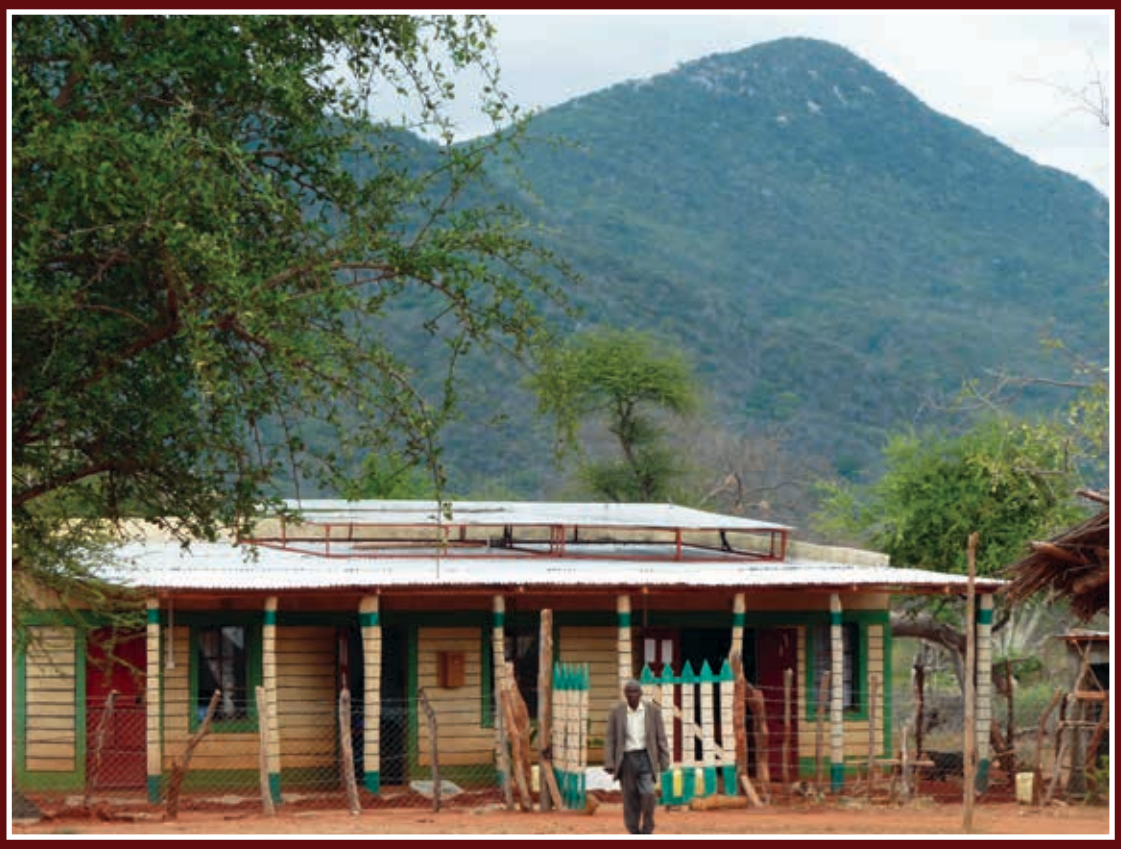
The Solar Energy Centre

An Approach to Village Scale Power Supply



The Solar Transitions pilot project in Kenya

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Executive Summary

Access to electricity has a positive impact on a wide range of factors influencing rural communities, from improved health, to access to communication and information, to better educational facilities, economic prosperity and improved standard of living. However, finding ways to expand energy services to marginalized households in developing countries is one of the most pressing challenges facing the world today.

Globally, there is no universal approach to provision of access[1] to electricity in marginalized areas. A number of factors determine what approach would be most suitable for a given community: local dynamics such as the type of settlement (centralized or decentralized), density of the population, ability to pay, available energy resources, proximity to the national grid and the degree of social inclusion one seeks to obtain.

The village energy centre model, developed by the Solar Transitions project, targets provision of affordable and accessible basic lighting and electricity services for off-grid communities through an approach where all services are housed in one centre proximate to the community. The system design attempts to minimize the number of centralized batteries required to reduce future battery replacement costs. To achieve sustainability and enable expansion, the centre is designed to be operated by local residents on financial principles.

The energy centre model described here is based on a 2.16 kW solar PV system which provides energy for a range of services i.e. lantern charging and renting, charging of mobile phones, IT-services (typing, printing and photo-copying) and television and video shows. Fees are charged for the provision of these services to cover operation and maintenance costs (e.g. battery replacement) and generate a surplus for energy centre improvement and expansion. The centre has the capacity to serve up to 200 households (1,000 people). Solar PV technology is selected because of the abundance and availability of the solar resource is Kenya, the modular nature of the technology and its minimal operational and maintenance requirements. The solar PV market in Kenya is also commercially mature with high levels of awareness and availability of products and services.

The total investment cost for the centre was 43,000€[2]; 11,000€ for the building structure which houses the energy centre and 32,000€ for the solar PV equipment, furniture and appliances. The services provided by the centre generate an average revenue of 460€/month. Operation and maintenance costs average 400€/month. This includes staff salaries, petty cash, consumables, general maintenance and contribution to a battery replacement fund i.e. to raise 4,600€ every 2-3 years (130-190€/month).

With a typical solar PV system life span of 15 years, the project is low-cost compared to other options for provision of basic energy services to low density off-grid communities. Considering the average population density in the general area[3] is 9 households/km^2 and conservatively assuming that 1km of low voltage grid network would be sufficient to connect 10 households; the total cost for a electricity grid to connect 100

1 *The UN uses a three-step scale to denote various types of energy access: Level 1 - Basic human needs (electricity for light, education, health, communication and community services, and modern fuels/improved stoves for cooking with biomass), Level 2 Productive uses and Level 3 - Modern society needs. http://www.un.org/millenniumgoals/pdf/AGECCsummaryreport[1].pdf*
2 *Excludes costs related with developing the model, training the staff and follow ups. In January 2012, the time of implementation, 1€ = 110KES.*
3 *Kitui County, Eastern Kenya*

households would be about 80,000€. In Kenya, this would theoretically be financed through the rural electrification fund. In addition, each connected household or business would be required to pay a connection fee of 150-320€[4].

The energy centre is designed to be run by the local community under a concessional arrangement. Under the terms of the concession, ownership is not transferred; the energy centre and the equipment therein remain the property of the project implementer. In addition, the operator is required to submit quarterly operational financial reports and an annual audit. The operator is also required to make an agreed upon monthly deposit to a joint bank account for the battery replacement and maintenance fund. If the operator fails to adhere to these terms and no suitable remedial action is identified and effected, then the concession is terminated and the system reassigned or relocated to another community.

Although it is possible to achieve operational sustainability with this model, it does not generate enough profit to be of interest to investors who might generate quicker and more substantial returns elsewhere. In the interim, investment support from government, NGOs, and funding agencies is required for replication and roll out of the model. However, with design reviews it is possible to scale down investment and operational costs to make the model attractive for private sector investment.

The revenue trends from 18 months of operation indicate that the lantern renting and mobile phone charging services are by far the highest and most consistent source of revenue; they represent 70% of all revenue generated by the energy centre and about 50% of the costs. They essentially subsidize the other services provided at the centre i.e. the IT services and TV/video shows. Whereas these are viewed as important services by the local community they are not sufficiently subscribed to cover their operational costs. An analysis of investment costs also indicates that a model targeting only the provision of lantern renting and mobile phone charging services would require a capital investment of less than one third of the investment costs. Such a model could prove interesting for businesses.

For local staff and board members, learning through practice is important, in addition to good training on a variety of themes. Follow-up visits and phone calls by implementers can assist them to learn fast and be innovative. This can enable them to make improvements underway, based on the accumulation of practical experience. Committed follow-up will also enable the implementers to stay updated on the details of the progress and problems that may need attention. Objectives like financial self-sustenance and strict enforcement of rules for renting of lanterns may be difficult to achieve and a full recognition of how to achieve it may only come over time. Concern about the details of the operations has shown to be important, and allows for mutual exchange of ideas between implementers and local actors. Gradual expansion from the first location to larger geographical areas can be achieved through ensuring good build-up of the capacities and motivation of a few key persons. The energy centre can then become a hub for activities in several villages.

4 *After the rural electrification authority commissions the grid it is then handed over to the national electricity utility who will be responsible for operation and maintenance. Once this hand over is effected the fees for new connections rises from 150€ to 320€.*

Acknowledgements

We thank the community of Ikisaya, and the staff and board of the Ikisaya Energy Centre for working with the Solar Transitions team on this pilot project.

We also thank the Research Council of Norway for funding the research cooperation between practitioners and social scientists from three continents.

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Introduction

A model for off-grid, village scale power supply has been developed through a pilot project in Ikisaya in Kenya. The project was initiated and carried out by a team of social scientists and practitioners from Kenya, India, Norway and Austria through the Solar Transitions research project, led by the University of Oslo. The team studied examples in India that inspired the development of a model in Kenya. Through a participatory approach with the local community, the project developed an energy centre model which became operational on March 20th, 2012.

The model creates affordable and accessible basic lighting and electricity services for off-grid households and businesses through a financially sustainable design. The development of this model was motivated by the need to solve the challenge of developing an effective off-grid energy supply system.

The centre is designed to be operated by local residents on commercial principles. Today, it provides lighting services to about 100 households in the village and 120 households in sub-centres in other villages. Other services provided at the centre include phone charging, photocopying, typing, TV/video shows and electric shaving.

The report describes and rationalizes the model and shares experiences from the first 18 months of operation. The financial performance is documented and suggestions are provided on how the model could be improved. The local context is described so that the model's potential for transferability to other places may be considered.

The purpose of the report is to describe the village energy centre model in a way that gives practical information to people who consider implementing similar energy systems in other places or building on certain elements of the model.

The model is described through the following sections:

- **An Overview of Ikisaya – Understanding the Local Context:** There is no standard approach to provision of energy services. For a model to be effective it has to be suited to local conditions. The village energy centre model is therefore best understood in the context in which it was applied. This section describes the local conditions in the area for which the model was designed.

- **A Technical Description of the System:** This section describes the overall system design. It provides an overview of the structure built to house the energy centre, the design of the system used to power the energy services and a breakdown of the capital investment costs.

- **An Overview of the Services Provided:** The energy centre targets affordable, accessible provision of basic lighting and electricity needs for off-grid households and businesses. This section describes the services provided at the energy centre, the pricing of these services and the operational modalities for their provision.

- **The Institutional and Operational Framework:** The energy centre is designed to be run by a local community or a business entity under a concessional arrangement. The section describes how energy centre is staffed, the operational and book keeping procedures and the details of the concessional arrangement

- **How the Model Fared:** The centre has been in operation for 18 months. This section presents the operational challenges experienced during this period and the strategies developed to address these challenges. It also presents and discusses the energy centre's revenue and expenditure.

1 An Overview of Ikisaya – Understanding the Local Context

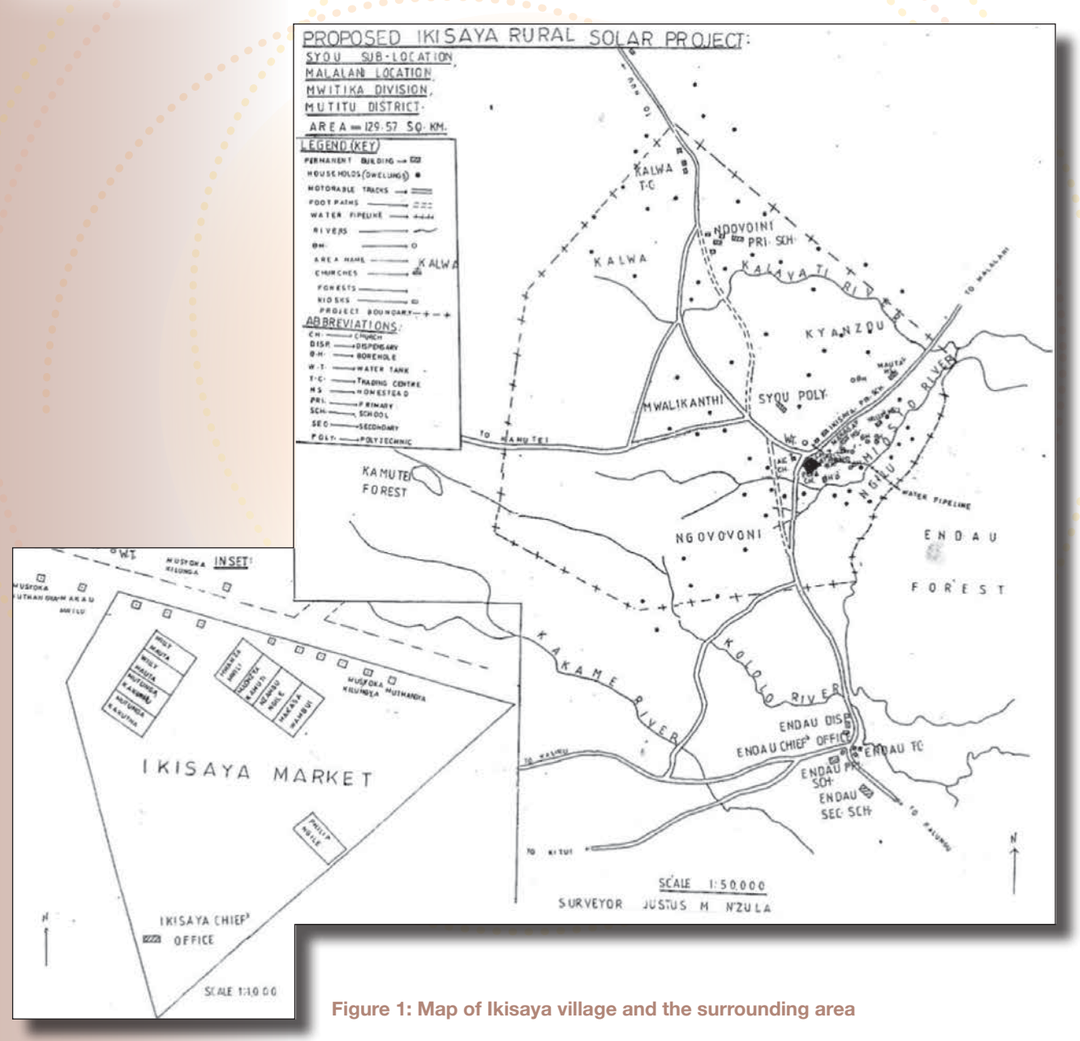


Figure 1: Map of Ikisaya village and the surrounding area

1. An Overview of Ikisaya – Understanding the Local Context

The energy centre model is the result of a process aimed at identifying an approach for energy service delivery suited to the identified local conditions. The process took into account local dynamics i.e. the type of settlement pattern, density of the population, ability to pay, electricity services prioritized by community members, gender aspects, available energy resources, proximity to the national grid and social inclusion.

Ikisaya is located in the Eastern Province of Kenya, 250km east of Nairobi and 100km east of Kitui town. Ikisaya is a sub-location in Malalani location of Kitui District. Ikisaya sub-location comprises six villages/wards; Kyanzou, Mwalikanzi, Ndovoini, Ngiluni, Ngovovoni and Kalwa (see Figure 1). The population of Malalani location is 1,270 households and the population density[5] is 6 persons per km^2. The average household has 5-6 persons. The average population density in rural Kitui county is 46 persons per km^2.

Ikisaya has two primary schools, a small polytechnic school, 3 churches, a few shops retailing essentials, a private pharmacy and a maize mill powered by a privately owned diesel generator. There is no health clinic in the village.

Kitui district is semi-arid and drought prone. Subsistence farming, charcoal production and livestock keeping are the main sources of livelihood in Ikisaya. The crops commonly grown are maize, sorghum, cow peas, green grams and millet. As a result of frequent droughts, crop failure is common and food aid is sometimes required.

Kerosene and dry cell batteries are the main sources of energy for lighting. A household survey revealed that the average household expenditure on lighting is 32 €/month and the average expenditure on phone charging is 10 €/month. Phone charging services were provided by businesses/shops using small solar PV systems.

Transport within the sub-location is mainly by foot, but bicycles, donkeys and motorbikes are used for longer distances and when carrying water and goods. There is no regular public transport within the sub-location and it is not uncommon for people to walk 6-8 km to school or fetch water. Daily public transport to and from Kitui and Nairobi is available.

Ikisaya is representative of Kenya's arid and semi-arid lands (ASALs) which make up 88% of the country and are inhabited by approximately 25% of Kenya's population. These areas have the highest incidences of poverty and the lowest level of access to basic services.

At the water point in Ikisaya village

5 2009 Kenya Population and Housing Census

2 Technical Overview of the Energy Centre in Ikisaya

Installation by experienced technician
Photo: Marius Grøtvedt

2. Technical Overview of the Energy Centre in Ikisaya

The village energy centre model targets provision of affordable and accessible basic lighting and electricity services for off-grid communities though an approach where all services are housed in one centre proximate to the community. A mini-grid model had been considered initially, before studying the local context, but could not have reached the same number of households and would not have been economically sustainable here. The system design minimizes the number of centralized batteries required thus reducing future battery replacement costs.

The energy centre model is based on a 2.16 kW solar PV system which provides energy for a range of services i.e. lantern charging and renting, charging of mobile phones, IT-services (typing, printing and photo-copying) and television and video shows. Solar PV technology is selected because of the abundance and availability of the solar resource is Kenya, the modular nature of the technology and its minimal operational and maintenance requirements. The solar PV market in Kenya is also commercially mature with high levels of awareness and availability of products and services.

The total investment cost for the centre was about 4,730,000KES (43,000€)[6]; 1,210,000KES (11,000€) for the building structure which houses the energy centre and 3,520,000KES (32,000€) for the solar PV equipment, furniture and appliances.

This section describes the overall system design. It provides an overview of the structure built to house the energy centre, the design of the system used to power the energy services and a breakdown of the capital costs.

6 2009 Kenya Population and Housing Census

2.1 Building Design

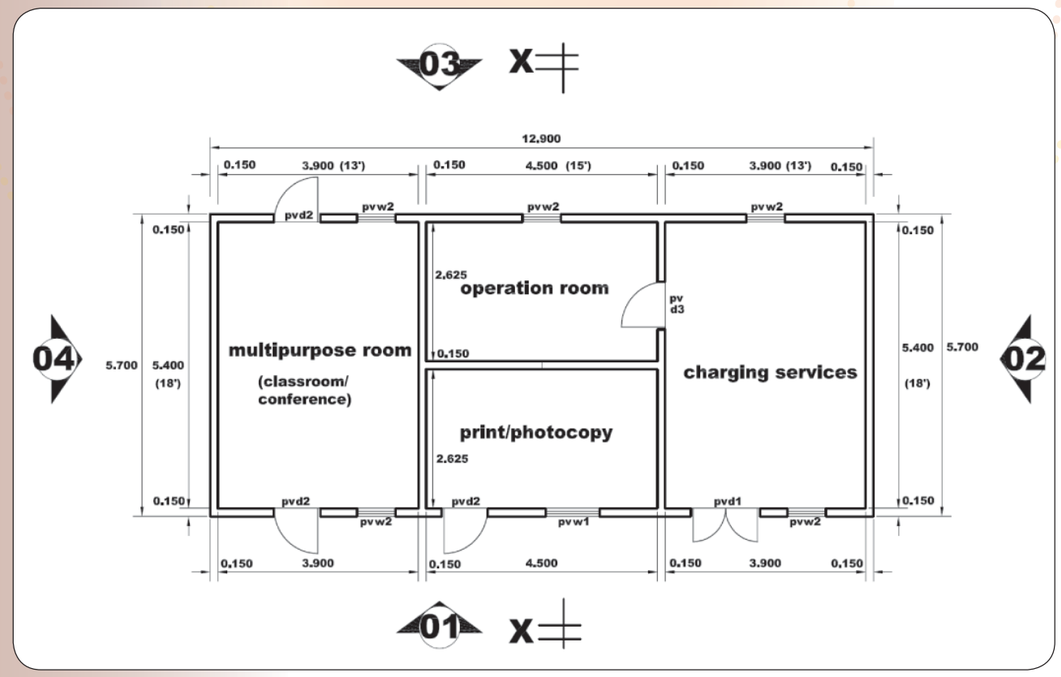
The energy centre building is designed to separately house the services offered. The area of the building is slightly below 70 square feet. It has 4 main rooms:

- The charging station - where phones, lanterns and small batteries are received, charged and given out. It is also the room from which retail sales are made.
- The IT room - where photocopying, typing, printing and other IT related services are offered. It is envisioned that basic computer training could also be provided here.
- The TV room – where TV and video shows are screened. The room may also be hired out and used for meetings and training.
- The back office and store – where most of the installed equipment (batteries, inverters, charge controllers) is kept. The room is used as an office and a store.

Although the prototype village energy centre is a permanent building; a better approach could be to use a portable structure that can be assembled and transported relatively quickly e.g. a modified container or prefab. The main reason for this would be to facilitate replication through quick and easy installation and relocation e.g. in the event that the energy centre was not viable due to insufficient demand for services to ensure operational sustainability, connection of the village to the national electricity grid or poor management by the concessionaire.

Permanent structures require leasing or acquiring of land and local coordination during construction both of which consume time and money which would be a barrier to replication and roll-out of the model. A permanent building may nevertheless have advantages in that it is likely to provide a better working environment for staff and a nicer atmosphere for the users of the various rooms. A container could possibly be used in combination with existing buildings. Figure 2 shows a drawing of the building of the energy centre.

Figure 2:
Ground Floor Plan



2.2 System Design

The energy centre is based on a 2.16kW solar system, broken up as follows:

1) A 600Wp lantern charging system with the capacity to charge 120 lanterns per day. Because the lanterns are rented out for 2 nights at a time, the system can effectively charge a maximum of 240 lanterns. The lantern charging station is made up of 12 lantern charging units. Through each unit, 10 lanterns are charged centrally from a 50Wp module via a junction box with 10 charging ports. The charging ports have indicators that change from red to green when the lantern battery is fully charged.

2) A 240Wp solar PV array designed to charge forty, 3.3Ah batteries per day. The 3.3Ah batteries are part of the Barefoot Power's Sola Powapack Junior Matrix, which is a 2 LED light "plug and play" solar system with the option for charging a mobile phone and powering a radio. The Powapack batteries are charged from two 120Wp modules each powering a DC charger with 20 ports.

3) A 240Wp phone charging system with the capacity to charge up to 120 phones per day. The phones are charged with AC via a 350W inverter.

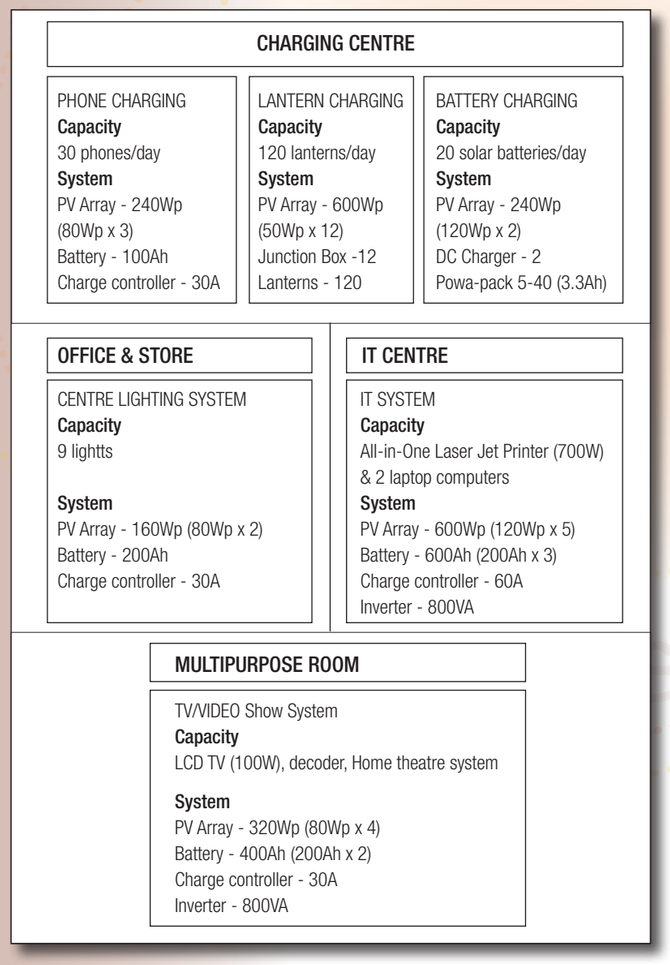
4) A 600Wp AC system (PV array, battery, charge controller, inverter) for printing, photocopying and other computer services. The system powers an all-in-one laser jet printer, scanner and copier. The system also powers two laptop computers for the IT services.

5) A 320Wp AC system (PV array, battery, charge controller, inverter) to power a TV/Video and public address system. The room and facilities are on hire for meetings, local training workshops and to screen educational programs for schools.

6) A 160Wp DC system (PV array, battery, charge controller) to power the lighting system for the centre. The lighting system uses CFL light bulbs and is made up 6 indoor lights, 6 outdoor lights and a light for the outdoor toilet.

The overall system layout is shown in Figure 3 to the left. The area of the solar arrays is approximately 22 square feet.

Figure 3:
System layout, the Energy Centre Model



2.3 Capital Costs

The capital costs of the system are broken down in the table below.

Table 1
Summary of Capital Costs for the Energy Centre

	Item	Cost (KES)	Cost (Euro)
1	Building, construction and oversight costs	1,156,000	10,509
2	Furniture and fittings	90,000	818
3	Solar PV system equipment and installation costs (including lanterns and other accessories) at the energy centre and for agents	2,827,000	25,700
4	Appliances (e.g. laptop computer, laser-jet printer, TV, decoder, home theatre)	196,000	1,782
5	Start-up stationary and equipment (e.g. receipt books, counter books, cash boxes, folders, stapler, punch)	108,000	982
6	Retail outlet stock (40 lanterns & 40 powapacks)	301,000	2,736
	TOTAL COSTS	**4,678,000**	**42,527**

The building was constructed by a local contractor. The costs of the materials and construction work for the building was 700,000KES (6,363€) and the oversight cost was 456,000KES (4,145€). The construction costs included wooden shelves, tables and chairs for all rooms, handmade locally.

With design reviews it is possible to scale down investment costs. Some cost cutting options include:

- Using a container or prefab instead of constructing a permanent building could reduce the costs. Excluding transport and installation, a fully modified 40ft container would cost around 350,000KES (3,182€). Transport costs will vary depending on the location. The container option has not been tried out in this project.

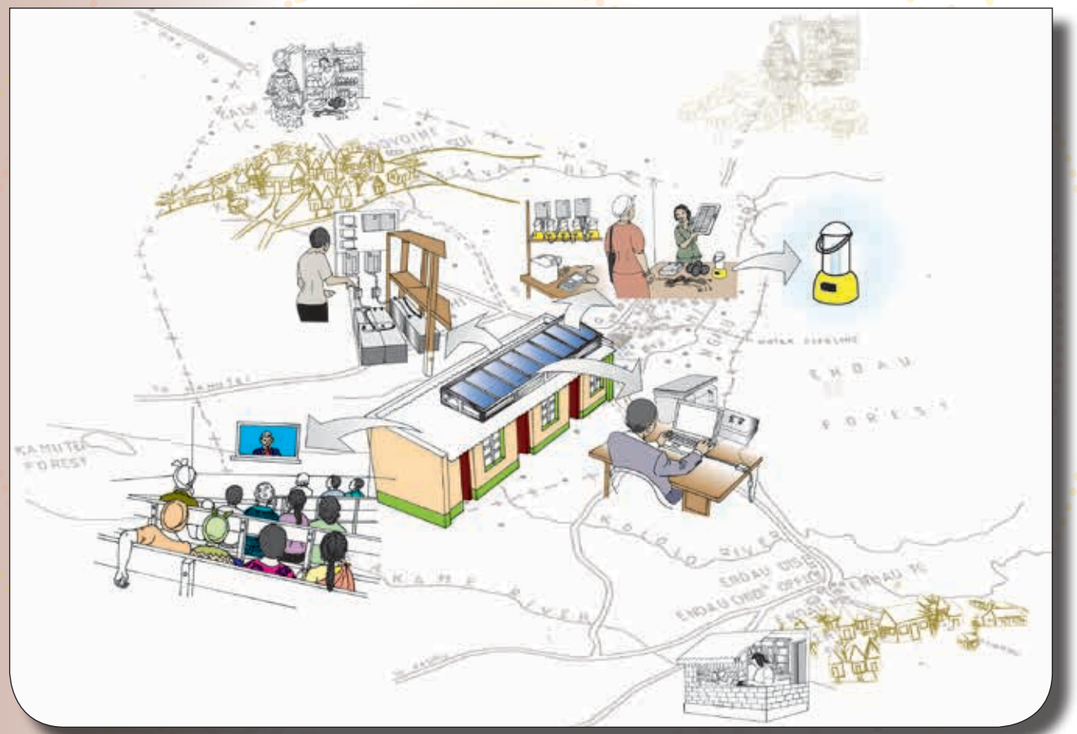
- Reducing the system size: The demand for phone charging and battery charging are not as high as anticipated. There is therefore scope for reducing the system size by as much as 500Wp and therefore saving 500,000KES (4,545€) i.e. by reducing the phone charging system to 60Wp (sufficient to charge the current capacity of <20 phones per day), by reducing the battery charging system to 100Wp (sufficient to charge 10, 3.3Ah batteries per day) and the IT system to 400Wp (by switching from a high consumption laser-jet printer to an ink-jet printer, although considering that the laser-jet printer has been reliable and has a good capacity). Using LED lights in the energy centre lighting system can further reduce the system size.

It could therefore be possible to reduce the capital costs by up to 1,100,000KES (10,000€).

Carefull lifting of the Solar PV panels
Photo: Marius Grøtvedt

The batteries for the TV, IT and lighting systems at the Energy Centre

3 An Overview of Services Provided



Ikisaya Energy Centre and its three first sub-centres, operated by agents
Illustration: Mike Mabwa

3. An Overview of Services Provided

The energy centre targets affordable, accessible provision of basic lighting and electricity services for off-grid households and businesses. Lighting needs are currently served through the use of kerosene and torches with expenditure from 150-400KES/month (1.4 – 3.6€/month); which is likely to increase with increasing fuel costs. Mobile phone owners often have to travel long distances to charge their phones in addition to spending 20KES/charge (18€¢[7]). Printing, photocopying, computer services and TV/video shows are also not readily accessible within the vicinity of most off-grid communities. All these services were pointed out as important by the community members. Furthermore, there is little or no competition for the provision of all these services under one roof as most entrepreneurs are unwilling to make large investments to provide energy services in off-grid areas.

This section describes the services provided at the energy centre, the pricing of these services and the modalities for their provision.

3.1 Lantern Charging and Renting

The lanterns were supplied through The Energy and Resources Institute (TERI) in India, who are implementing the Lighting a Billion Lives (LaBL) campaign. Through the LaBL campaign, TERI has been working with Indian lantern manufacturers to improve LED lantern design and quality. The lantern used in the pilot is the result of one of these design-iterations; it provides a 360° light, has a high lumen output[8] and is simple and robust.

The LED lantern can provide 5-6 hours of light in full brightness mode and 7-8 hours in dimmer mode. It takes 5-6 hours to charge on a clear sky day. The lantern battery is a 6V lead acid battery which has a life-span of 1-2 years, depending on how it is used. The landed value of a complete lantern (with individual 5Wp charging module) is in the range of 4,500-5,500 KES (41-50€) and the cost of replacing the battery is 1,000KES (9€). Batteries for the first replacement will be imported from India. These will be li-ion batteries. Such batteries are expected to become available for sale in Kenya.

The LaBL lantern used at the Energy Centre

The target market for the lantern renting consists of approximately 400 low-income households living within a 5-10km radius of the energy centre. For the majority of these households kerosene is the most commonly used lighting source. Although the lantern charging system has a capacity of charging 240 lanterns (i.e. 120 lanterns per day at maximum capacity), the approach used was to start with 160[9] lanterns with the option of increasing the number of lanterns as demand would grow.

Lanterns are rented out at 20KES (18€) for 2 consecutive nights. At a lower light output setting and fewer hours of use per day, it may be possible to use the lantern for more than 2 nights; however usage is restricted to only 2 consecutive nights per charge to protect the lantern battery from deep cycling. Regular deep discharging of lead acid batteries can significantly shorten battery life.

The general rules for operating the lantern charging station are as follows:

- Each lantern has an identification number (written with permanent marker).
- Since the centre is managed through a community based organization (CBO), customers are required to pay membership fees and become members of this CBO. This is so that they can have a direct or indirect influence on how the centre is managed.
- Each lantern customer is required to pay a one-time non-refundable deposit of 200KES (1.8€) for each lantern to be rented. Customers can rent more than one lantern; however a deposit has to be paid for each lantern.
- The cost for renting a lantern is 20KES (0.18€). Customers can keep the lanterns for a maximum of 2 nights after which they have to be returned to the energy centre before 11 a.m.
- Upon renting the lanterns, the lantern ID number and the membership number are recorded. The condition of the lantern will also be noted and confirmed by the person renting the lantern.
- When the lanterns are returned, their condition is checked again upon receipt. If there are damages caused by mishandling, the cost of small repair/replacement is to be covered by the customer. If the customer refuses to cover these costs, then they will be recovered from his/her deposit and the customer will be barred from renting lanterns in the future until he/she repays the cost.
- Large maintenance costs such as electronic failure/printed circuit board (PCB) replacement or battery replacement, which are not caused by misuse, are covered by the energy centre
- A fine of 10KES (0.09€) is levied for returning the lantern later than 11 a.m. on the agreed day and for each additional night the lantern is kept beyond the agreed upon 2 nights.
- Lanterns can be collected from the energy centre from 5 p.m.

7 *€¢ (Euro cents)*
8 *The LaBL lantern has an illumination of 250 lumen*

9 *40 of these lanterns were intended for sale with their own solar PV panels for charging by the owners, but very few households have so far chosen to do so. The rental model is the preferred option.*

Staff member and customers

3.1.1 Use of Agents

The lantern charging and renting service has evolved from being a purely centralized model where the lanterns and lantern charging system were all housed at the energy centre to a decentralized model where lantern renting services are also provided in neighbouring villages through agents. The reason for this change was demand for lantern renting in these other villages around Ikisaya. The Ikisaya energy centre currently has 5 agents located in other trading centres that are 10km or more from the energy centre. These agents are in the trading centres of Endau, Malalani,Ndovoini, Kathua and Yiuku.

The charging units are easily set up by installing one or more lantern charging units per agent. Each charging unit, initially developed as part of the LaBL campaign in India, is made up of a 50Wp module, a junction box/charging unit and 10 lanterns. In some areas agents have also been provided with additional equipment to enable them to also offer phone charging services. The two newest agents test out a new type of equipment with remote monitoring of the charging. The lantern charging capacity of the energy centre and of the different agents is currently: Ikisaya – 66, Endau – 71, Malalani – 22, Ndovoini – 10, Kathua – 10 and Yuiku – 28.

The agents are typically existing shop-owners in these trading centres interested in generating additional income. These agents earn a commission of 30% on the lantern renting revenue they collect.

The energy centre has also been experimenting with an alternative kind of agent. In one trading centre the energy centre has employed a local person to manage the lantern charging services there. This person is paid a fixed monthly salary (irrespective of the revenue collected). The centre also directly covers the rental costs of the premises where the services are housed.

The major challenge with the agent approach is the inability to determine the actual revenue collected by the agents. A number of options are being tried outto address this:

- A fixed monthly amount payable by an agent to the centre be determined and any revenue generated over and above this amount be retained by the agent as his/her income. It is anticipated that this approach would not only guarantee the centre a predictable monthly income but that it could also incentivize the agent generate as much revenue as possible.

- Implementing a system that could remotely monitor an agent's performance and that could also remotely control the agent's system. Such a system would ensure timely monthly payments by enabling the centre to remotely disconnect an agents system if payment is not remitted. In Kathua and Yuiku, the energy centre is piloting lantern and mobile phone charging systems with the capacity for remote monitoring and control.

It is important to consider that the logistics of remittance or collection

of payments from agents is difficult in areas with limited inter-village public transport and poor or limited mobile network coverage. The energy centre staff uses a motorbike belonging to a staff member, paying for the fuel only, to keep costs down.

3.2 Battery Charging

The battery charging option with the Powapack was seen as suited for households or businesses that prefer having a multiple light[10] system and the ability to charge a mobile phone and small radio. The Powapack includes two lights, connecting cables, switches for each light, a phone-charging outlet and connectors, a DC socket for radio and overcharge and over-discharge battery protection. The system also comes with a 2.5Wp solar module. When both lights are in use the system can operate for 7 hours with a full charge.

Under the energy centre design, the Powapacks were primarily intended for sale. The centralized battery charging option was designed to provide a foundation for consumer financing for the Powapacks. Due to the high upfront cost of the Powapacks i.e. 6,800KES (62€), a consumer financing approach was considered as a means of enabling interested households or businesses to spread the payment of the system.

A component based approach was initially developed, through which customers were provided the option of purchasing the system components over time e.g. first purchasing the battery, one light and phone charging connector. These components would represent a fraction of the total Powapack cost and with them customers could still access lighting and phone charging services by charging the Powapack battery at the centre every 3-4 days. Over time they could then gradually purchase the additional lights and finally the solar module. Through this approach interested households or businesses could grow their systems affordably over time while at the same time generating income for the energy centre.

This approach was however not adopted; customers instead opting to deposit small amounts of money with the centre over time until they had saved enough to purchase the entire system.

After a few months of operation, the centre also implemented a rent-to-own model. Through this model customers are required to first make a deposit of 1000KES (9€) for the Powapack (without the panel) to be installed in their home or business. They are then required to pay 130KES (1.2€) per week for 52 weeks (1 year). During this period, they can charge their batteries at the charging centre as required, and upon completion of these instalments they will own the system and be provided with the solar module. This approach was also not adopted much. Some Powapacks are currently rented to customers at a monthly fee, and a few have been sold.

3.3 Mobile Phone Charging

Mobile phones are charged at 20KES (0.18€) and the 240Wp solar PV charging system has the potential to charge 120 phones per day.

To ensure that phones are fully charged before customers collect them, phones are to be delivered to the charging station no later than 5 p.m. otherwise a full charge cannot be guaranteed on that day. Phones are labelled using stickers for easy identification so that any energy centre attendant can receive and return phones.

10 *The illumination of the Powapack LED lights is 58 lumen*

3.4 IT Services

The following IT-services are available at the energy centre:

- Photocopying (per page): 10KES (0.09€)
- Scanning (per page): 15KES (0.14€)
- Typing and printing (per page): 30KES (0.27€)
- Laptop charging (per charge): 350KES (3.2€)

The energy centre staff carry out many typing jobs, which takes time for the staff, while adding relatively little to the revenue because of the low price per page. However, the service is regarded as important for the community and the staff is reluctant to increase the price.

Toner for the photocopy-machine is ordered by the staff every second month from a town 90 km away. It is sent by the local bus, and paid for through M-Pesa (mobile phone payment).

3.5 Retail and Spares Outlet

The initial retail outlet stocks with items for sale included

- 40 lanterns (similar to those used at the lantern charging station) with solar modules. A handful of these have been sold, the rest are being charged at the centre and rented to the customers.
- 40 Barefoot Solar Powapacks with 2.5Wp charging modules.

The retail outlet provides the option for interested customers who can afford it, to purchase a complete set of lantern with charging module or Powapack. Potentially, other locally available LED lantern models or energy products (e.g. energy efficient cook stoves) could also be stocked and/or purchased by order if there is demand. Pricing is based on a 25% margin for the energy centre.

Staff members

In addition, lantern spares e.g. batteries, switches, housing, PCBs etc. are also being stocked, but these are mainly for purposes of maintaining the energy centre lanterns.

Other models of lanterns were later purchased i.e. Sun King Pro, Sun Transfer and Prakruthi Power lanterns. Most of these are currently being rented. Some of the lantern models are available in Kenya. The customers of the pilot project have appreciated several varieties of lanterns.

3.6 Multi-purpose Room for General Hire and TV/ Video Shows

The table below shows the initial rates proposed for hiring the multi-purpose room. Different rates were applied depending on whether electricity is used or not.

Table 2:
Overview of initial room-hire options and costs

Duration/ Time of Day	Hire with Electricity Use	Hire with No Electricity Use	School Rate
Half day hire	500KES	250KES	200KES
Full day hire	1,000KES	400KES	
Evening hire (6-9 p.m.)	500KES		

The target markets for hiring services are general meetings, training seminars/ workshops (e.g. where the TV is used as a projector), church meetings, educational shows (e.g. for schools), wedding receptions etc.

The energy centre also screens TV/ video shows, with the following initial prices:

- Afternoon news 1-2pm @ 5KES (0.045€) per person
- Evening news 7-8pm @ 5KES (0.045€) per person
- Evening movie 8-9:30pm @ 20KES (0.18€) per person

Movies are also screened in the afternoon on weekends if there is demand.

Due to low uptake of these services the rates for the room hire and TV/ video shows have subsequently been reviewed downwards. The use of the TV/ video services has gradually increased. TV-subscription costs 1000KES (9.1€) per month (lowest rate) and payment is sent by M-Pesa by energy centre staff.

3.7 Information and Marketing

As with the introduction of any product or service, once commissioned, it is necessary to create local awareness about the products and services offered. For the energy centre, this included providing information about the type of services offered, operating hours, operating rules etc. Due to the participatory approach used to develop the model most people were aware of the project and the services before the centre was commissioned.

Considering the lack of regular public transport within the area, the products and services offered at the centre would be mostly procured by businesses and households within a 10km radius. This catchment area was later widened through the use of agents and because some of the services have started to attract customers to Ikisaya from farther away

Due to the limited catchment area, simple yet cost effective approaches were used to market the energy centre and create awareness about the products and services offered. These approaches included:

- Marketing activities at forums in Ikisaya and neighboring villages where large numbers of people typically gather e.g. market days, religious gatherings (church or mosque services) and village meetings organized by the local administration.
- Use of sign boards and notice boards. Notice boards are used for providing regular updates on products and services e.g. what TV shows or sports programs are being screened on a given day/ week.

- Use of open days; a day dedicated to encourage locals to visit the centre and learn about the products and services offered. To make it attractive, the costs of services are subsidized on this day to encourage members of the community to try out the services.
- Use of agents to market some of the products retailing at the energy centre. Agents could be provided with a sample product for display.

Open Day at Ikisaya Energy Centre

4 Institutional and Operational Framework

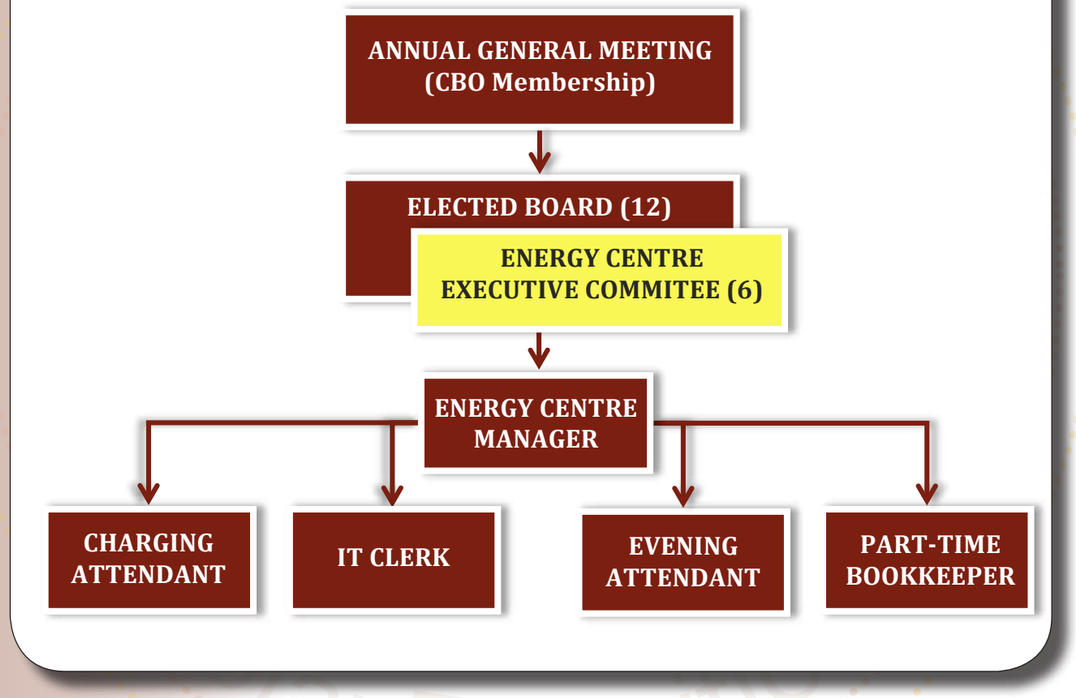


Figure 4:
Organisational Model

4. Institutional and Operational Framework

The energy centre in Ikisaya is operated and managed through a community based organization (CBO), the Ikisaya Energy Group, which was formed on the initiative of the community[11]. The energy centre is registered with the local authority as a business entity and operated as such.

Community based organizations are a common approach to organizing members of a community through registration as self-help groups by the District Office of the Department of Culture and Social Services administratively under the Ministry of Home Affairs, Culture and Social Services. CBOs have a constitution/by-laws which detail the CBO objectives and their operational and governance structures.

Users of the energy centre are encouraged to become members so as to have a voice in how the energy centre is operated and managed; to access lantern rental services CBO membership registration was made a mandatory requirement. At an annual general meeting, the CBO membership elects a 12 member board with gender balance and geographical balance. Six members from this board then form the executive committee responsible for overseeing the management of the energy centre.

4.1 Concessional Model

To encourage sustainable operation, a concessional model has been employed. Under this model a concessional agreement is signed between the energy centre sponsor and the energy centre operator. The key terms of the concession agreement are:

- The energy centre and the equipment therein remain the property of the sponsor or its chosen representative (i.e. ownership of physical assets is not transferred to the community or business running the centre).

- The centre operator is required to submit quarterly operational financial reports and an annual audit to the sponsor. This is to enable the sponsor to keep track of financial performance of the centre.

- The centre operator is required to deposit, in a joint bank account, an agreed upon amount for the maintenance fund on a monthly basis from the revenue generated. This is to ensure that sufficient funds are available for both anticipated and unexpected cost-intensive maintenance/replacement requirements that will arise after 2-3 years.

If the operator fails to adhere to these terms and no suitable remedial action is identified and effected, then the concession is terminated and the system relocated or reassigned.

4.2 Staffing

Day to day energy centre operations are undertaken by a team of locally employed and trained staff. The members of staff earn a monthly salary from the revenue generated from the services provided at the centre.The team is made up of:

- *A charging attendant* who is responsible for the lantern charging and renting, battery charging, phone charging and retail shop operations.

- An *IT clerk* who is responsible for operations related to printing, photocopying, computer services, laptop charging as well as managing the TV/Video room.

- A *part-time* book-keeper who is responsible for preparing weekly and monthly financial statements, preparing the pay roll and general preparation and filing of records, receipts, bank statements and reports for the annual external audit.

- An *evening attendant* who is responsible for fee collection from the TV/Video shows screened at night, night-time security and general cleaning.

An additional position of energy centre manager was also created, although with hindsight it is more efficient and cost-effective to have the charging attendant, IT attendant or bookkeeper also undertake this role. The *energy centre manager's* responsibilities comprise:

- Reporting to the executive committee of the CBO on the energy centre operations.

- Monitoring operations and proposing operational changes to the executive committee of the board.

- Consolidating energy centre records daily and preparing weekly reports and documentation for the accountant.

- Collecting all the daily revenue for the energy centre from the staff at the end of the day for safe keeping in the energy centre safe, depositing of the cash in the energy centre bank account after a given number of days as proposed by the executive committee, keeping records and documentation of cash deposits for the accountant and executive committee.

- Budget preparation and preparation of cash requisitions for monthly operational expenses to be approved by the executive committee.

- Customer service i.e. handling complaints, queries and requests.

All the recruited staff are local residents. They were trained in energy centre operation and maintenance during the installation of the system. The nine days' training program included basic technical skills, book keeping and business principles, and service delivery to the customers. Over the 18 months of operation, regular follow up visits have been undertaken to review the staff's progress and brainstorm on how operations can be improved. Regular phone calls have also been made in order to provide moral support and inspiration, discuss challenges and get information about problems at an early stage. The visits and phone calls have been important in addition to the initial training and has led to considerable learning through practice for the staff, as well as the project team.

4.3 Operation Procedures and Book-keeping

The operations of the centre are based on the following guiding principles:

- The centre shall operate its own dedicated bank account where all money shall be banked. The signatories for this account will be the board members as outlined in the CBO constitution.

- All receipts books and other stationery will be serialized and one must sign for any stationery taken and the serial numbers recorded. All stationery will be maintained by the manager and issued upon presentation of the filled stationery. Employees will be responsible for all the stationery in their custody.

- Until the centre is able to print stationery in their logo, all stationery needs to be stamped by the manager with the centre stamp. The stamp must

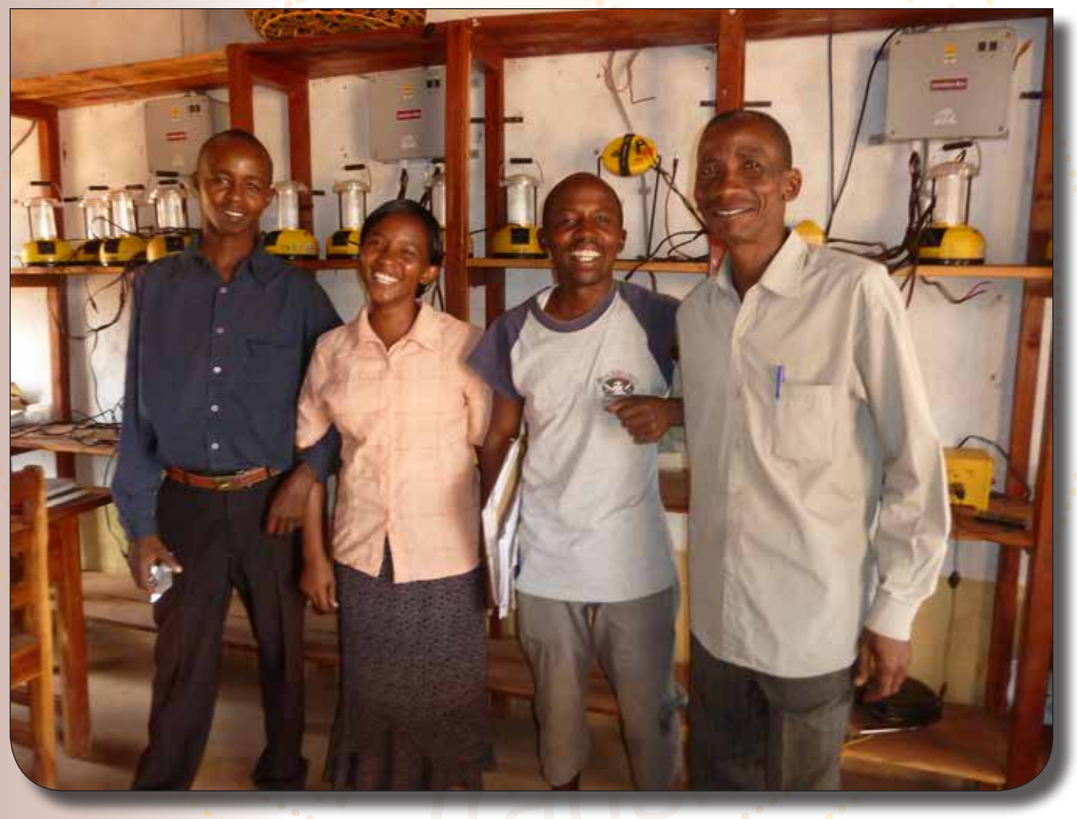
11 *Such a centre can also be run by an NGO or set up by an NGO and run by an entrepreneur, but this has not been tried in this particular project.*

always be kept in the safe.

- All cash collections must be receipted and subsequently banked.
- A separate cash box shall be used by each attendant (i.e. the charging, IT and evening attendants) to store cash collected during the course of the day.
- Attendants shall submit all their daily collections to the centre manager for safe keeping in the safe at the end of each day. The money should be banked at least once a week and a banking slip attached to the daily collection sheets.
- The accountant will reconcile all the books of accounts in relation to cash and actual stock at least once a week.
- The manager shall prepare a budget for consumables (e.g. printing paper, cartridges and stock replenishment) at the end of every month and present it to the accountant for verification and presentation to the board for approval. Such purchases will be done once in a month except in emergency cases.
- A petty cash float of up to 4,000KES (36€) shall be operated for emergency purchases. All purchases must be accompanied by authentic tax receipts. An additional cash box shall be maintained for petty cash.
- Sales money must not be used for normal office purchases.
- All expenses above 10,000KES (90€) must be authorized by at least 2 board members.
- If the income from the centre proves to be too little to support the salaries of the staff, the staff may be asked to take a pay cut until such a time as when the centre can fully sustain itself.

Detailed operational guidelines and general book keeping requirements for the different business sections are outlined in the annexes.

5 How the Model Fared



Energy Centre staff November 2012

5. How the Model Fared

During the design of the energy centre in Ikisaya, a number of projections were made with regard to revenues and expenditure. As is often the case, the projections were higher than the actual. The visits and phone calls for regular follow up since its commissioning at the end of March 2012 have enabled the continued collaboration between the project team and the energy centre staff and board. Challenges and opportunities have been identified and suitable strategies have been developed. This has enabled these key people to administer and follow up not only the operations in their own village, but also the five sub-centres operated by agents. Their vision is to increase the number of sub-centres further. Gradual changes have been implemented underway and the energy centre and its agents continue to evolve and expand.

The table below highlights some of these challenges and the strategies developed to address them.

Table 3: Overview of challenges identified over the first few months of operation and strategies developed to address them

Challenge	Reasons	Strategy Developed
Very low uptake of rental lanterns (8/120) during the first month of operation	• Customers unhappy because they were only permitted to rent the lanterns for 2 days and when they returned them, they still had power. As a result of this they felt that they had paid for more than they got.	• Consumer education – the centre arranged for a public meeting where the reason behind renting out the lanterns for only 2 nights was given. Also explained was that completely discharging the lantern battery would shorten its life.
Delay in returning of lanterns i.e. customers kept lanterns for an extra day resulting in lost revenue	• Convenience of keeping lantern longer. Poor enforcement of fines for overdue lanterns by the charging attendant and agents. Periods of drought and famine.	• More stringent enforcement of fines for overdue lanterns and at the same time introducing a lower fine than initially suggested. Patient, clear and repeated explanations of the reasons for the rules and fines. Suggestions for how to find practical solutions for the customers for bringing and delivering lanterns, including school children carrying lanterns before and after school.
Low retail sales for Powapacks and lanterns; an average of about one per month, and problems of collecting installments	• High upfront cost of Powapacks (6,800Ksh) and lanterns with charging module (6,500Ksh) • No interest in component approach to selling of powapacks, customers preferred to make small deposits with the energy centre and then collect the system once they had finalized the payment. • Renting is the preferred option	• Lanterns intended for sale incorporated into the lantern rental business due to increased demand for lanterns for hire • A rent-to-own model piloted for the Powapacks. • Renting out Powapacks on monthly basis.
Lantern renting service not affordable for all	• Low income for large parts of the population, neither kerosene nor lanterns affordable, some households only using firewood for lighting.	• Considering to lower the price for lantern renting, but this is not yet possible if financial self-sustenance is to be upheld.

To increase revenue, the energy centre introduced hair cutting as an additional service. The hair clippers are powered with some of the surplus available from the solar PV system powering the TV and video system. Also under consideration is the introduction of a training course for basic computer skills. With 2 laptop computers, the centre has the capacity of providing practical computer training for at least 2 students a month.

The table below compares actual average energy centre revenues from different services. It compares average revenues for two separate periods; Oct-Dec 2012 and Apr-Jun 2013.

As shown in the table, the usage of services at the centre increased by 44%, from 117 services used per day in the Oct-Dec 2012 period. The total number of services used and paid for in a given

Table 4: Average Monthly Revenues Oct-Dec 2012 and Apr-Jun 2013

Business Section	Services	Average daily users (Oct-Dec12)	Average Monthly Revenue (Oct-Dec12)	Monthly Revenue/ Section	Average daily users (Apr-Jun 13)	Average Monthly Revenue (Apr-Jun 13)	Monthly Revenue/ Section
Charging Services	Lantern charging	26	7,930	13,563	40	11,940	21,373
	Mobile phone charging	9	5,513		31	9,433	
	Battery charging		120				
Agents	Lantern charging	55	16,390	16,390	52	15,690	16,687
	Mobile phone charging				3	997	
IT Services	Photo-copying & Sale of Envelopes	15	4,622	9,292	16	4,800	6,003
	Typing and Printing	2	1,387		4	1,203	
	Laptop charging		3,283				
Retail Outlet	Lanterns		667	2,053	2	667	667
	Powapacks		1,387				
Multipurpose room	TV & Video Shows	7	2,165	2,432	13	3,917	4,083
	Room Hire		267			167	
Other Services	Hair cutting	3	912	912	7	1,960	1,960
Totals (KES)		**117**	**44,642**	**44,642**	**169**	**50,773**	**50,773**

day now averages about 169. Lantern renting and mobile phone charging are the most used services; they together represent 77% of all services used at the centre. The percentage usage of other services is: IT services – 13%, TV/ Videop – 7% and hair cutting – 3.

The table below shows projected and actual average monthly expenditure for the energy centre. On average the energy centre's expenditure has not varied much over the course of its operation. Staff salaries and the battery replacement fund represent the largest operational expenditures.

Although the initial energy centre design considered the need for a larger number of staff, as described in section 4.2, the centre is now effectively run by a staff of 3 complementary staff that can perform each other's tasks. This has managed to significantly lower the wage bill from the initial 30,000KES (273€) to 21,500KES (195€).

The battery replacement and maintenance fund is based on raising an estimated 506,000KES (4,600€) every 2-3 years. This amount is to cover future battery[12] replacement costs and unexpected system component repair or replacement costs. The centre target is therefore to set aside 21,300KES (193€) every month towards this fund. The actual amount raised is typically the difference between the monthly revenue generated and the recurrent monthly operational expenditure; as at the end of August 2013, the centre had managed to set aside a total of 168,500KES (1,532€).

Table 5: Average Monthly Expenditure Nov 2012-Jan 2013 and Apr-Jun 2013

Energy Centre Expenses	Details	Projected Expenditure per month	Average Monthly Expenditure (Nov 12-Jan 13)	Average Monthly Expenditure (Apr-Jun 13)
Salaries	Manager	8,000		
	IT clerk	6,500	6,500	7,167
	Centre technician	6,500	6,500	
	Evening attendant	5,000	5,000	6,333
	Part time accountant	4,000	4,000	6,000
Other Staff Payments	Overtime (evening attendant)		999	745
Agents Commission	Commissions for lantern renting agents		3,289	1,851
Consumables	Printing paper	480		760
	Cartridges black	1,560	2,167	2,723
	DSTV monthly subscription	4,300	2,150	1,015
Petty Cash		4,000	2,296	3,142
Transport	Monitoring of agents		850	1,500
Business Permit	County Council Payments			440
Maintenance fund contribution	Estimated 500,000 needed after 2 years for battery replacement and other emergency maintenance requirements	21,300	1 3,600	12,333
Total expenditure, monthly (KES)		**61,640**	**46,735**	**44,010**

12 *These include small batteries for the individual lanterns and the larger batteries used in the solar PV system for powering the IT, TV/Video and hair cutting services as well as the energy centre lighting.*

As indicated from the energy centre revenue, lantern renting and mobile phone charging contribute to 70% of the total revenue generated by the centre,with the revenue from the agents making up about half of this revenue. Review of the energy centre expenditure indicates that the costs required to provide these two services alone represents only about 50% of the total expenditure. Therefore, the revenue generated from lantern renting and mobile phone charging effectively subsidizes the other services provided at the centre.

Whereas these are viewed as important services by the local community they are not sufficiently used to completely cover their operational costs. The retail shop has had low demand, and the stock of some of the items could have been smaller.

Carrying light for the grandchildren so they can read and play in good light in the evening

6

Concluding Remarks

The services provided by the Ikisaya Energy Centre are used by households, small businesses, schools, a health clinic, local government administrations and churches.

Photo: Lan Marie Nguyen Berg

The energy centre was designed to be operated on commercial principles to ensure financial sustainability while at the same time attempting to ensure that the services provided are affordable and accessible. The pilot energy centre in Ikisaya demonstrates that the model can be sustainable; revenues generated from service provision can cover operation and maintenance costs if the implementer allows a period of building up the operations and revenue.

The significant upfront investment required for the energy centre and small margins make the model uninteresting for private sector investment. In its current form, the model would not attract businesses who could easily generate quicker and more substantial returns elsewhere. A capital subsidy, e.g. from Government or NGOs, is therefore required if such a model is to be replicated.

Nevertheless, components of the model could be interesting for private sector investment. Revenue and expenditure trends from 18 months of operation indicate that the lantern renting and mobile phone charging services are by far the highest and most consistent source of revenue; they represent 70% of all revenue generated by the energy centre and about 50% of the operation and maintenance costs. An analysis of investment costs also indicates that a model that targets only the provision of lantern renting and mobile phone charging services would require less than one third of the investment costs used for the Ikisaya energy centre.

A key lesson from the pilot is that location is a key consideration when selecting the services to be provided and best way to deliver them. In areas where household incomes are low it may be necessary to focus on the provision of the most basic services i.e. lighting services (lantern renting) and phone charging only. In economically active areas, the demand for TV and IT services would be higher, as would be the ability to purchase lanterns or small solar home systems. For purposes of standardization and replication, it may therefore be necessary to develop criteria for assessing and categorizing sub-locations based on socio-economic activity and then develop services best suited for each category.

For local staff and board members, learning through practice is important, in addition to good training on a variety of themes. Follow-up visits and phone calls by implementers can assist them to learn fast and be innovative. This can enable them to make improvements underway, based on the accumulation of practical experience. Committed follow-up will also enable the implementers to stay updated on the details of the progress and problems that may need attention. Objectives like financial self-sustenance and strict enforcement of rules for renting of lanterns may be difficult to achieve and a full recognition of how to achieve it may only come over time. Concern about the details of the operations has shown to be important, and allows for mutual exchange of ideas between implementers and local actors. Gradual expansion from the first location to larger geographical areas can be achieved through ensuring good build-up of the capacities and motivation of a few key persons. The energy centre can then become a hub for activities in several villages.

We hope that the description provided of the Ikisaya energy centre will be useful and inspire the establishment of similar energy centres elsewhere.

Annex 1: Operational Guidelines

Energy Centre Business Section(s)	Operational Guidelines
Lantern Renting	• Each lantern will have an identification number. • Customers are required to have a membership number. To receive this, they are required to pay a CBO registration fee of 50KES (0.45€). • Each lantern customer will be required to pay a one-time non-refundable deposit of 200KES (1.8€) for each lantern to be borrowed. • The IT attendant shall also be responsible for collecting CBO registration payments and lantern rental deposits and maintain the member register. • Although customers can borrow more than one lantern, a deposit has to be paid for each lantern borrowed. • The cost for renting a lantern is 20KES (0.18€) for 2 consecutive nights. Customers can keep the lanterns for a maximum of 2 nights after which they have to be returned to the centre for recharging. • A receipt will be issued every time a lantern is rented. • Lanterns should be returned to the energy centre for charging before 11am. • Upon renting of the lanterns, the lantern ID number and the customer ID number will be recorded. The condition of the lantern will also be recorded, with the borrower confirming this with his/her signature. • When the lanterns are returned, their condition will be checked again upon receipt. If there are damages caused by mishandling, the cost of repair/ replacement will be covered by the customer. If the customer refuses to cover these costs, then they will be recovered from his/her deposit and the customer will be barred from renting lanterns in future until he repays the cost. • Large maintenance costs e.g. electronic failure (PCB replacement) and battery replacement will be covered by the energy centre. • A fine of 10KES (0.09€) will be levied for returning the lantern later than 11am. In addition, for each additional night the lantern is kept beyond the agreed upon 2 nights a fine of 10KES (0.09€) per night will be levied. • Lanterns can be collected from the energy centre from 5pm.
Phone charging and battery charging	• To ensure that phones are fully charged before customers collect them, phones should be delivered to the charging station no later than 5pm otherwise a full charge cannot be guaranteed. • A receipt should be issued for every phone charged. • Phones should be labelled using stickers for easy identification and the details of the sticker and the customer recorded so that any energy centre attendant can receive and/or return phones. • The centre provides a number of assorted mobile phones although customers should be encouraged to carry their AC chargers, due to the large variety of mobile phones in the market. • Only powapack batteries will be charged at the energy centre. Since the batteries need to be charged for 8 hours to get a full charge; they have to be delivered to the station by 9am and picked up from 5pm to ensure a full charge. • Customers who purchased the powapack system through a rent to own model and whose weekly repayments are up to date, can charge their powapack batteries at no extra cost. (Counter/record book for this?)
Retail Shop	• A stock card shall be used to record the number of incoming and outgoing items and show the closing balance. This closing balance should agree with the actual number of items left in the store. (Is this being done?) • Dates must be clearly written and a stock of all items in store must be taken monthly and reconciled. A stock card must be maintained for the different items sold in the retail shop. • For every item sold, a receipt should be issued to the customer and the receipt should indicate the date, buyer, and details of what is bought as well as the amount for which the item has been sold. • A counter book shall be kept to provide a summary of all the daily transactions. • A separate record shall be kept for all items paid for in instalments.
Photocopying, printing and IT services and Room Hire	• Typing, photocopying, printing and scanning will be charged according to the number of pages at the prescribed rate per page. • All jobs should be charged and receipted. • A counter book shall be kept to provide a summary of all the daily transactions. • Room availability will be discussed with the facility IT attendant and all charges paid in advance. • Room hire details e.g. customer, date, time and duration shall be recorded in a separate counter book.
TV/Video Shows	• A public notice board is used to inform customers which programs will be shown and at what time. • TV/Video shows shall be screened at specific times as prescribed by the energy centre. Entry to the TV room is by ticket only and this ticket shall be issued by the IT attendant during the day and by the evening attendant during the night. • All tickets shall be pre-stamped by the energy centre manager • Customers shall receive a ticket upon payment. Since the costs vary between different shows, to reflect the price of the show different color ticket books will be used. • The counterfoil of the ticket will be left in the book and used to do the cash reconciliation. • Collections taken by the evening attendant during evening shows should be handed over to the IT attendant the following morning.
Energy Centre Manager	• The manager will maintain a cashbook to record all cash received from other shop attendants. • Cash collected from other attendants must always be locked in the safe plus own cash at close of business. • Maintain a cashbox for minor office expenses. The petty cash float shall not exceed 4,000KES (36€). All expenses must have a valid and authentic tax receipt. • All petty cash payments must have unique voucher numbers. • Once someone has been given money to purchase an item for the office, all details e.g. date, name of person, details of item and amount must be written on the voucher. The recipient of the money must always sign the voucher after receiving cash.

Energy Centre Business Section(s)	Operational Guidelines
	• The manager should do a daily cash sale reconciliation of all the business sections to ensure that the cash collected tallies with the receipt books and sales records. • Cash must be banked at least once a week and the banking slip should tally with the daily sales recorded in the sales return sheets.
Energy Centre Manager Book-keeper/ Accountant	• The accountant shall reconcile the energy centre manager's collection sheets and reconcile them with the actual cash banked and in the receipts. • Shall ensure that NSSF, NHIF and any council or government licenses are registered and paid within the prescribed time. • Will verify by way of comparing the cash handover sheets and the receipt books for each shop to ascertain whether there is a short banking. • Will receive the monthly budgets from the manager, verify them and present to the board for approval. The approved budget will then be filed. • Will ensure that all rental lanterns are accounted for, from the lantern rental records. • Will ensure all stock as recorded in the stock card of the retail shop is available and in working condition and will be present during the monthly stock take. • Compare the bank in slips with the attached, sales return sheets and the manager's cashbook to ascertain whether all cash was banked. • At the end of the month, the accountant will also reconcile the banking slips and the bank statement to verify that all cash has been banked. • Will review the petty cash and the attached receipts and ensure that petty cash accounted for and receipted. • Will maintain a payroll book to record all transactions that relate to salaries. If money is lost or one is loaned as an advance, it must be recovered from that person at the end of the month. Advances given will be supported with a petty cash voucher signed for receipt of cash. • Any money receipted but cannot be accounted for or is lost will also be recovered from the salary of the responsible member of staff and the unbanked receipt money will be the supporting document. • The accountant will maintain a cashbook and a petty cashbook. • When the petty cash balance is close to or at least 1,000KES (9€), the accountant should request for a reimbursement of the float balance. He should only request for the amount spent such that actual money at hand plus all the petty cash payments since the previous reimbursement does not exceed the authorized petty cash balance of 4,000KES (36€). • The accountant shall prepare the quarterly returns in the format prescribed.

Annex 2: Book-Keeping Requirements for Each Business Section

Energy Centre Business Section(s)	Bookkeeping Requirements	
	Receipt Books	Records/Register
Charging Station	• Lantern renting • Battery charging • Phone charging • Fines • Damages	• Lantern charging register • Phone charging register • Battery charging register • Lantern stock book • Damages book • Cash handover book
Photocopying, printing and IT services, TV/ Video Shows and Room Hire	• Printing • Typing • Photocopying • Laptop charging • Scanning • Deposits - Lantern renting • Blue ticket books with counterfoil (for news) • Green ticket books with counterfoil (for TV/Video shows)	• IT register • TV/Video show register • Room hire register • Cash handover book
Retail shop	• Retail shop receipt book	• Retail shop register • Retail shop credit/repayment register • Cash handover book • Stock cards (items for sale) • Stock card (spare parts)
Energy Centre Manager	• Petty cash voucher	• Cash book • Banking reconciliation
Accountant		• Payroll book • Cash book • Petty cash book • Approved monthly budgets • Quarterly reports

The action oriented research project Solar Transitions

The research project Solar Transitions is a collaborative research project coordinated from the Department of Sociology and Human Geography, University of Oslo, Norway. The project is carried out by social scientists, engineers and development practitioners and has five Kenyan team members, one Indian, one Austrian and three Norwegian. The research investigates ways to implement and use solar energy in rural communities in developing countries that are viable in the long run and contribute to social and economic development. The research has been funded by the Research Council of Norway.

Team members in the Solar Transitions project: Charles Muchunku, Camco, Kenya; Debajit Palit, K Rahul Sharma, TERI, India; Harald Rohracher, IFZ, Austria; Kirsten Ulsrud, Tanja Winther and Karen O'Brien, University of Oslo, Norway; Benard Muok, ACTS, Kenya; Siri Eriksen, University of Life Sciences, Norway; and the individual experts Anjali Saini, Gathu Kirubi, and Wycliffe Mauta, Kenya. Co-opted member: Henry Gichungi of Kenya Power. Earlier team members: Jonas Sandgren, Sweco and Akanksha Chaurey, TERI.

Some of the Solar Transitions team members. *Photo: Karen O'Brien*

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See the documentary film about the Ikisaya Energy Centre on
http://vimeo.com/mgfilm/ikisayaenergycentre

For further information, see http://www.sv.uio.no/iss/english/research/projects/solar-transitions.

For details of the model and experiences so far, see the full report on the Ikisaya Energy Centre model.
www.sv.uio.no/iss/english/research/projects/solar-transitions/Energy Centre