intervention. Each guest at the camp is encouraged to plant a tree, from the camp's tree nursery managed by the local community, at a cost of USD 5. Seedlings are also distributed to the local community for free for planting in their settlements and surrounding woodlands.

In 2003, the Foundation started the Basecamp Maasai Brand (BMB) economic empowerment project, where women from neighbouring villages gather at a workshop within the camp to produce handcrafted beaded products, which include colourful bracelets, belts, and key chains. The project has 158 women aged between 17-60 years, and one physically challenged man. 75% of the proceeds from sales go directly to the artisan while 25% is retained to cover for administrative and marketing expenses. 60% of the products are sold online while the rest are sold in the workshop and BMB shops within the Basecamp Explorer camps. Says, Jemaima Saroiwua, the BMB Project Manager:

"The project has offered the women an economic lifeline as they now have a reliable source of income. They use the money to support their families often by paying for clothing, tuition, and health services. This has helped eradicate poverty among the local population. Indeed, the project impact has been so great that even some men who had initially refused to allow their wives to participate also want them to join in!"

The Foundation has also supported upgrading of local primary schools, drilling water boreholes and building medical clinics. In addition, it supports the local community during periods of drought by allowing cattle grazing within the camp and allowing women to collect prunings for firewood from within the camp. Most of the staff they employ is local and wherever possible, they embrace gender balance in employment. A plastic recycling project has also been established that has set up collection points; purchases plastic bottles; promotes bulk water use by encouraging refills of larger 20 litre bottles to replace smaller ones.



Through an afforestation program started in 2000, over 80,000 trees have been planted, which have helped reforest the ecosystem that was severely degraded before the intervention.

Use of solar for lighting, communication and water pumping has reduced reliance on diesel generators resulting in reduced related emissions which would otherwise contribute to global warming and climate change. In this particular case, the clean energy technology used eliminates the noise pollution from diesel generators which negatively affects the wild animals.

Use of solar water heaters has eliminated the need to cut trees for firewood to heat water thus contributing positively to forest conservation. Solar cooking demonstrations, if adopted by the community, could also support the forest conservation efforts by reducing firewood demand within the villages.

Solar installation and maintenance has created new income generating opportunities for the local qualified people. Basecamp Foundation now has plans to give a new life to the Solar Mamas project. They intend to build on existing skills, expand their reach to include more women and improve their access to solar products and services through a different delivery model. This will provide additional opportunities for women and girls in the area by empowering them economically to fight poverty.

Basecamp Maasai Mara is a world-renowned hospitality facility that boasts of having hosted globally renowned persons including former US president Barack Obama and family, who stayed in the camp in 2006 when Barack Obama was the Senator of Illinois. They are among the pioneers of ecotourism in the country and have received many awards and recognition for their efforts. Among the awards the camp has received are:

- Gold medal in the 2017 Green World Environment Award for Tourism/Leisure category in the international campaign to find the world's greenest countries, companies, and communities.
- The EuroCHRIE Regional Industry Award 2017. EuroCHRIE is the official federation for Europe, the Mediterranean Basin and Africa of International CHRIE, the leading international organization that

supports education and training for the world's largest industry

- Honored as the 1st runners-up during the 2017 Mazingira Innovation Awards by Kenya's Sustainable Travel and Tourism Agenda (STTA Kenya).
- The Certificate of Excellence, 7 times in a row (2010-2017), based on positive reviews received on TripAdvisor.
- Basecamp Maasai Mara and the Basecamp Afforestation Project won the Green Apple Environment Award 2016, in the international campaign to find the greenest companies, councils and communities.
- The 2015 Skål Sustainable Tourism Award in the category of Rural Accommodation. Skål International is the world's largest association for professionals within the tourism industry, with about 20,000 members in 90 countries
- The Eco Warrior Award 2012 for Best Eco Rated Facility of the Year, for promoting responsible and sustainable tourism through links with community development and nature conservation.
- Recognized as the world's best ecotourism hotel 2009 by Skål International.
- The Responsible Tourism Award 2005 by the World Travel Market in London.
- The Eco Warrior Award 2006 by Ecotourism Kenya for leadership in eco-tourism and commitment to best tourism practice.
- Won the World Travel Market First Choice Responsible Tourism Award in the Protected Area/National Park category 2005.

Basecamp Maasai Mara continues to receive more than 1,000 educational visits from universities, government departments and aspiring ecotourism operators each year to learn about ecotourism ■ ■ ■

Basecamp Maasai Mara is a world-renowned hospitality facility that boasts of having hosted globally renowned persons including former US president Barack Obama and family, who stayed in the camp in 2006 when Barack Obama was the Senator of Illinois.



Case Study 9: Empowering Women Through Solar Entrepreneurship

Women in sustainable energy and entrepreneurship, WISEe



Background

Kenya enjoys over 3,500 hours of sunlight every year highlighting the potential for solar photovoltaics (PV) to play a key role in energy provision in the country given that by 2016, over 50% of the Kenyan population were not connected to the national grid.

Huge disparity on the number of qualified solar PV technicians in the country with statistics showing that in 2010, only 1 out 100 of the registered technicians was female. This figure was reported to have increased to 6 out of 252 registered technicians by 2014.

Despite the booming energy demand the uptake of solar energy technology remains relatively low. To put this into perspective, the government's development plan for the next 20 years foresees solar providing just 1% of the energy mix while coal, considered harmful to the environment due to associated carbon and particulate matter emissions is expected to provide 9%.

Some researchers attribute the low uptake of solar energy to poverty and general lack of public financial support, but that is only part of the story. Inadequate technical support to the rural households that are mostly not served by the national grid and choose to go solar has been huge a barrier. The few qualified solar PV practitioners available tend to stick to Nairobi and other big urban centres where it's easier to do business. Indeed, data from the Energy Regulatory Commission (ERC) shows that over 65% of the 356 registered technicians by 2018 operate around Nairobi. In addition, there has been a

huge disparity on the number of qualified solar PV technicians in the country with statistics showing that in 2010, only 1 out 100 of the registered technicians was female. This figure was reported to have increased to 6 out of 252 registered technicians by 2014.

WISEe was founded in 2015 to build women's technical capacity in designing, installing, maintaining and training in solar PV while addressing the stark gender imbalance in solar engineering. This is achieved through technical training and capacity building; providing a networking platform for members; mentoring upcoming entrepreneurs; internships and providing site installation experience. It is an energy service Co-operative registered by the Ministry of Industry, Trade and Cooperatives under the Department of Co-operatives in Kenya.

Technology

WISEe organizes training workshops where qualified and interested women get comprehensive know-how for photovoltaics through hands-on training with technical components. The solar training consists of a ten-day crash course conducted by the WISEe trainers after which a certificate is issued. The training workshops are normally funded and supported by a network of partners that include USAID, GIZ and Strathmore University.

After the training additional support is given to the participants if they wish to obtain the required license that will allow them to practice in the field. To get this license, the participants sit for the T2 or T3 solar technicians' tests, administered by the Energy Regulatory Commission (ERC). The T2 qualification holders can carry out solar PV system installation work for medium systems or multiple batteries which may include an inverter. This training is open to: the Kenya Certificate of Secondary Education (KCSE) certificate holders or those with a Certificate in Electrical and/or Electronic and Intermediate Solar Training with verifiable 4 years solar installation experience; Diploma in Electrical and/or Electronic and Intermediate Solar Training with verifiable 2 years solar installation experience, or; a BSc Electrical Engineering or relevant degree or Higher National Diploma with one year of solar installation experience. The T3 certificate holders can carry out solar PV system installation work for advanced projects, including grid connected and hybrid systems. This training is open to holders of: a KCSE, Diploma in Electrical and/or Electronic and Advanced Solar Training with verifiable 4 years solar installation experience, or; a BSc Electrical Engineering or relevant degree or Higher National Diploma with 2 years of solar installation experience.



WISEe is involved in solar projects design, implementation and maintenance for paying clients. The jobs are procured through networking or competitive tendering process. These jobs are the main platforms where the trainees get the much-needed experience after attaining their qualifications. The cooperative is also engaged in mentoring women who wish to start a hands-on career in the solar energy sector or set up their own renewable energy businesses.

Training

The main business of WISEe is capacity building to empower women technicians and entrepreneurs in the solar PV sector. This includes the following types of training:

- T1 (Small systems or single battery DC system of up to 100 watts)
- T2 (Medium systems or multiple battery systems which may include an inverter.)
- T3 (Advanced larger systems including grid connected and hybrid systems) level solar PV technician training
- Training of Trainers (TOT) in T1 and T2.

These are levels of training defined by the Energy Regulatory Commission (ERC) of Kenya for which the curriculum has been approved by the National Industrial Training Authority (NITA). WISEe conducts its trainings in partnership with SERC, which is NITA certified, after which trainees can apply for an ERC license. Train-



ings delivered by WISEe incorporate modules on entrepreneurship and mentoring sessions that include sharing of individual experiences in the field.

Training activities, facilities and equipment are quite expensive, and the Co-operative cannot manage to offer these services on its own. In addition, many of the participants cannot afford to pay the full cost for the training. WISEe has overcome this challenge by fund-raising from various organisations under their existing Solar PV training portfolios, by developing subsidised training courses tailored for women trainees. The training is then delivered as a partnership between WISEe and SERC. Part of this funding is training fee paid to WISEe creating a revenue stream for the Co-operative.

WISEe trainings are advertised through the internet and via the SERC website. Successful applicants are then admitted into the 8-10day training program once they meet the required criteria. The first two trainings were wholly funded by USAID-VOCTEC and trainees were not required to pay anything but the final one that was funded by GIZ was partially financed and trainees paid a small fee

Through this initiative, WISEe has trained over 65 women solar technicians. Many of these have gone ahead to do the solar technicians trade tests conducted by the ERC. Ruth Nzioka, an alumnus of the program and a member of the cooperative, had this to say,

"Since inception, WISEe has inspired and empowered a lot of women technicians. To date, we can proudly report that through the WISEe initiative, a total of three members have attained a T3 license and eight the T2 license."

The trainees come from all over the country.

Solar PV installations

Solar PV installation jobs are very important to the cooperative in two ways. One is that they give the new trainees hands-on field experience in preparation for their ERC examinations and before they venture out on their own. This enables the trainees to design, implement and deliver high quality systems to the customers' satisfaction. Secondly, it is an important revenue stream for the Co-operative and an income source for the installers involved. The Co-operative has so far been involved in installations in Nairobi, Kajiado, Machakos and Makueni counties.

The solar PV industry is quite competitive as there are very many companies currently doing installations in the country. Some clients are surprised that a women-only team can deliver a

quality system. Ruth Nzioka reported, *"When we started work clients were initially skeptical about a women-only team doing installations – which meant climbing on a rooftop, into the attic and wiring a building. Nowadays it is easier because we have many referrals from the clients we have already served."*

The Co-operative procures installation jobs through marketing, client referrals and partnerships with practitioners, companies or organisations energy access in remote off-grid areas through solar. One such partnership is with We Share Solar, a USA based NGO that distributes solar suitcases for education made by students in the USA to schools or community centres in energy-poor regions of the world. The Blue Solar Suitcase is a portable system that comes complete with a 30A Charge Controller, 65 watt LED bulbs and all the necessary mounting accessories including electrical cable. An external solar module and battery are connected to make the system complete. The solar suitcase is imported, while the solar modules and batteries are procured locally. Through this partnership, We Share Solar (WSS) supplies the solar suitcases to WISEe which identifies beneficiary institutions in the education sector, installs and trains the institutions on use and general care and maintenance of the system. In Kenya, WISEe has installed WSS solar suitcases mostly in children's orphanages, rescue centres and schools. After installation, all beneficiaries are trained in the use and maintenance of their systems. The WISEe team also mentors the youth especially girls and encourages them to study technical subjects in school. The beneficiaries are also sensitized on the benefits of adopting clean energy like solar PV. To date, almost 20 orphanages and rescue centres and 2 schools, with a total of above 2,500 children and adults, have benefited from the We Share Solar /WISEe partnership.



"When we started work clients were initially skeptical about a women-only team doing installations – which meant climbing on a rooftop, into the attic and wiring a building. Nowadays it is easier because we have many referrals from the clients we have already served."

Ruth Nzioka
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Ronesa Junior School in Olosho Oibor village, Kajiado County is one such beneficiary. The school has 139 pupils from the largely pastoralist community in the off-grid village and surrounding areas. Due to lack of power, the pupils were not able to study in the evenings or early morning while the teachers could not use electrical powered ICT equipment like laptop computers and printers. They received their system, consisting of two solar suitcases systems comprising one 120-watt Solar Module, a 40AH sealed deep cycle sealed battery, six 5-watt energy efficient LED bulbs and ports for mobile phone and laptop charging, one for the staffroom and one for a classroom in May 2017. Since then, the school was able to integrate ICT in their learning activities through laptop computers and the teachers can now work in the evenings. This has led to improvement in the overall school performance.

Governance, Business model and Partnerships

WISEe was conceptualised by seasoned women energy practitioners who felt it was time to create a platform that can promote women participation in solar PV entrepreneurship. These women comprise engineers, trainers, development experts, consultants, entrepreneurs, researchers and graduates. Founder members include Tameezan wa Gathui who is also the current chairperson; Teddy Nalubega; Caroline Mackenzie; Catherine Nyambala; Rodah Mulili; Daphin Juma and Aisha Abdulaziz, among others. The leadership of WISEe is comprised of a steering committee of 10 people who work on voluntary basis, which include a chairperson, a vice-chairperson, secretary, treasurer and 6 co-opted members. As the cooperative is in its nascent stages of development, it has one part-time coordinator. The activities of WISEe are coordinated from the Strathmore University Energy Research Centre (SERC) of Strathmore University in Madaraka, Nairobi.

The Co-operative aims to be an organisation with a strong membership base and the Steering Committee is currently in the process of developing requirements for membership and detailing the benefits of becoming a WISEe member. The cooperative has two main revenue streams namely technical training and solar PV installations. For any income generated by the cooperative through either training or installations, 90% is disbursed to the members involved in that project based on their respective contributions, while the remaining 10% is saved in the Co-operative's bank account for the day-to-day running and future investments.



Installing a WSS solar suitcase at Tania Integrated Centre in Kiserian, Kajiado County

Challenges and Lessons learned

There was a lot of discussion between WISEe founders over the best option for legalizing the organisation. Because of the unique activities of WISEe, there were many available options open for registration, including registering as a non-governmental organisation (NGO), a community based organisation (CBO), a private company, a network, an Association or a Co-operative. The Co-operative model was finally selected as the best option as it is an internationally recognised model that embraces principals of working together, building capacity, at the same time making profits. Unfortunately, the government registration process was much slower than expected, taking around 6 months, and required a lot of patience and follow-up with the Department of Co-operatives in the Ministry of Industry, Trade and Cooperatives. However, WISEe is now among the first energy service cooperatives registered in the country.

Occasionally there are questions the focus on women's-only trainings, since solar PVT1/T2/T3 and other short trainings are already available at accredited institutions at a fee. Unfortunately, women's actual participation in such technical training courses is usually very low, around 10-20%. WISEe tries to fill this gap by pro-actively identifying interested women contractors, technicians, entrepreneurs, trainers and students who meet the basic criteria and then trains and

One of the biggest challenges in the solar PV sector in Kenya has been poor quality equipment, poor quality installations and lack of capacity to maintain and repair systems.

WISEe has trained at least **200 beneficiaries** comprising men, women and youth in all their installations on operation and care and maintenance of the systems.

mentors them, giving them the necessary hands-on skills and knowledge to compete effectively in the solar PV market.

One of the biggest challenges in the solar PV sector in Kenya has been poor quality equipment, poor quality installations and lack of capacity to maintain and repair systems. WISEe addresses these challenges by doing professional installations coupled with requisite end-user training and provides a warranty on all their installations. Any initial gender bias during installation quickly disappears when clients see the team at work especially when the installations are well planned, organised and carried out. Training is carried out and adequate training material is left on site after every installation. As a result, WISEe has built a good portfolio of clients and is getting an increasing number of customer referrals.

Impact and Future Plans

WISEe was started to empower women in renewable energy entrepreneurship while extending energy access in the country, roles they have so far successfully undertaken. The 65 women who have been trained by WISEe have been good ambassadors of the cooperative and a testament that when women are equipped with the requisite skills and given the opportunity, they can excel comfortably in a technical field. The fact that WISEe was conceptualised and is managed by women to empower women in a largely male-dominated sector makes it a model

for promoting technical related disciplines to the girl child. On this, Ruth Nzioka had this to say,

“...During installation when men see an all-women group on rooftops fixing solar panels and wiring the houses, they marvel at this and say this has helped change their perspective that installation and technical field is cut for the male fraternity. The men say they will henceforth embrace and appreciate working with skills and not gender”.

WISEe stresses on quality service delivery by its members as they know that poor quality will be counter-productive in promoting women technician and entrepreneurs. They have therefore helped improve the general quality of solar installations in the process increasing the confidence on adoption of solar PV technology in the country.

Through its partnership with We Share Solar, WISEe has managed to positively impact on the lives of many children in schools and children's homes through clean energy access. Faraja Adventist Children's Centre, a children's home in Ngong, Kajiado County is one of the beneficiary of this partnership. The centre has 63 children of which 27 are girls. The children were forced to use candles and tin-lamps to light their dormitories when grid power was disconnected due to inability to pay the monthly bills. They received two solar suitcases, one for the boys' and the other girls' dormitories. The management of the centre reported that before the installation, the home would spend KES 2,000 (USD20)



on candles and about KES 3,000 (USD30) on kerosene per month for lighting. In total they are now able to save KES 5,000 (USD50) per month which is spent on improving the welfare of the children. The children are also able to enjoy doing their homework and other chores in good quality light which has led to improvement in their school grades.

WISEe has trained at least 200 beneficiaries comprising men, women and youth in all their installations on operation and care and maintenance of the systems. In addition, the members have inspired many children in the beneficiary institutions through the awareness creation sessions that they hold. This has aroused the interest in some children in the school, including girls, who would like to be solar engineers like members of WISEe. Ruth Nzioka was quite excited to report,

“...Girls from Olooloitkoshi Rescue Centre in Kajiado County where we installed one system were very enthusiastic in what we were doing and wanted to become solar engineers in the future. They actually requested us to mentor them to pursue careers in solar engineering, which made us very happy”.

The cooperative has also empowered the women financially by giving them an opportunity to earn a living using the gained skills. Some of the women who have gone through the entrepreneurship mentorship program have started their own solar businesses creating more job opportunities. Some existing entrepreneurs have expanded their existing businesses by adding solar PV as another product line. Others are applying their skills at their own respective places of work and providing training to their colleagues.

Through established partnerships, WISEe has successfully delivered three training workshops for solar technicians between 2015 and 2017. Two of the workshops were supported by the USAID VOCTEC programme, through the Arizona State University and SERC and the other was supported by the GIZ ProSolar programme in Kenya. The Co-operative is building more partnerships for training in order to accelerate their capacity building activities over the next 3 years.

“

During installation when men see an all-women group on rooftops fixing solar panels and wiring the houses, they marvel at this and say this has helped change their perspective that installation and technical field is cut for the male fraternity. The men say they will henceforth embrace and appreciate working with skills and not gender”.

WISEe has achieved a lot in the few years of its existence in terms of empowering women and promoting energy access through solar PV. In the coming years, they intend to grow and to achieve much more. First of all, they would like to increase the share of trained women technicians to 50%. They are working to get more funding support to organise additional training courses from their current and other partners. Through We Share Solar, they plan to install another 30 Solar Suitcases in 2018. The Co-operative will continue in its growth by having scheduled annual training courses and to undertake large-scale projects within the East Africa region. In addition, they are exploring avenues to build their own internal capacities through specialised training and networking. They also hope to create more working partnerships for technical training, consulting and solar PV installation so as to increase their revenues and job opportunities.

Through their partnership and work with Strathmore University, We Share Solar and others, WISEe is slowly gaining recognition as a reputable and reliable all-woman solar capacity building and installation co-operative. In 2017, some of their members have received individual awards for their work with WISE and their contribution to the renewable energy sector as a whole, as follows:

- Tameezan wa Gathui, received the Energy Professional Development Award, Sub-Saharan Africa from the Association of Energy Engineers (AEE) based in Atlanta in September 2017 for her work with WISEe
- Caroline Nyawira Mackenzie, who is the first woman to obtain her T3 license from ERC in Kenya, won the Top 40 Under 40 awards in October 2017
- Catherine Nyambala won the Women in Energy (WIE) award in the Professional (Technical) category, in December 2017
- Waringa Mindo won the WIE award in the best student category in December 2017 ■

Case Study 10: Solar Roofing Tiles As A Sustainable Energy Source

Gaitheri Secondary School Solar PV Roof



Background

Kenya's high reliance on hydropower means that production goes below the peak demand during drought. To meet the extra power demand, the country resorts to expensive power from diesel generators leading to increase in cost of power for the consumers. The power burden has been increasing progressively since the beginning of 2017 impacting negatively on the consumers' finances. Moreover, power supply in the country has been intermittent leading to downtimes in operations for the consumers. To cushion themselves against the rising cost of power and shutdown in learning activities due to frequent power blackouts, Gaitheri Secondary School in Muranga County has adopted Building Integrated Photovoltaics (BIPV) manufactured by Strauss Energy in Kenya. The BIPV is a new concept where solar photovoltaics technology is integrated into the basic building materials on roofing, paving slabs, walls, roads etc.

Governance, Business Model and Partnerships

Gaitheri Secondary School is a public school located in Gaturi Location, Mugeka Division, Kiharu Constituency, within the Muranga County. It is a mixed -day school that caters to ordinary students from the largely small-scale farming community around Gaturi Location. The school has 207 students of which 117 are girls and 90 boys.



The school is connected with power from the national grid for lighting, computer lab and operation of other electrical appliances. However, the school faces numerous blackouts every month which compromises on the security and interrupts computer and other ICT related uses. To cope with the blackouts, the school was using a diesel generator which was very expensive to run. In addition, the school paid an average of KES 5,000 (USD 50) per month for the power which put a lot of strain on the school's modest budget.

In 2016, the school board met and decided to explore the possibility of investing in alternative energy sources to address these challenges. It was during this brainstorming meeting that one board member suggested adoption of solar technology which could serve them well as the area has good irradiation and the system has little operation and maintenance cost. During the meeting, the members were informed about the Building Integrated Photovoltaic (BIPV) energy technology system from Strauss Energy that has the capacity to act as a roof as well as generate electricity. Luckily, Daisy Karimi, one of the founders of Strauss Energy was participating in the Mandela Washington Fellowship of the Young African Leaders Initiative (YALI), a program launched by former President of the United States Barack Obama in 2010 as a signature effort to invest in the next generation of African leaders. The main objective of YALI is to support young African leaders to spur growth and prosperity, strengthen democratic governance, and enhance peace and security across Sub-Saharan Africa. Through the YALI program, Strauss Energy received a grant of USD 2,000 from the United States African Development Foundation (USADF) to implement the Gaitheri solar roof project. Through the USADF grant, Daisy and her team at Strauss Energy installed the solar BIPV roofing tiles in a classroom at Gaitheri Secondary School as part of the company's pilot project aimed at testing the scalability of the technology in schools.

Technology

The Gaitheri solar PV system is a 2.4-kilowatt (kW) system comprising of 300 BIPV tiles connected to a power control unit and a battery bank of 8 (Volts?) batteries. It is mounted on top of an existing roof of a classroom which the



school management did not want to remove. The system is remotely monitored at the Strauss Energy offices in Nairobi to identify any problems and assist in the company's research and development. The generated power is used in a computer lab with 18 computers, in the staffroom for charging teachers' laptops and mobile phones, in the secretary's office for printing and photocopying learning materials and for lighting in the classrooms. The solar tiles produce power that can completely sustain a modern household in periods of good sunshine without the need for a secondary power source. However, since Gaitheri is already connected to the grid, the system has a change-over switch with which to change to grid power during periods of low sunshine. This, however, happens only two or three times in a month. Jackson Kiragu, the teacher in charge of system, reports that the only maintenance required by the system is to clean the tiles regularly, when there are covered with dust or leaves.

Impact and Future Plans

Gaitheri Secondary school installed the solar PV system to address the high cost of power and ensure uninterrupted power supply for the ICT lab. To this end, Jackson Kiragu has this to say,

"Since the installation of the power, the school power bill has dropped from about KES 5,000 per month to about KES 1,500. This has translated to savings of about KES 3,500 per month easing the economic burden of the school as the money can be used to purchase other essential commodities."

The school has also adopted energy saving bulbs to conserve the power. Since the system has a power control system, there is no danger of power surge that used to destroy plugged-in

electrical gadgets after a blackout thus reducing related losses for repair or replacement of affected gadgets.

The school has a computer lab equipped with 15 computers that are networked. Since the installation of solar power, the school enjoys uninterrupted power supply which enables the teachers to offer computer classes for extended hours unlike before when we had to rely on the intermittent grid power. Currently, students in Forms 1 and 2 have 5 hours of computer studies per week while those in Forms 3 and 4 have two hours. The teachers are also able to download materials online, store them in a central computer and then re-use them for teaching. Consistent use of computers for learning has seen the interest in IT among the students increase unlike before when they did not have reliable access. Interest in computer studies has even extended to the neighbouring primary school whose teachers and pupils frequent the secondary school to use the Computer lab until the secondary school management decided to donate one computer to them.

Due to availability of reliable and safe power, the students are able to undertake early morning and late evening preps in school. This is particularly important because many of the students come from homes where there is no electricity and use kerosene lanterns for their evening studies. This has led to a general improvement in the student's performance in all subjects and the school and is also attracting more students—the 2017 student intake has almost doubled from 38 in 2016 to 63 in 2017.

Apart from the original objectives that the solar PV system was planned for, there have been other desirable outcomes for the school and the students. Jackson Kiragu observes:

“... The system has become a teaching aid for the students on solar pv power generation, use and advantages over other sources of energy. A lot of students are showing interest in renewable energy and many express a desire to work in the renewable energy sector. Moreover, the female students were amazed to see women (Daisy Karimi and her team) on the rooftops installing the system and from that day they have changed their perspective about technology related jobs which they previously believed was a domain for men.”

After understanding the link between renewable energy and clean environment, the students initiated an environmental club which is engaged in tree planting and awareness creation activities. Indeed, they are planning to start a tree nursery to sell seedlings to the school and the neighbouring community.

Even though the solar roofing project was a brainchild of the school board of management, Jackson Kiragu the teacher in charge of managing the project has great plans moving forward. During a visit to the school, Jackson passionately outlines his vision for the renewable energy projects in the school.

“Our main vision is to expand the capacity of the solar PV form the current 2.4KW to about 8KW. With the increased power, the school can expand the computer lab so that each student can use his or her own computer instead of sharing, during lessons. Currently, five students share one computer. We will then be able to sell surplus electricity to the neighbouring community which is connected to the national grid but is still facing the same challenges as we used to face in the past. Secondly, we are planning to start a biogas project in the school that will meet the cooking energy needs and also act as a teaching aid to the students. The biogas project will replace firewood which the school currently uses, thus will help conserve our environment. It will also improve on sanitation as the digester will be connected to the latrines”.

The school is however not able to raise the requisite capital for this investment and is actively seeking support by writing proposals to organisations and individual for funding support.

The innovative approach to sustainable energy supply adopted by the school has received recognition within the country and abroad. In 2017, the school was a finalist in the Zayed Future Energy Prize, in the Global High Schools Category, Africa Region. The Prize aims at inspiring future generations across the world to be responsible and sustainable citizens. The Prize hopes to encourage young people to learn about sustainability and clean energy from an early age. Although they did not win the prize, they are proud to have been short-listed and continue with their drive to embrace sustainability in all their school activities.

The school's initiative has also been covered by both the local and international media such as “The Star” newspaper in Kenya, The Solar Magazine and Reuters. Strauss Energy has also used the project to showcase their technology in both local and international fora. In 2016, Charity Wanjiku, a co-director of Strauss Energy, used the project as an example to pitch to investors at the Global Entrepreneurship Summit at Silicon Valley USA where Strauss Energy won a cash prize in the People's Choice category of the Global Innovation through Science and Technology competition in the USA



Case Study 11: Sunculture

Transforming Agriculture Through The Power Of The Sun

Background

It all started when Samir Ibrahim and Charles Nichols, two students at New York University (NYU), won the Audience Choice Award in 2012 at the Stern Social Venture Competition. This was for their idea to harness the power of the sun and combine this with the effectiveness of micro-irrigation systems to make it cheaper and easier for farmers to grow high quality crops and achieve greater yields. Spurred on by the award and armed with passion, the duo mobilised funds from friends and family and established SunCulture to pilot their dream in Kenya - a place they already had strong existing ties.

Only 17% of the 5.4 million hectares of arable land in Kenya is suitable for rain-fed agriculture, leaving the remainder in need of irrigation and pumping technology. Rain-fed agriculture however, limits farmers to harvesting twice per year, with unreliable rainfall posing an even greater challenge. Irrigation unlocks this restriction by giving farmers more control over timing of their crops thus enabling them to keep in tune with market demand. With the abundance of sunshine in the region, low-maintenance solar water pumps in combination with water efficient irrigation technologies, offer an attractive and appropriate alternative to petrol, electric and

manual treadle pumps in the market.

The mission of Sunculture is two-fold: to run a successful and profitable business and to put more money in farmers' pockets in a sustainable and environmentally friendly way. Through persistent research, innovation and end-user engagement, the company is now breaking the barrier of high cost, which since the early 1980s, has been the greatest hindrance to increased uptake of affordable solar powered water pumping, to farmers in Eastern Africa.

Technology

Sunculture technologies include the Rainmaker Solar powered Water Pump; Micro- Irrigation Systems as well as Single and Three phase Solar Powered Water pumps, which can cater for a range of farm sizes **from small farms of up to 1.5 acres to larger projects of more than 1000 acres**

The RainMaker is a portable solar powered water pumping system designed for small-scale farming and household use. It can lift water to a head of 100m, with a capacity of 7 cubic metres per day and can provide sufficient water for up to 1.5 acres of irrigation. It can also be used for livestock and domestic household needs.

Sunculture technologies include the Rainmaker Solar powered Water Pump; Micro- Irrigation Systems as well as Single and Three phase Solar Powered Water pumps, which can cater for a range of farm sizes **from small farms of up to 1.5 acres to larger projects of more than 1000 acres**



The pump is suitable for many water sources including wells, boreholes, dams and lakes. The RainMaker system comprises of:

- A 24V stainless steel submersible water pump
- 120 watt portable solar modules
- 480 watt hour 24V waterproof battery bank paired with a WeatherSmart Maximum PowerPoint Tracking (MPPT) charge controller in a lockable water proof portable case
- A Brass impact sprinkler with a 10m radius

The Sunculture Micro-Irrigation systems are easy to install, can operate with low pressure (minimum 3m head), easy to move around and their plug and play features allow for easy expansion. There are two types:

- A Drip Irrigation kit consisting of long-life drip tape; PE lay flat pipe; filtration system and connector valves. This system provides water directly to the root of the plant, increasing water use efficiency of up to 90% and yields up to 300% when compared to furrow irrigation methods. The emitters, through which water exits the tape, are spaced at 20 cm or 30cm as standard but customized spacing is also available if required. Emitter flow rate for drip Irrigation is 1.4litres/hour.
- A Mist Irrigation kit which includes mist tape with micro-pores. This system spreads a mist over the crops. One line of mist tape irrigates two beds of crops and is ideal for leafy ground produce. The emitter flow rate is 2litres/hour.

A key innovation in the SunCulture irrigation kits is flexible piping which, unlike other systems currently available in the market, can easily be configured to suit different sizes and shape of

small farms. Secondly each drip line comes fitted with a plastic gate valve that enables easy water control in each drip line, which conserves water, directing it only to where it is needed.

Sunculture Single and 3 phase solar water pumps are compatible with a broad range of commonly available AC surface and submersible pumps and systems, are scalable and can be customised to the needs of specific projects. They can pump to a head of 545m and can pump up to 1000 cubic metres of water per hour. The pumps can be surface or submersible, have a Variable Frequency Drive (VFD) and MPPT for efficient solar operation, and are coupled to a 1.5kW (Kilowatt) - 1.5kW solar array.

Based on continuous engagement with end-users, SunCulture has worked with pump and accessory manufacturers, to improve on the design of their products in order to come up with the right solution for their clients.

Governance, Business Model and Partnerships

SunCulture is a private company registered in Kenya in 2012 whose purpose is to ensure that every farmer, regardless of where they live, can earn enough income to support and feed their families. SunCulture solutions are designed to improve farmers' productivity and profitability. The two directors Samir Ibrahim and Charles Nichols have a dedicated team of 75 staff of which 60% are male and 40% female, based in various parts of the country. These include 16 full-time field based technicians and 30 field sales agents who work on a commission basis. The field agents work in, and report to Regional Representatives in 3 main regions, namely Western, Central and the Coast.

"Getting the right people with the right skill set – people with passion, humility and ability to interact with small scale farmers was initially a challenge", says Hannah Dohrenbusch, Head of Corporate affairs, "but now we have a great team!"

SunCulture operations are currently supported by grant funding, income from sales and strategic partnerships. Key funding partners include the Shell Foundation, USAID, Microsoft, among others. The company has also attracted investment from international institutions such as Energy Access Ventures and Partners Group which has enabled them bring on board business management, wide geographic reach, and sector specific partners. Other partners are contributing valuable experience in operating agriculture and energy businesses in Africa.



The Sunculture sales outlet near entrance of the Blue Post hotel in Thika

SunCulture is currently competing with other long-established leading suppliers in the country on many fronts including price, survey fees and customer service. The RainMaker, their latest product, is a simple portable user-friendly solar pump that can be used without drip or mist irrigation and costs USD 500 (KES 50,000). It can be put to a wide variety of uses including agriculture; livestock; household use and even car washing. Over 300 units have been sold, since it was launched in September 2017, with around 65% of their customers paying cash, and the others through direct small holder financing dubbed Pay As You Grow (PAYG), which few such companies offer to their clients. Under this arrangement, after an initial down-payment, customers pay the balance in monthly instalments over 12 months or less.

SunCulture supplies its products to all parts of Kenya, with most of their sales done through Facebook, radio and direct enquiries made at the head office. Many customers also buy SunCulture systems based on referrals from satisfied end-users. Others buy after having seen a demonstration at the head office, or demonstrations conducted by field agents at rural market centres and elsewhere. Field agents transmit site survey information to the head office in Nairobi, via a special software application, where it is logged and the customer monitored for further analysis action. SunCulture currently has 2 sales outlets in Thika and in Nanyuki, with more being planned to cater for growing demand.

A survey fee of KES 4,500 (USD 45) is charged when a field agent visits a site, of which KES 2,000 is a sales analysis fee. Once a sale is made, the customer gets a refund for the full amount. The system is then packed and dispatched via Wells Fargo, a courier company, to a convenient location for the customer to pick up. The technician nearest to the site then does the installation which usually takes one day and conducts prop-

er on-site training for end-users. Any post-installation issues are first addressed over telephone, and a technician is dispatched to the site, should further support be required. In some cases a customer may require that the solar modules be roof-mounted permanently and will need to pay for this additional cost. All SunCulture systems carry a one-year warranty. Interestingly, according to Charles Ngaria, SunCulture's Irrigation Engineer, most of the buyers are men, while the users are mostly women. This indicates that while men have the purchasing power and play a bigger role in decision making, especially when buying the solar pump, it is the women who use the pump once it is bought.

Lessons learned

In the beginning, the SunCulture solar pump sold for around USD 3,000 (KES 300,000). However, between 2013 and 2017, by working closely with end-users, understanding their needs and understanding the market and, as a result of high demand, these costs have been brought down to less than 20% of the original selling price.

An important contribution to their success is that SunCulture has constantly designed and re-designed their systems to meet farmer's needs. CEO Samir Ibrahim in the 2017 SunCulture Newsletter, says:

"The best thing that Charlie and I did in the early days of SunCulture was realize that it's our job to listen to what our customers need and come up with solutions with them and for them. Our vision to transform the way food is grown, to make it cheaper and easier for farmers to grow food, can only be achieved by working with the people we want to affect, which are our customers. From Day 1, farmers taught us that their challenges are systemic and complicated, rooted in centuries of traditions, and that a solution for them needs to combine access to tools, know-how, and capital. So that's the solution we developed."

The overall policy environment is favourable for SunCulture operations in Kenya and they are able to import all their products with ease. Imported solar irrigation systems are tax exempt and this favourable regulatory framework contributes to lower selling prices. The exemption however, applies only to complete systems so if it is necessary to import specific components separately, import duty and taxes have to be paid. However, importation tax regulations vary from country to country. For example, in Rwanda, tax exemption for irrigation equipment is 50%.

One potential concern in Kenya is the need to address entry of cheaper, fake and counterfeit products into the market, which, according to

Hannah, could affect the customer trust and confidence that has been built in their products so far, and could lead to a negative impact on sales.

Impact and Future Plans

In Kenya, SunCulture is looking to partner with food processing companies that work closely with small scale farmers as well as selected Micro Finance Institutions to improve their reach. As well, they are also exploring partnerships with local solar companies and exploring other innovative ways in which to use their solar pumps in green houses and rain water harvesting systems.

Naftaly Munyiri, a small scale farmer in Kivin-goti, Karatina in Kirinyaga county, part of the RainMaker PAYG pilot, describes his experience with the pump:

"I grow potatoes and cucumbers and used to spend KES 3000-4000 every month buying fuel for my petrol pump. When I heard about the Rain-Maker from my neighbour, I made a down-payment the same evening instead of waiting for the 2-week grace period. Having bought the Rain-Maker in March 2017, I am now making monthly payments to SunCulture using the money I would have used for petrol. The biggest advantage of the RainMaker is its portability – I can move anywhere with my pump! I initially started irrigating my own 2 acres of land, where I have installed an overhead water tank. The income I have generated has enabled me to lease 4 more acres of nearby farmland - one can lease land from KES 2000-4000 per growing season depending on proximity of the river. I use the SunCulture sprinkler on the leased land and hire casual labour to help me in my work. I do not need to look for a market for my harvest as buyers come directly to me and purchase my produce."



Naftaly Munyiri explains how the SunCulture pump has enabled him increase his income

Another small scale farmer, Tabitha Muthoni, who lives 1km from Karatina town and grows passion fruit, tree tomato and ordinary tomatoes, says she enjoys using the RainMaker because it pumps a lot of water and does not use any fuel. She had been using an electric water pump since 2007 to irrigate her crops and used to pay an average of KES 4,500-5,000 (USD 45-50) in monthly electricity bills. Since her husband bought the RainMaker in 2017, she now pays KES 2,500-2,800 per month. She pumps water from her 20 m hand-dug well into two 2000 litre overhead tanks, 3 times a week. The solar modules of her system have been permanently mounted on her roof. She repays KES 3,000 in monthly instalments for her pump - an amount she is now finding challenging, since the recent death of her husband. SunCulture is currently in favourable discussions with her over this.

"I usually sell my produce directly at Karatina market. However, sometimes I find it more convenient to sell to brokers who come to purchase directly from my farm, even if it means selling at a lower price." However, despite the challenges due to her changed circumstance, she is very happy with the pump:

"I have not had any issues with the pump. The tanks get filled up very quickly after only 3 hours of pumping," Tabitha adds happily. *"I have spread the word to my neighbours and 3 of them have already installed their systems. One of them has even fully paid up. All of them are happy – if there was a problem, I would have known immediately!"*

In Africa, SunCulture has supplied solar water pumping systems to Zambia, where there is a distributor, Uganda, Somalia, Ethiopia, Rwanda, Nigeria, Ghana and Mozambique. They have recently completed Somalia's largest irrigation



project, part of a larger mission to improve the resilience of rural and at risk communities in Somalia. SunCulture is currently offering services at a discount to any organization working in humanitarian relief in the region to stave off the ongoing and debilitating drought

Over the years SunCulture has won international recognition, attracting more funding and partnerships, including:

- United Nations Foundation Global Accelerator Member, 2014
- Finalist, Sankalp Awards, East Africa, 2014
- Winner, CTI-PFAN African Forum for Clean Energy Financing, 2014
- Winner, EEP (The Energy and Environment Partnership Program), 2014
- Winner, REEEP (Renewable Energy and Energy Efficiency Partnership, 2014
- Winner, The Future Awards Africa Prize in Agriculture, 2014
- Winner, GSMA Mobile for Development Utilities Innovation Fund, 2015
- Winner, Powering Agriculture: An Energy Grand Challenge for Development, 2015
- Winner, Sustainia Award, Food Innovation Category, 2015
- Finalist, Ocean Exchange, The Solutions Awards, 2016
- Finalist, Start Up Energy Transition Award, Strat Up SDG7 category, 2017
- Finalist, Ashden International Award, 2017

In addition, they have been recognised by others including Forbes 30 Under 30, Bloomberg New Energy Pioneers, the Financial Times, Bloomberg and the Harvard Business Review

With support from Shell Foundation SunCulture recently conducted a successful 6-month pilot of their new Pay-As-You-Grow (PAYG) financing model with 200 small scale farmers in Kenya, which allows customers make a down payment of KES 10,000 (USD 100), followed by monthly payments over one year through a mobile payment platform.

The soon-to-be launched PAYG model will mean that farmers who couldn't afford SunCulture products and services before will now be able to do so. There are lots of exciting and innovative ideas that SunCulture has lined up for the future, including:

- Remotely monitoring a farmer's system at certain times based on a number of data points tracked by sensors, flow meters, and camera technology.
- Sending farmers a daily SMS with pump usage information and weather reports along with crop management recommendations
- Field agents on stand-by for phone or on-farm consultations.
- Farmers uploading photos of their crops to enable agronomists to give advice on treating common pests and nutrient problems.
- Notifications sent to partner fruit and vegetable traders when the crops are ready so they can collect the ready produce from the farm.
- An IoT (Internet of Things) platform that will monitor crop health to ensure that these crops are consistently of high-quality.

In the long term, SunCulture also looks to increasing its operations across the continent and developing a DIY (Do It Yourself) package that is easily exported and easy to self-install ■■■

SunCulture is currently offering services at a discount to any organization working in humanitarian relief in the region to stave off the ongoing and debilitating drought



Conclusion

Case Count of Decentralised Renewable Energy Projects in Kenya 2017 made a selection of case studies of small-scale, decentralized renewable energy (DRE) systems in Kenya in 2017. The study highlights 11 unique renewable energy cases dealing with different technologies that include solar PV, hydro, biogas, briquettes and clean cookstoves. The technologies are applied across a range of uses from basic household energy use, institutional uses, commercial uses and

irrigation. These cases provide an insight into how renewable energy is empowering people across the country especially in areas not covered by the national grid. The study examines four main elements of the concerned projects namely: social ownership and local governance; access to technology, skills, and services; access to finance and operation/business model. The finding of the study was found to answer or clarify the key concerns in RE sector.

1. Decentralised renewable energy provide opportunities for productive use at the local level

The study findings highlight key approaches that have been adopted by the project developers to harness the use of decentralized renewable energy technologies in promoting development in remote rural areas. The key approaches can be summaries as:

Entrepreneur-led initiative: This is an initiative conceptualized and implemented by an entrepreneur. Majority of the cases fall in this category and include: Magiro Mini-Hydro Power, Takamoto Biogas, Sunculture, WISEe, Wisdom Innovations, Base Camp and Sanivation. These examples demonstrate how an entrepreneur identifies an opportunity and either through private funds or through different fundraising initiatives set-up a RE company that addresses the identified energy supply gap. The examples under this initiative have a robust business model anchored on energy supply to improve the living standards of the people. As such, these initiatives have remained largely popular to the users for being able to address their specific needs at affordable prices.

Community-led initiative: This is an initiative conceptualized and implemented by the community through a community-based organization or cooperative. Though the initiatives have a business model to raise funds for general operations and maintenance of the system, their core objective is provision of quality energy to the community. The best example in this category is the Ikitaya Energy CBO in Kitui County and Gaitheri Solar roofing project in Murang'a. Though community mobilization and the project establishment process may be supported by donors or well-wishers, it is the community that identifies the main community energy needs, the technology that can be used to address this and even the premises where the project will be installed. The final management of the project is left to the community through a legal body wholly owned by the local people. In the case of Ikitaya, the project is owned by the Energy CBO while the Gaitheri project is owned by the school. Entrenching the project into the user community creates a sense of ownership that promotes prudent management. Major decisions regarding operations, maintenance and even

energy pricing are made by the community which means there is less resistance during implementation and consequently high probability of success.

Donor/government-led initiative: These initiatives are conceptualized and implemented by either the government or a donor. The best example is the Talek Mini-grid that was constructed through collaboration between the county government and GIZ. On completion, the project was handed over to the county government for overall management through a limited registered company. The main aim of the initiative is to provide energy services at a fee to the people who are in remote areas that are not covered by the grid.

Out of the three listed approaches, the Entrepreneurship-led approach is the most sustainable as it is controlled by the market forces which guarantees quality products and services to the customers. The approach also creates room for development of innovative products like is the case with Sunculture with solar pumping solutions and Wisdom stoves with the gasifiers. However, development of such products and services might be too expensive for the nascent companies to fund, a problem which stresses the need to have access to credit facilities or grants to support the activities. Government support in form of favorable policy and legislations is also needed in order to attract potential entrepreneurs in the sector.

These initiatives have remained largely popular to the users for being able to address their specific needs at affordable prices.

2. Entrepreneurs have opportunities in decentralised renewable energy to build successful businesses.

Many DRE entrepreneurs have invested their own limited funds and initiated their enterprise which then attracts government or donor funding due to the resulting local impact. A good example is John Magiro and the Magiro Mini Hydro Scheme which has attracted funding from Netfund among others. Other entrepreneurs have linked up with international funding sources or applied for international recognition and then used the publicity and prize money to grow their businesses. An example of this is Takamoto Biogas, which has tapped into KIVA, an international on-line lending platform through which they got funding from the African Enterprise Challenge Fund. Sunculture has also used this approach to raise money from the Shell Foundation for piloting new technology.

Through sheer hard work and persistence, innovative DRE entrepreneurs have created their own small value chain of actors and players to create a local market for their products and services. Entrepreneurs such as Wisdom Innovations initially tapped into local markets including neighbours, surrounding community, local institutions among others to create a successful customer base for their TLUD gasifier cookstove. Their product and services have now been promoted by word of mouth to other areas/counties in the country and with support from partners; the company is now planning an expansion programme by setting up a bigger manufacturing facility in Kikuyu town where they will have greater visibility and access to a broader national market.

Many of the case study entrepreneurs have partnered with local and international organisations, networks and associations such as KCIC, KEREIA, CCAK, and KBP, SNV and leveraged these partnerships to enhance their knowledge and technical skills and broaden the market for their products. The Wisdom Innovations partnership with KCIC, for example, provides the enterprise with technical support, market platforms, networking opportunities, training and

mentorship, as well as an office space in Nairobi. Affiliation with such organisations also helps entrepreneurs to collectively voice their concerns and lobby government on issues such as unfair competition from cheap low-quality imported goods, which is a potential threat for social enterprises such as Sunculture.

Using localised and appropriate energy delivery models, energy access has been made possible and opened up previously remote areas such as Kitonyoni and Ikitaya in Makueni and Kitui Counties respectively. Both projects were built with strong collaborative efforts between local communities, researchers, donors, government agencies, among others. Local communities that came together as the Makueni County Solar Energy Cooperative in Kitonyoni and the Ikitaya Energy CBO in Kitui are now successfully managing the provision of energy services to rural market centres in Kenya and building on the initial installation and capacity building investment that came from external sources.

Through sheer hard work and persistence, innovative DRE entrepreneurs have created their own small value chain of actors and players to create a local market for their products and services.

3. Enabling regulatory environment required to promote decentralised renewable energy entrepreneurship in the country.

Findings from the case studies show the need for greater supportive regulatory and policy framework at the county level, including efficient and harmonised licensing policies across the counties. Harmonising licensing fees, for example, across all the 47 Kenyan counties will reduce the cost of doing business and encourage DRE enterprises to grow. Takamoto Biogas pays for a separate branding license, whose cost varies between counties, in every county they work in. In 2017 alone, the enterprise paid around KES 60,000 (\$600) for licenses to various county governments in the course of their

work, which can be exorbitant for many DRE entrepreneurs in the country. Harmonization of taxation and licensing can also eliminate double taxation for goods or services moved across various counties.

Many case study DRE Entrepreneurs have knowledge about the policy and regulatory frameworks that govern DRE entrepreneurship in Kenya and are taking advantage of this. Takamoto Biogas benefits greatly from the tax exemption on the biogas equipment they import from China and this in

turn enables them to pass on lower prices to their customers. Sunculture imports solar water pumping systems duty free, which in turn has enabled them develop a competitive price for their new Rainmaker Solar Water pump for launching into the Kenya Market.

In Kenya, DRE Entrepreneurs need to understand the technical competence requirements and to follow the ERC guidelines for technicians and contractors in order to set up compliant businesses. The GIZ Talek mini-grid installation was carried out using strict criteria under a competitive bidding framework to ensure technical competence with REA and ERC requirements as well as cost effectiveness and is now considered a best practice project in Africa. In order to successfully implement the project, GIZ carried out all

the necessary data collection including energy resource assessments, community energy demand studies, and project feasibility studies that supplied the data and information that supported the design and installation of the Talek Minigrid. Lack of availability of reliable data can be a hindrance to DRE entrepreneurs, especially smaller companies, who need this data to understand the market for their products and service. Key stakeholders such as the Kenyan government, international development agencies, donors, local and international research agencies, among others, can play a key role in facilitating data collection, conducting feasibility studies, resource assessments and energy needs assessments etc. which in turn can be used by DRE entrepreneurs to set up viable DRE businesses in the country.

partners to expand its Womens-only training programme to Kenyan counties by working with Technical Training Institutes and Vocational Training Centre to deliver training in DRE in accordance with NITA approved solar PV Technician Training Curriculum. Sunculture encourages women technical sales agents to sell their RainMaker Solar Water pump, knowing that despite not having the initial buying power; it is women and the youth that will be directly involved in the day-to-day handling, operating and maintenance of their solar pumps. While favourable policies already exist to ensure gender balance, it becomes the responsibility of the DRE entrepreneur to implement and put into practice these policies in their enterprises to make them socially inclusive and gender sensitive.

Many DRE case study entrepreneurs have also recognised the importance of having a gender balance in their own staffing.

4. Decentralised renewable energy entrepreneurship under devolved governance.

DRE entrepreneurs in these case studies have steadily built relationships with County Governments to work in partnership on joint DRE projects that benefit local communities. A good example of this engagement is Sanivation which signed an MOU with the Nakuru County Government, to work with Naivawass (the Naivasha Water, Sewerage and Sanitation Company). Under this agreement, Naivawass will provide space in Naivasha town on which Sanivation will set-up a briquette manufacturing plant while Naivawass sewage collection trucks will supply them with human waste instead of taking it for standard waste treatment.

County governments can play a big role in enhancing DRE entrepreneurship in the counties by allocating financial resources under the County Integrated Development Plans (CIDPs) specifically for investment in DRE programmes and projects. The Makueni County Solar Energy Cooperative Society, for example, has plans to work in collaboration with the county government to drill a borehole, install an overhead water tank and build a solar-powered water kiosk for selling water in the centre. Allocation of a budget for these activities by county

planners into the Makueni County CIDP, for example, will enable the county government avail the required financial resources and technical capacity to support expansion of services already provided by the Cooperative in Kitonyoni.

Larger private sector organisations such as Basecamp Explorer Group, an international tourism company, are playing an important role through their use of DRE in their own camps to create sustainable destinations in developing countries. The Basecamp Foundation works with host communities and partner organizations in Kenya to champion community development in a responsible, informed way, without compromising on sustainable natural resource management or the protection of wildlife. Through its work in Maasai Mara, it has encouraged Solar PV entrepreneurship through training of solar mamas from the local Maasai community. Solar PV and solar hot water systems installations created opportunities for local solar PV companies to provide design, installation and maintenance services. In addition, they have built internal capacity of their staff to operate and carry out basic maintenance of their DRE systems in the Mara ecosystem.

5. Making entrepreneurship in decentralised renewable energy socially inclusive and gender sensitive.

Case study entrepreneurs have put in special efforts to understand the end-users of their products and are tailoring their marketing strategies to suit the needs of their clients. Wisdom Innovations, through constant monitoring of their end-users, have ensured that they understand the needs of their clients who are mostly women, and avoid selling their gasifier stoves to men who they know will not use the TLUD gasifier stove once they are purchased. Many DRE case study entrepreneurs have also recognised the importance of having a gender balance in their own staffing. In addition they pro-actively encourage women's participation through special initiatives such as Basecamp Foundation's Solar Mamas project and the beadwork Basecamp Maasai Brand (BMB) economic

empowerment project. Sanivation Sales Agents in Karagita, Naivasha, are all women, since they sell a product that will be used mostly by women. To encourage mainstreaming of gender, DRE entrepreneurs can incorporate gender inclusive strategies in their own staffing as well as promote DRE technologies that are affordable and gender-friendly.

WISEe is contributing to the steady increase of the number of licensed women solar technicians and trainers through its women-only trainings. In addition WISEe also provides hands-on installation experience to their trainees so that they can attain the confidence to sell and install solar PV systems on their own. The Womens cooperative is working with

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Publication Information

Publisher	Heinrich-Böll-Stiftung
Publication Date	July 2018
Editors	xyxyxy xyxyxyxy
Cover Image	© Heinrich-Böll-Stiftung
Design & Layout	Michael Lusaba



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