Utilising Electricity Access for Poverty Reduction

ANNEX 2 -
CASE STUDY REPORT: KENYA

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Executive Summary

The research presented in this report forms one of two Case Studies prepared for the study on Utilising Electricity Access for Poverty Reduction. The Case Study seeks to answer, in the Kenyan context, the questions:

1. **What level of electricity access is required to enable and sustain poverty escape?**

2. **What constraints, despite increased access to electricity, mean that people are not able to use that electricity productively?**

The research has been carried out through desk studies of policy and regulation, consultations with stakeholders involved in electricity provision and field research focusing on communities touched by four different electricity access programmes.

Overall, the field research has not revealed a consistent relationship between levels of electricity access and its impacts in terms of either productive activity or poverty reduction. In certain instances patterns have emerged to support the assertion that improved electricity access can lead to enhanced levels of productive activity; for example, beneficiary enterprises tended to have considerably higher revenues and profits than non-beneficiary enterprises (although it must be noted that it may be the case that better-performing enterprises are more able to afford improved electricity access).

However, examination of other impact indicators has often discerned no relationship or found influence in the opposite direction to that anticipated. No impacts were observed in terms of enterprise creation, while it appears that beneficiaries of an electricity access programme (particularly women) may be less likely to gain employment.

The effects of electricity access, and the productive uses it enables, on poverty are even more difficult to observe. The impacts on household income appear to be very mixed. Positive impacts in terms of education are commonly reported and attributed to improved electricity access; this is also true to a lesser extent for healthcare.

Throughout the field research, convincing patterns between the level of electricity access (as assessed by the SE4ALL Global Tracking Framework) and productive use or poverty impacts have not been found, affirming that the mechanisms by which electricity access enables poverty reduction are numerous and complex and are influenced by many other factors beyond the level of electricity access available.

The second part of this Case Study research has sought to identify some of the enabling factors and barriers that affect electricity access provision, take-up and productive use by enterprises and households. Numerous policy factors were identified, including ambitious but underperforming grid electrification programmes, helpful duty exemptions for off-grid equipment but also lengthy and unnecessarily complicated permitting and licensing procedures. The Kenyan government recognises the crucial role of off-grid systems for electricity access provision, but has not successfully tackled some of the barriers to mini-grid development such as tariff

setting restrictions, imbalances caused by cross-subsidisation of the grid (but not private off-grid systems) and contingencies for grid arrival.

For end-users of electricity, high upfront and ongoing costs – coupled with a lack of access to affordable finance – are seen as a key barrier. Of the attributes of the electricity supply itself, reliability is most strongly reported as a barrier although the assessment of households' and enterprises' electricity access in the field research communities established that capacity and duration were more likely to be limiting factors.

Acronyms

ASAL	Arid and Semi-Arid Land
CAFOD	Catholic Agency for Overseas Development
CB-GEP	Community Based Green Energy Project
DfID	Department for International Development
EAC	East African Community
EPP	Emergency Power Producers
ERC	Energy Regulatory Commission
ESMAP	Energy Sector Management Assistance Programme
FiT	Feed-in Tariff
GDC	Geothermal Development Company
GDP	Gross Domestic Product
GMG	Green Mini-Grids
GTF	Global Tracking Framework
HH	Household
ICT	Information and Communications Technology
IEA	International Energy Agency
IPP	Independent Power Producer
KEBS	Kenya Bureau of Standards
KEEP	Kenya Electricity Expansion Project
KEMP	Kenya Electricity Modernization Project
KETRACO	Kenya Electricity Transmission Company
KNBS	Kenya National Bureau of Statistics
KPLC	Kenya Power and Lighting Company
kW , kWh	kilo Watt , kilo Watt hour
LCPDP	Least Cost Power Development Plan
MDG	Millennium Development Goals
MoE&P	Ministry of Energy and Petroleum

MW, MWh	mega Watt, mega Watt hour
NERA	National Electrification and Renewable Energy Authority
NGO	Non-Governmental Organisation
PAC	Practical Action Consulting
RBF	Results Based Financing
REA	Rural Electrification Authority
RISE	Readiness for Investment in Sustainable Energy
SE4ALL	Sustainable Energy For All
SESA	Sustainable Energy Services Africa
SHS	Solar Home System
SME	Small and Medium Enterprises
SREP	Scale-up Renewable Energy Programme
USAID	United States Agency for International Development
VAT	Value Added Tax
W , Wh	Watt , Watt hour
WB	World Bank

Contents

Introduction

This document is one of a pair of Case Study Reports prepared to communicate the findings of the in-country research carried out in Kenya and India respectively as part of the DfID-funded study on Utilising Electricity Access for Poverty Reduction.

This research has been carried out to elaborate and confirm the conclusions derived from the literature review regarding the relationship between levels of electricity access provided and poverty impacts and to further explore constraints on take-up and utilisation of available electricity access for productive purposes. The research has also examined:

- What regulatory and policy measures will be most critical in increasing use of electricity access for productive purposes by poor people?
- How programmes for electricity access can best be designed to incorporate measures which will allow constraints on productive uses to be overcome?
- What technologies and on and off grid electricity systems can provide the levels of electricity access needed for productive use while achieving the greatest value for money?

This Case Study Report begins with a review of Kenya's electricity access regulatory and policy frameworks (Section 1).

In order to explore further how this regulatory/policy framework affects the implementation and success of electricity access programmes in Kenya, a consultation of electricity access provision stakeholders was conducted. The consultation also explored some of the technical, economic and socio-cultural constraints behind implementing and operating such projects, and considered factors affecting the take-up and productive use of available electricity access. The results of the consultation are outlined in Section 2.

The third section of this report describes the results of the field research, which involved the gathering of primary data from communities that had and had not benefitted from four different electricity access programmes:

- Machakos County grid extension programme
- Access:Energy's, Mageta Island mini-grid project, Siaya County
- Solar Transitions Energy & Lantern Charging Centre in Ikisaya, Kitui County
- CAFOD Community Solar PV Project., Kajiado County

Section 3 begins by outlining the methodology by which the four sets of survey data and supporting information were analysed. Each programme case study is then described with discussion of its design and focus, costs, scale, impacts, constraining/facilitating factors identified as having been present, and feedback from the group discussions held with community stakeholders.

Finally each of the programme case studies concludes with an analysis of the field survey data and the relationships between:

- level of access made available and any increase in productive activity
- increase in productive activity and the scale of poverty impact
- level of access made available and the scale of poverty impact

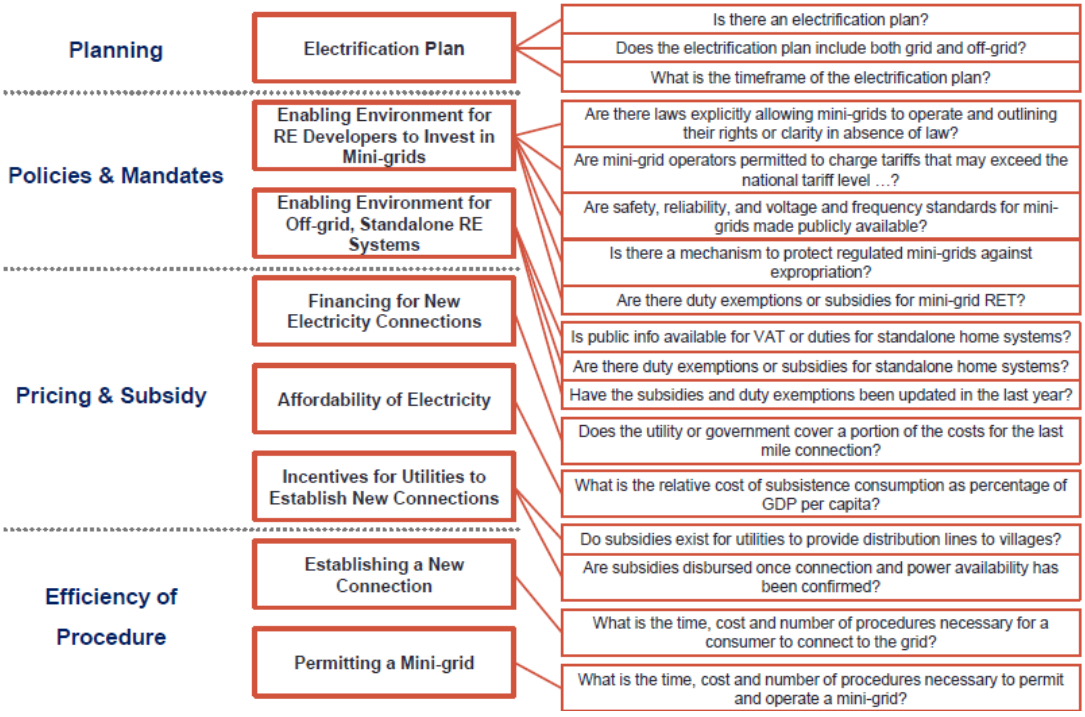
The report then looks across the programmes at the factors influencing households and enterprises in their decisions as to whether to take up electricity access (Section 4) and at the costs of providing electricity relative to the level of access provided (Section 5).

Section 6 brings together the findings from all the components of the case study research and presents conclusions and recommendations.

1. Review of Electricity Access Regulatory and Policy Framework

This review first sets the scene by providing an outline of the key players and institutions involved in electricity supply and distribution in Kenya. It then goes on to describe Kenya's electricity access landscape with respect to on-grid and off-grid supply, before reviewing the regulatory and policy framework against the factors identified in the energy access element of the Readiness for Investment in Sustainable Energy developed by the World Bank Group as part of the Sustainable Energy for All (SE4All) initiative (Figure 1). The study also makes reference to the issues raised by World Bank's Ease of Doing Business report (World Bank, 2013) to the extent that these are specifically relevant to electricity access providers or enterprises making use of electricity access.

Figure 1: Readiness for Investment in Sustainable Energy



1.1. Kenya's Electricity Sector: Institutional Landscape

The power sector reforms which started in 1996 have seen a complete re-organisation of the functions hitherto concentrated in the Ministry of Energy and the Kenya Power (formerly KPLC). This was a result of the need to transfer responsibilities to separate institutions that would be able to specialise in the mandates vested in them under the Energy Act, 2006 (currently under review) to enhance efficiency. Accordingly, these were unbundled into generation, transmission, distribution, oversight and policy functions. The institutional structure in the electricity sub-sector in Kenya comprises the Ministry of Energy and Petroleum (MoEP), Energy Regulatory Commission (ERC), Kenya Electricity Generating

Company (KenGen), Kenya Power, the Rural Electrification Authority (REA), Kenya Electricity Transmission Company (KETRACO), Geothermal Development Company (GDC) and Independent Power Producers (IPPs).

Ministry of Energy and Petroleum (MoE&P) is in charge of making and articulating energy and petroleum policies to create an enabling environment for efficient operation and growth of the entire energy sector. It sets the strategic direction for the growth of the sector and provides a long term vision for all sector players.

Energy Regulatory Commission (ERC) is responsible for regulation of the energy sector. Its functions include tariff setting and oversight, coordination of the development of Indicative Energy Plans, monitoring and enforcement of sector regulations.

The Energy Tribunal is an independent legal entity set up to arbitrate disputes in the sector.

Rural Electrification Authority (REA) is charged with the mandate of implementing the Rural Electrification Programme and came into operation in July 2007. Since the establishment of the Authority, there has been accelerated connectivity of rural customers.

Kenya Electricity Generating Company (KenGen) is the main player in electricity generation, with a current installed capacity of 1,765 MW of electricity. It is listed at the Nairobi Stock Exchange with the shareholding being 70% by the Government of Kenya and 30% by private shareholders. The Company accounts for about 75% of the installed capacity from various power generation sources that include hydropower, thermal, geothermal and wind.

Independent Power Producers (IPPs) are private investors in the power sector involved in generation either on a large scale or for the development of renewable energy under the Feed-in Tariff Policy. Current players comprise IberAfrica, Tsavo, Or-power, Rabai, Imenti, and Mumias. Collectively, they account for about 28% of the country's installed capacity from thermal, geothermal and bagasse.

Kenya Power is the off-taker in the power market buying power from all power generators on the basis of negotiated Power Purchase Agreements for onward transmission, distribution and supply to consumers. It currently operates 15 publicly-owned mini-grids with an installed capacity of 15 MW.

Geothermal Development Company (GDC) is a fully owned Government Special Purpose Vehicle (SPV) intended to undertake surface exploration of geothermal fields, undertake exploratory, appraisal and production drilling develop and manage proven steam fields and enter into steam sales agreements with investors in the power. Currently, Kenya has an installed capacity of 200 MW and there are plans to generate 1,900 MW of electricity from geothermal by 2016 and 5,500 MW by 2030.

Kenya Electricity Transmission Company (KETRACO) was incorporated in December 2008 as a State Corporation 100% owned by the Government of Kenya. The mandate of the KETRACO is to plan, design, construct, own, operate and maintain new high voltage (132kV and above) electricity transmission infrastructure that forms the backbone of the national transmission grid and regional inter-connections. It is expected that this will also facilitate evolution of an open- access- system in the country.

Private Distribution Companies are expected to improve the distribution function currently being undertaken by Kenya Power. It is envisaged that future power distribution will involve purchase of bulk power from the generators and with KETRACO facilitating the transmission; it will be possible for independent players to sell power directly to consumers. This is likely to enhance distribution competition and hence improve efficiency. Unilever and James Finlay are the other privately owned and licenced distribution companies in Kenya. We also have other privately owned power producers that distribute electricity they generate to specific locations (mostly plantation estates and off-grid areas) but do not have a distribution licence from ERC.

1.2. Rural Electrification

Despite the evolution and the unbundling of the Kenyan energy sector brought about by the Energy Act, 2006, and in spite of recent robust economic growth, consumption of modern energy is still very low. Kenya's per capita electricity consumption is estimated to be 156kWh per capita (IEA, 2011) compared to the global average of 2,751kWh per capita. Total installed generation capacity increased from 1,691MW in 2011 to 1,765MW in 2012. This is approximately one sixteenth of Argentina's installed capacity with a similar population size. The growth in electricity generation was mainly driven by commissioning of OrPower4's second plant (39.6MW) and the restoration of two Kindaruma units which were optimised to provide an additional 8MW (Kenya Power, 2013).

The number of electrical connections has risen seven-fold from a low of 265,413 customers in 1990 to 2,330,962 in 2012 (Kenya Power, 2013). The Kenyan population is 40.7 million (KNBS, 2013). However, electricity access is still very low with rural access averaging below 5% while urban access is estimated at 51%. The number of connections under the Rural Electrification Programme rose from 205,442 in June 2009 to 382,631 in June 2012, an average increase of 23% per year.

The electricity utility has a target of reaching 100,000 annual connections and to expand rural electrification penetration to 20% by 2010 and 40% by 2020 respectively. Unfortunately, the 2010 target has not been met and judging from the trend, achieving it will take still take many years unless radical measures are instituted to increase the country's generation capacity. Progress towards the connectivity targets has also been affected by the upward review of connection charges that was implemented in the financial year 2012/2013 commensurate with increased cost of materials and operations. In order to mitigate this trend and to put the rate of new connections back on track in line with the country's social and

economic objectives, the Government initiated a KShs.2.7 billion subsidy programme in August 2013 to finance some categories of new connections to end of the year.

A proposal by Kenya Power (seconded by ERC) seeking to amend the Energy Act was published in the Kenya Gazette in 2009. Kenya Power sought changes to the Act to allow it to connect new users before they complete paying the now-standard installation charge of KShs 35,000, and to allow it to set penalties for defaulters on payment-by-instalment plans. While Kenya Power had already started plans to have new power consumers pay connection fees in instalments — aimed at boosting its revenues and easing connection difficulties for new customers — it could not disconnect consumers who defaulted on the instalments. This disadvantaged consumers as well in that those paying by instalments could not enjoy mains supply until they settled the assessed installation fee, effectively slowing down the utility company in meeting new connection targets of 100,000 sites per year set in 2008.

The amendments were written into the Statute Law (Miscellaneous Amendments) Bill, 2009, and were expected to increase the pace at which rural and peri-urban areas can get access to electricity and double the penetration rate in these segments of the population through flexible connection and payment arrangements.

The Rural Electrification Master Plan offers a longer-term vision for rural electricity access and considers both on- and off-grid electrification as the means to achieve the 100% connectivity target. To meet the increased electricity demand due to new connections and enhanced economic activities in rural areas, various generation sources have been considered for further exploitation. The Master Plan suggests targets of 5,110 MW from geothermal, 1,039 MW from hydro, 2,036 MW from wind, 3,615 MW from thermal, 2,000 MW from imports, 2,420 MW from coal and 3,000 MW from other sources. The investments required for generation, transmission and distribution to meet this demand will be enormous.

All over the country rural areas present similar challenges for electrification: low population densities coupled with nomadic ways of life (especially in the North Eastern part of the country), weak customer bases, large distances between communities and inadequate infrastructure. This calls for particular methodologies to supply them with electricity compared to urban and peri-urban power supply.

An ‘Electricity Planning and Investment Costing Model’ has been developed for use by the Ministry of Energy and Petroleum, Kenya Power and the World Bank to determine the most cost-effective model for electrifying rural areas. The model enables planners to choose between on-and off-grid solutions.

The Energy Act 2006 (Part III) recognises that some rural areas may not be viable for electrification by the normal licensees. It prescribes that the Rural Electrification Programme Fund should be utilised in powering such areas, although the Act fails to establish under what model this investment should be deployed.

1.3. Renewable Energy Incentives

The 2006 Energy Act (under Part V) mandates the Minister (now Cabinet Secretary) to promote the development of renewable energy technologies and sources.

Kenya's Feed-in Tariff (FiT) scheme was first enacted in 2008, and further revised in 2010 and 2012. The 2012 FiT Policy sets out the tariffs currently available for grid-connected wind energy, biomass, small hydro, geothermal, biogas and solar electricity generation. A tariff is also available for off-grid solar generation, although the minimum capacity of 500 kW which applies limits the degree to which the Feed-in Tariff can support solar mini-grids in sparsely populated rural areas.

The policy recognises that electricity generation costs vary according to the renewable energy resource exploited and technology used, and as such the FiT levels are technology specific. The tariffs are paid instead of, and not in addition to, the electricity purchase price that would otherwise have been paid to independent power producers. Table 1 details the Feed-in Tariff rates currently in force.

Table 1: Feed-in Tariff rates according to the Feed-in Tariff Policy, 2012

Technology	Plant capacity (MW)	FiT 2012 (US¢/kWh)
Wind	Less than 10	11
	10 – 50	11
Solar PV	0.5 – 10	12 (Grid) 20 (Off-grid)
	10 – 40 (solar grid)	12
Biogas	0.2 – 10	10
Geothermal	35 – 70	8.8

The FiT policy is intended to facilitate resource mobilisation by providing market stability and investment security, reduce transactional and administrative costs related to power procurement and encourage local participation in investment in power plants to spur technology and skills growth. These intended benefits are more applicable to on-grid generation projects than off-grid electrification. Although the FiT Policy offers a higher tariff for off-grid solar, the 20 US¢/kWh tariff is not high enough to enable rapid uptake of this energy source.

In addition to the financial support it provides, the FiT Policy was designed to reduce the burden of contracting and negotiations for renewable energy developers through the provision of template FiT Power Purchase Agreements. Again, these provisions are of no help to developers of off-grid electrification projects.

In complement to the Feed-in Tariff, the 2014 Energy Bill proposes to develop a tariff for net-metering for electricity generated from renewable energy sources by electricity consumers. This is expected to attract more private sector investment in small- and medium-scale grid-connected electricity generation. Households and businesses see net-metering as being financially attractive because it offers the potential for cutting their electricity costs and hedging against electricity prices. However, net metering provisions do nothing for those households, enterprises and communities who wish to invest in electricity generation but are not located in areas where a grid connection is available.

The existing Energy Policy (Section 6) mandates the Ministry of Energy & Petroleum (MoE&P) to undertake feasibility studies to establish the potential of renewable energy sources, and for the packaging and dissemination of information on renewable sources in Kenya to create investor and consumer awareness on the

economic potential they offer. To this end, a Wind Atlas containing indicative data on wind energy potential was made available in 2008. The government has installed more than 60 wind masts and data loggers in various counties across the country to collect site-specific data and thus encourage the installation of new wind generation capacity.

1.4. Assessment of Policy Environment: Electricity Access Provision and Use

This section looks at the policy and regulatory framework in Kenya, using the energy access element of the Readiness for Investment in Sustainable Energy (RISE) framework developed by the World Bank Group as part of Sustainable Energy for All (SE4All) as a guide to the key policy and regulatory elements needed to create a an enabling environment for provision of electricity access.

1.4.1. Planning

In relation to planning, the RISE Framework asks:

- Is there a national electrification plan?
- Does it include both grid and off-grid?
- When was the last update?

Kenya is judged to have fully met this element of the RISE framework. There are numerous documents addressing the general energy planning in the country (see **Appendix 1** for more detail). These are the Least Cost Power Development Plan (LCPDP); Vision 2030; Rural Electrification Master Plan; EAC Strategy to Scale-up Access to Modern Energy Services; Scale-up Renewable Energy (SREP) Programme Investment Plan and the Kenya Country Baseline Report and Work Plan.

Through the Rural Electrification Master Plan, the government seeks to have 100% connectivity across the country by the year 2020. This is to be achieved through grid extension and off-grid systems. The last update of the electrification master plan was carried out in the year 2013.

1.4.2. Policies and mandate

Under Policies and mandate the RISE Framework asks:

- Are there regulations outlining rights of mini-grid operators?
    - Can mini-grid operators charge tariffs that exceed the national tariff level?
    - Do mini-grid operators need prior regulatory approval to enter into a power sales contract with consumers?
    - Are safety, reliability, and voltage and frequency standards for mini-grids made publicly available?
    - Is there any general law that deal with expropriation of mini-grids?
    - Are there duty exemptions or subsidies for mini-grid RE technology?

- Are there regulations covering standalone home systems?
    - Are there duty exemptions or subsidies for standalone home systems?
    - Are there minimum performance standards for SHS?
    - Are there national programs that promote the deployment of SHS?

In relation to mini-grids, Kenya is judged to have been successful in achieving the required regulations for tariffs, sales and standards but to be less advanced in relation to provisions regarding expropriation and any duty exemptions. In relation to standalone home systems Kenya is thought to have fully implemented the policy measures suggested by RISE.

The Energy Act, 2006 established REA which is charged with electrification of the rural areas where the national utility has for some time found it uneconomical to extend the grid. In line with this, there are 15 public operational mini-grids operated by the national electricity utility with a total installed capacity of 15 MW.

The publicly owned mini-grids which are owned by MoE&P/REA charge uniform tariffs as dictated by the regulator. For the privately owned mini-grids, the operator must propose a tariff which has to be approved by the regulator. The tariffs may be approved at levels higher than Kenya Power's grid tariffs, but the regulator's rulings are not usually favourable for small scale electricity generators.

All mini-grids, whether publicly or privately owned must comply with the requirements of the Kenya Grid Code(s) which stresses on safety, reliability, voltage and frequency standards. All energy related projects must also undergo environmental and social impact assessment as stipulated in the Environmental Management and Coordination Act (EMCA), 1999. Both EMCA, 1999 and the Grid Code are publicly available. There is no law in Kenya that deals with expropriation when it comes to mini-grids.

All mini-grid equipment (solar PV products and accessories and equipment for small hydro) is value added tax (VAT) and import duty exempted. Moreover, there is also a 150% capital tax waiver. In addition to standalone home systems being duty exempted, there exist minimum performance standards which were set and regularly revised by the Kenya Bureau of Standards (KEBS) in collaboration with other energy stakeholders.

The MoE&P has set up a number of "energy centres" across the country. These energy centres have acted as hubs where individuals interested in renewable energy technologies have been trained and exposed to different systems including standalone home systems. There are a total of 16 such energy centres in Kenya with plans to have each of the 47 counties to have one.

1.4.3. Pricing and subsidy

In this area the RISE Framework asks:

- Does the government have a dedicated funding or budget for electrification?
- Does the utility or gov't cover a portion of the HH connection costs?
- Do capital subsidies exist for utilities to provide distribution lines to villages?

- What is the relative cost of subsistence consumption?

Kenya is considered to provide a strong enabling environment in relation to the first two of these criteria and the cost of subsistence consumption, though direct capital subsidies for distribution lines to villages are not generally available.

The government provides electrification subsidies to an equivalent of KShs. 100,000 per household, with the household contributing KShs 35,000 which can now be paid in instalments. Consumption of electricity up to 50kWh/month is charged at the so called 'lifeline tariff', that is, a subsidised rate of KShs. 2 per kWh. Although this tariff is intended for the poor, it benefits all domestic consumers. The subsidy is funded by domestic consumers whose consumption is above 1,500kWh/month. In addition, since there is a policy for implementing uniform tariffs across the country, rural consumers are effectively subsidised by those in urban areas. The relative cost of subsistence consumption as percentage of GDP per capita stands at 1.8% (World Bank, 2013).

REA plans and builds rural electrification projects through labour and transport contractors or turnkey contracts. For projects that are connected to the grid, REA retains ownership of assets, while Kenya Power undertakes the operations and maintenance. Grant-funded rural electrification assets do not earn a rate of return in the Kenya Power revenue requirement for tariff purposes, but depreciation and operations and maintenance expenses are allowed on these assets. The Rural Electrification Programme Fund finances the programme. According to the clause 79 (2) of the Energy Act, this fund comprises: a levy of up to 5% on electricity sales, fees and other charges levied by the ERC, appropriations by the parliament, donations, grants and loans; and all other moneys lawfully received or made available for the programme as the minister may approve.

1.4.4. Efficiency of procedure

Here the RISE framework considers:

- Time and cost to connect to the grid by rural customers
- Time and cost to provide licenses/permits to operate a mini-grid

In this area Kenya is considered to perform only moderately compared with other countries in Africa and South Asia, as discussed below:

Securing a Connection

It takes approximately 75 days for a household to be connected to the national grid at a cost of KShs. 35,000 (as indicated above, this is significantly subsidised by the government – KShs. 100,000).

According to data presented in the World Bank's Doing Business 2014 report (World Bank, 2013), for an enterprise to get connected to the electricity grid there are a total of 6 procedures, taking on average a total of 158 days and costing over 1,000% of Kenya's per-capita income (see Box 1 below). There have not been any relevant reforms to improve the ease of connection in the past three years. While this relates

to a hypothetical warehouse with significantly higher electricity consumption than the small rural enterprises on which this study focuses, it is nevertheless indicative of the scale of the challenge facing businesses seeking to secure an electricity supply in the Kenyan context.

Box 1: Procedures to establish a new connection (large enterprises)

1. Submit application to Kenya Power and await site inspection
   The client submits the following documents:
   - Enquiry for supply of electricity form – collected from Kenya Power and duly filled out
   - Copy of certificate of registration
   - Copy of PIN certificate
   - Sketch map to the premises
   - Permit from county government to show that the land is occupied legally and structure is correctly done and approved by it; Kenya Power conducts external site inspection during this period and gives recommendations if client has not met standard requirements or price estimate/quote if all standards are met and procedures for set-up can proceed. During this inspection period, Kenya Power looks at some key aspects that also determine the price estimate that the client will receive.
   - Amount of power required for the building.
   - Existing infrastructure (poles and transformers) and their proximity to the premises. It is important to note that if the premise is within 600m of existing infrastructure, this considerably lowers the cost.
   - Way leaves clearance – pathways for laying down infrastructure and any permits or notifications needed to facilitate this.

   This procedure takes 28 calendar days and it is free-of charge.

2. Receive site visit from Kenya Power and await estimate
   Kenya Power conducts external site inspection and gives recommendations if client has not met standard requirements or price estimate/quote if all standards are met and procedures for set-up can proceed. During this inspection period, Kenya Power looks at some key aspects that also determine the price estimate that the client will receive.

   This procedure takes 21 calendar days and it is free of charge.

3. Customer pays estimate and signs supply contract
   Connection costs include capital contribution charges for network reinforcement for up to 1,000 meters. Customer fills in Supply Contract form and submits to the Meter Installation section through the Customer Service Department. Customer also submits internal wiring clearance certificate from the electrician.

   This procedure takes 1 calendar day and costs KShs. 860,000.

4. Customer calls utility and collects meter and meter number
   This takes 13 calendar days and it is free-of charge.
   .

Box 1: Procedures to establish a new connection (large enterprises) continued

5. Customer obtains excavation permit from County Government and submits to utility
   Customer needs to obtain an excavation permit from the County Government.

   This takes 5 calendar days and costs KShs. 7,500.

6 Kenya Power conducts external connection works, meter installation and electricity starts flowing
   External connection works are done by the Distribution Department, and when reaching completion, they inform the Meter Installation Section in the Customer Service Department to complete metering setup. This is an internal procedure, and the customer is not involved. This takes 95 calendar days and is free of charge.

Establishing a mini-grid

In order to be issued with a permit to generate and distribute electricity via a mini-grid, the following procedures have to be followed:

1. A licence or permit is required, depending on the capacity;
2. 15 days' notice must be given before making application through public advertisement, stating the window for any objection;
3. Notice must be served in writing to local authority/ies (county government(s)) where the mini-grid is to operate;
4. The following factors must be assessed and means of mitigating adverse impacts proposed:
    a. Impact of the undertaking on the social, cultural or recreational life of the community;
    b. Need to protect the environment and conserve the natural resources;
    c. Land use or the location of the undertaking;
    d. Economic and financial benefit to the community or area of supply;
5. The technical and financial capacity of the applicant to render the service for which the licence or permit is required must be demonstrated;
6. The proposed tariff offered (Consumption and Connection) must be approved;
7. Compliance with the requirements of the Kenya Grid Code(s) demonstrated;
8. Payment of applicable fees (very minimal fee).

A summary of the findings of this review of the policy and regulatory framework for electricity access in Kenya, synthesized with feedback from stakeholders on the policy/regulatory environment, is presented at the end of section 2. Conclusions and recommendations for policy makers and programme designers are incorporated into section 6.

2. Electricity Access Provider Stakeholder Consultation

2.1. Introduction

A stakeholder consultation was carried out with the aim of understanding the impact of regulation and policy on the implementation of electricity access projects, especially for productive activities, while also focusing on technical, economic and socio-cultural constraints behind implementing and operating such projects, and on factors affecting the adoption of electricity for productive uses. The research methodology listed the following questions for investigation:

- How current policy and regulation has been successful in promoting (and/or has impeded) electricity access initiatives, especially the provision of electricity for productive applications;
- What factors, in the view of the respondents are most significant in facilitating or hampering the take-up and use of available electricity access for productive purposes;
- Any possible amendments required related to policy and regulation to enable scaling up of electricity access initiatives for productive applications;
- Considerations in the design of electricity access initiatives;
- Best practices and lessons from government and private sector for provision of electricity access for productive applications;
- Requirements for scaling up such initiatives: finance, technology, institutions, business models and level of importance given to productive activities in designing electricity access projects.

In order to solicit information on these questions, a structured questionnaire was prepared and administered to obtain insights from the selected stakeholders.

The following stakeholders, who included actors from the government, donor agencies, academia/research institutes and the private sector, were consulted for the study:

Table 2: Stakeholders consulted

Sl No	Type	Organisation	Name	Designation	Date of interview
1	**Government Agencies**	Energy Regulatory Commission	Eng. Joseph Oketch	Senior Manager-Consumer Affairs	22 July 2014
2		Kenya Power Company	Eng. Henry Gichungi	Deputy Manager, Off-Grid Power Stations	22 July 2014
3		Rural Electrification Authority	Ephantus Kamweru	Chief Manager Renewable Energy	23 July 2014
4	**Bilateral / Multilateral Donor Agencies**	KfW	Federico Hinrichs	Energy Economist	4 July 2014
5		GIZ	Jacinta Murunga	Programme Officer & HIV/Gender Focal Point	27 June 2014
6	**Project implementation agencies/ Private sector**	PowerGen Renewable Energy	Elizabeth O'Grady	Business Development Associate	4 July 2014
7		Skynotch Energy Africa	Patrick Kimathi	Chief Executive Officer	7 July 2014
8		Africa Enterprise Challenge Fund	Anjali Saini	Coordinator	
9		Access:Energy	Sam Daby	Project Developer	24th July 2014
10	**Research/ Academia**	Strathmore Energy Research Centre (SERC)	Geoffrey Rono	Project Manager	9 July 2014
11		University of Nairobi	James Cheselemi Wafula	Lecturer	3 July 2014

2.2. Stakeholder feedback - electricity access developments

The stakeholders consulted noted that the Kenyan electricity sector is undergoing a period of change with more and more private sector organisations getting involved in generation, both on an off-grid. Although the supplementary tariffs set by the FiT policy are not considered commercially economic for many off-grid electricity access programmes, more and more mini-grids are being installed to serve the large market that nevertheless exists in rural areas. Enhanced electricity access in these off-grid areas has enabled uptake of productive uses of electricity by users such as drinks vendors, restaurants, barbershops, salons and welding businesses, and has improved the operation of health facilities.

Kenya's privately owned and operated isolated mini-grids include examples in Nkoilale (1.4kW of solar capacity and 9kWh battery storage for lighting in hotels, restaurants, shops, hair salons, woodworkers and other businesses) and Ololailumtia (used to power shops, salons and restaurants and run refrigerators to sell cold drinks and store medication for a clinic).

Non-governmental organisations have also set up mini-grids to run their satellite offices in rural areas. One such project uses 102 solar panels (30 kW) to power a new DC water pump capable of pumping 180,000 litres of water per day from a depth of 170m, with the surplus electricity used to power 9 offices. Community run and operated mini-grids are also in operation; examples include the Olooshoibor community energy centre in Kajiado County and the Mutunguru and Tungu Kabiri hydro projects (both in Meru County).

There are 15 operational publicly-owned mini-grids operated by Kenya Power with a total installed capacity of 15 MW. These mini-grids are 100% government-owned through the REA and MoE&P, and are located in Lodwar, Wajir, Mandera, Marsabit, Mpeketoni, Hola, Merti, Habasweini and Elwak. A further 14 diesel-based mini-grids are being developed by the REA, mostly in the arid and semi-arid parts of the country. The operational expenditure for diesel-based mini-grids is generally high; for public mini-grids the premium is effectively funded through cross-subsidy via the uniform tariff policy and fuel adjustment costs. Fuel costs account for approximately 80% of the total operating costs of the existing mini-grids.

These high operating costs are encouraging the government to integrate renewable energy into these off-grid systems. So far, seven of them have been "hybridised": of these, two plants use wind generation with installed capacities of 50kW and 500kW respectively. Another 6 incorporate solar generation with installed capacities of 10, 30, 50, 60, 60 and 330 kW. There is both an on-going retrofitting programme and construction of new hybrid systems at Rhamu, Takaba and Laisamis. A total of 44 greenfield sites have been identified for development of hybrid mini-grids.

In addition to off-grid power plants being established by private companies, NGOs or directly by government, numerous donor organisations are progressing off-grid electrification projects. Brief details of the main projects planned and ongoing are given in Box 2; a more detailed description of each programme is contained in Appendix 2.

Box 2: Donor-led Off-grid Electricity Access Programmes

Department for International Development (DfID) – A study conducted by Innovation Energie Développement (IED) for DfID aimed to identify gaps in knowledge and to build the evidence base on low carbon mini-grids. Although the study focus was continent-wide, the fieldwork was carried out in Kenya and Mozambique. The study forms a preliminary part of a DfID initiative to promote Green Mini-Grids (GMG) in Africa through the International Climate Fund (ICF), with the study's objectives being to provide guidance and recommendations for DfID intervention and programme implementation.

The UK will provide support totalling £75 million from the International Climate Fund (ICF), of which £60m will support project preparation and leverage private investment in GMGs in Kenya and Tanzania. The remaining £15m will support a regional facility for market preparation, evidence and policy development, and prepare for wider scale-up of GMGs across Africa. Funding will commence in 2014 and run until 2019.

World Bank Group – the World Bank-assisted Kenya Electricity Modernization Project (KEMP) and Kenya Electricity Expansion Project (KEEP) will provide support to encourage investments in mini-grid systems. The former will promote small to medium size installations (200 to 3000 connections) in communities where there are public sector facilities, businesses and industrial loads as well as households. The KEEP (jointly funded by the Scaling-Up Renewable Energy Programme (SREP)) will promote the use of renewable energy technologies for off-grid power supply and the design and construction of hybrid mini-grid systems.

IFC is supporting Kenya's REA and ERC to identify opportunities for commercially sustainable mini-grids, estimate the level and structure of any required financial support, and identify key legal and regulatory requirements for private participation in the sector.

German International Cooperation (GIZ) – a Results Based Financing (RBF) programme to create markets for private sector-operated mini-grids is being implemented. The programme will provide ex-post incentives to private sector developers of small mini-grids (up to 50 kW installed capacity) to reduce market development risks and hence to entice the first private sector investments in mini-grids in Kenya.

Dutch Ministry of Foreign Affairs – the Sustainable Energy Services Africa (SESA) programme, covering five African countries including Kenya, is a result of collaboration between the Dutch Ministry of Foreign Affairs, ETC, Enclude and Philips. The programme aims to develop markets for community- and household-level off-grid energy products in rural and peri-urban areas with a focus on the poor. All three components (consumer lighting, community lighting and cookstoves) are to be implemented in Kenya. Three community lighting centres have already been installed.

French Development Agency (AFD) – AFD is heavily involved in financing rural electrification in Kenya. A component of its activities involves working with DfID to promote green mini-grids, firstly through a programme of technical co-operation (analysis of feasibility, incentives, implementation arrangements and financing schemes) and later the implementation of mini-grid projects through leveraging private sector investment.

German Development Cooperation - KfW (financial cooperation) and GIZ (technical cooperation) will work together with the Government of Kenya to promote the development of new medium-sized hybrid mini-grids (PV-diesel or wind-diesel up to 1 MW). The project design will determine the technical, financial and economic viability of the proposed hybrid mini-grid schemes, including an assessment of alternative delivery and management models. Technical assistance will be made available to explore the viability of private sector engagement in rural electrification.

United States Agency for International Development (USAID) - Through the Power Africa Programme, USAID is supporting the development of the Kenyan energy sector through financing, grants, technical assistance, and investment promotion.

Some private-sector companies are providing electricity access to rural areas through non-isolated mini-grids (distribution networks owned and operated by the installer, but indirectly connected to the grid via the generators' export connection). Several installations are in the process of planning and construction which will incorporate medium-to-large scale power plants to power the installers' own operations, supply local communities and deliver their surplus power to the main grid. These include Cummins Cogeneration, who will construct an 11.5 MW plant in Baringo County using biomass gasification technology with *Prosopis juliflora* as feedstock. The installation will supply 2,000 households. Another project in the pipeline is for the Teita Estate which will use sisal waste to generate approximately 10MW to power its own operations, sell to the national grid and distribute to the surrounding villages through a mini-grid.

2.3. Stakeholder feedback - policy/regulatory factors affecting provision, take up and productive use of electricity access

The stakeholders consulted generally felt that the existing Energy Policy and other legislation in the country do promote electricity access and its associated uses. There is no monopoly for a single distributor. Kenya Power encourages productive use of electricity and over time it has used this fact to extend the grid to areas where the incomes are high and there are also already productive uses of electricity albeit from privately owned thermal stations. Off-grid electricity providers use a similar approach to set up their businesses in locations where they will get returns on their investment in the shortest time possible.

Of the policy/regulatory features that promote or impede the provision of electricity

access through mini-grids, the most important enabling factors were considered to be a transparent and reasonable licensing process and provision for mini-grid operators to charge non-standard tariffs compared to the national grid. However, small-scale players in electricity access projects felt that the permitting and licensing process was still unwieldy with artificial stumbling blocks being introduced and the process taking an unreasonably long time.

It is also felt that the lack of detailed provisions to facilitate planning and encourage investment in off-grid areas within the existing Feed-in Tariff policy was a barrier to progress. Stakeholders emphasised the need for the government to recognise the specific characteristics of mini-grids, both in the service they can provide to customers and the costs they incur to provide that service, in developing policies and programmes.

One further specific factor identified by stakeholders as a disincentive to mini-grid development is the lack of regulatory provision in the event that the national grid extends into an area where a mini-grid has been established. In such cases the mini-grid has effectively had to be closed down and the only use for the equipment has been to dismantle it and move to another location. The risk of this occurring will inevitably discourage some mini-grid developments and drive up the costs of those which do proceed.

2.4. Stakeholder feedback - non-policy factors affecting provision, use and scale-up of electricity for productive purposes

A number of non-policy factors were identified as obstacles to the provision, use and scale-up of electricity for productive purposes:

Cost of Provision – The relatively large distances between households in most rural areas and the need to engineer off-grid systems with either energy storage and/or back-up in order to provide reliable supplies[1] raise both the capital and operation costs of rural off-grid electrification projects. Project implementers also reported the operation and maintenance costs of off-grid thermal stations to be high. High ongoing costs act as a disincentive to end-users (if a cost-recovery or cost-plus tariff is charged) and/or potential providers, who fear that prices may come under regulatory and/or market pressure and that costs may not therefore be recoverable.

Cost of Electricity Supplied - As the mini-grid operators interviewed recognised, high costs of provision mean that electricity supplied through private off-grid schemes is sold at unit prices that exceed the grid electricity tariff. Even the normally-subsidised grid electricity can be unaffordable for households and enterprises, particularly when the country's hydro-plant generation is low and the additional costs associated with electricity supplied by emergency power producers

[1] Energy storage or back-up is most commonly necessary where intermittent renewable energy sources are used, such as solar and wind.

(EPPs)[2] are passed onto consumers. Users of both grid and off-grid electricity may be willing to pay high prices because mini-grid power remains cheaper than the current alternative energy source for lighting (paraffin), but these prices, are likely to limit its productive uses, especially amongst rural and peri-urban households and SMEs.

Availability of Credit Facilities – Lack of availability of suitable credit facilities is seen as a barrier to provision, with private sector expansion of electricity access projects/programmes having been limited by access to credit and the high interest rates charged by commercial banks. Financial capacity also restricts local communities' involvement in projects and their ability to take up and make productive use of electricity access.

Nomadic Populations - In the northern parts of Kenya in particular, not only are population densities low but many communities are also nomadic. This was identified by a bilateral donor as a major complication and economic barrier to the provision of electricity.

Poor Infrastructure & Security - Poor infrastructure in some remote areas makes transport (particularly of sensitive equipment) difficult and expensive. Security is also an issue with arrangements needing to be made both to protect generating plants and to secure the transport of fuels and equipment. Cases of vehicles becoming stuck and people having to be hired to secure the equipment for extended periods were reported. These factors increase costs and are believed to have limited the development of projects in remote areas.

Community Engagement - Those projects that have reported the greatest success are those that communities have bought into. The need for community engagement is widely recognised, but where a foreign investor is interested in establishing an off-grid plant, the time (and money) required for negotiating with the community can represent a significant transaction cost. This can act as a barrier to provision, particularly for small projects. In addition, the need to build relationships with multiple local partners can hinder the scale-up and replication of electricity access projects across the country.

Poor Reliability - The national electricity regulator indicated that some consumers had reported poor service from off-grid mini-grid electricity suppliers. Instances of poor reliability were often attributed to thermal stations running out of fuel or power supply equipment experiencing technical problems where there was no qualified technician to deal with them. In other cases, consumers overloading off-grid systems were blamed for frequent blackouts. Poor reliability of supply will act as a barrier to the take up and use of electricity by households and enterprises.

Local Capacity and Awareness – Local communities are often unable to benefit from the income-generating potential of off-grid electricity systems themselves because of a lack of skills or knowledge. In areas where off-grid power plants have

[2] EPPs generate power from diesel, an expensive fuel with a price dictated by international petroleum markets.

been set up, the community's limited technical and financial capacity restricts their involvement in the project from inception to completion. Operation and maintenance jobs that could be done by local people are sourced elsewhere because the skills do not exist locally.

In addition, a common observation by the government and donor agencies, project implementers, research institutions and academia included in the consultation was that one reason for the limited take up of electricity for productive uses in many areas is low awareness of potential income generating activities and lack of training and knowhow about the kind of activities that could profitably make use of available electricity. Often, people have had limited exposure to alternative economic activities beyond farming and if the capacity for using electricity productively is not built, its use may not extend much further than lighting.

Box 3: Policy/Regulatory Summary

1. Plans and measures are in place to increase the pace of electrification, and specifically rural electrification, but targets are still likely to be missed by a considerable margin.

2. There is a regulatory framework in place in Kenya to enable private sector electricity provision through mini-grids and standalone systems

3. Policy and regulation assists mini-grid developers in some ways (standards, ease and cost of permitting) but is lacking provision in other areas (duties and expropriation).

4. Mini-grid developers may charge tariffs that are higher than grid tariffs, but are still constrained by the rulings of the electricity regulator and cannot always achieve cost recovery.

5. Feed-in Tariff and planned Net Metering arrangements provide no assistance for small off-grid electricity access provision.

6. Policy and regulation provide good support for the deployment of Solar Home Systems.

7. The government has a dedicated budget for electrification and subsidises household connections, but direct capital subsidies for distribution lines to villages are not generally available.

8. It is a lengthy process for households and enterprises to obtain connections to the main grid (where available).

Box 4: Electricity Access Provision Summary

1. High costs act as a barrier to both provision and productive use of electricity access, particularly in rural areas.
2. Electricity access providers and potential users alike are constrained by lack of affordable debt finance/credit to cover the upfront costs of electricity access and the appliances needed to use it.
3. Poor infrastructure and security in some remote areas makes transport of equipment for electricity access provision, and of the products of electricity-using enterprises, difficult and expensive.
4. In some areas not only are population densities low but many people are also nomadic, presenting special challenges to the provision of electricity access
5. Local communities are often unable to benefit from the income-generating potential of off-grid electricity systems due to lack of knowledge and technical capability
6. Poor reliability of supply is a particular barrier to the productive use of electricity access.

Conclusions and recommendations regarding the policy and regulatory framework have been incorporated into section 6.

3. Programme Case Studies

3.1. Methodology

3.1.1. Selection of Programmes

A detailed review of electricity access programmes in Kenya was undertaken to identify four programmes to form the basis of the field studies. In carrying out this review we have sought to identify programmes which encompass a range of:

- Means of energy access provision (including main grid extension, mini-grids, and standalone systems and appliances)
- Types of programme (e.g. utility/government driven, NGO/agency led, private sector)

The programmes selected were such that the following types of electricity access interventions could be studied:

- Main grid extension
- Mini-grid systems
- Stand-alone systems

The rationale behind the selection of programmes providing electricity services from different types of electricity access interventions was to ensure that access options along different tiers of electricity access (as defined by the Global Tracking Framework) were covered in the study. The selection of the programmes also ensured that different types of programme-implementing institution were covered in order to understand the various prevalent institutional models and level of electricity access provided. Thus, programme implementation agencies considered included government owned distribution utility (central grid), private sector utility (mini-grid) and NGO/civil society organisations for stand-alone systems.

The selection process considered only programmes which had been substantively implemented (so that their impacts can be observed), and insofar as it is possible only programmes implemented within the past five years (so that data is relatively recent, and survey respondents may be expected to remember details about their past situation). The programme selection has also been guided by the level and quality of data about the programme and the willingness of the programme stakeholders to engage with this study. As far as possible we have focussed on programmes designed with the aim of fostering electricity access for productive use/income generating activities, and those that have been monitored programmatically and able to provide data on levels of poverty before and after programme implementation. Where appropriate an element of a larger programme, such as a single mini-grid scheme or a grid connected village within a wider programme, has been selected.

The four programmes selected for the Kenya are summarised in Table 3.

Table 3: Programmes Selected for Study

Sl No.	Programme Name	Means of Electricity Access	Type of programme	Implementing Agency
1	Machakos County	Main Grid Extension	Government led grid connected electricity access programme	Rural Energy Agency
2	Access:Energy Mageta Island	Mini-grid	Private sector	Access Energy
3	Solar Transitions	Solar Energy Centre + Lanterns	CSO led input from team of social scientists and practitioners	Led by University of Oslo
4	CAFOD Community Based Green Energy Project	Solar Irrigation[3]	International NGO led grant-funded	CAFOD

3.1.2. Community Selection

In order to select the most appropriate sites for the study, the following key characteristics were taken into account:

- Date of establishment of the electricity access project or date of extension of the grid should be between 2 and 6 years ago to ensure that the project has had sufficient time to impact the community. In addition to this, such a time period also would result in more authentic data about the past use of electricity and associated questions regarding past income while respondents may not be able to recollect data accurately over a longer time period;
- Except for the grid connected communities, it was essential that the communities where mini-grid or stand-alone systems have been installed were not previously electrified through main grid extension. Hence the selection of communities where the selected programme was the first source of electricity (other than standalone systems) narrowed down options;
- Communities were also selected such that in addition to provision of electricity services to households, SME's[4] are also being served with electricity services from the programme[5];

[3] Part of wider programme incorporating solar PV electricity access for schools and health facilities

[4] A Small and Medium Enterprise (SME) includes a range of possible enterprises including shops, small traders, restaurants/eateries, weaving, tailoring, welding, milling enterprises etc. The SME may be located in the market-place either within or adjacent to the village and or in the household. SMEs located inside a household have been considered as an SME if the accounts of the SME business are separate from the other household accounts.

- The Community selection process also considered existence of a completely off-grid community in the vicinity of the Beneficiary community where the non-beneficiaries of the programme could be surveyed. Further, the Non-beneficiary community was selected such that they are as similar as reasonably practicable (in terms of socio-economic characteristics) to the Beneficiary community. It is to be noted here that while the attempt was to identify two communities which have largely similar characteristics such as social status of residents and income profiles before the advent of electricity programme but due to the historical remoteness and isolation of the present non-beneficiary off-grid communities does contribute to some differences in the baseline income levels between the Beneficiary and Non-Beneficiary communities. These same conditions (such as remoteness, poor accessibility, lack of infrastructure etc.) that contribute to these communities continuing to be off-grid also contribute to the differences in baseline data between these non-beneficiary communities and the shortlisted Beneficiary communities. In other words, while there may be strong similarities in the types of occupation, language (dialects), family structure etc. the baseline income levels of the Non-Beneficiary communities may be lower than those of communities where either the grid or another programme has reached in recent years;
- In identifying these communities we have also sought (across the four programmes) to include communities with a range of poverty levels, levels of productive and economic activity and scale and remoteness;
- For timeliness, ease of mobilisation and cost effectiveness, communities have also been selected from geographical areas where PAC Kenya maintains strong local presence either directly or through local partners.

Further, the geographical proximity of the Beneficiary Community and its Non-Beneficiary counterpart has been an important consideration. This is to ensure that the two communities are more likely to share cultural, social and environmental characteristics. While a degree of geographical proximity is also required such that the field research can be completed within the available time, very close communities are likely to affect each other as a result of their different levels of electricity access. For example, some effects of improved electricity access may 'spill over' beyond the boundaries of the Beneficiary Community and electricity access may be a driver of migration between two nearby communities. For this reason, when selecting the 'control' community we have attempted to strike a balance between using closeness as a proxy for similarity and using separation as a means to avoid unintended interactions between communities. Thus, non-beneficiary households within the Beneficiary communities as well as completely different Non-Beneficiary communities have been selected for the survey. We have not considered any specific level (or lack) of electricity access for the Non-Beneficiary Community, other than the requirement that the community should not have benefitted from the programme under study. Table 4a provides data on the communities selected.

[5] The exception was the CAFOD Solar irrigation programme, which does not include household electricity access

Table 4a Community Information

Programme Name	Machakos Grid Extension		Access:Energy Mini-grid		Solar Transitions		CAFOD Solar Irrigation	
Implementation Year	2012		2012		2011		2011	
	Beneficiary	Non-beneficiary	Beneficiary	Non-beneficiary	Beneficiary	Non-beneficiary	Beneficiary	Non-beneficiary
Community Name(s)	Kola	Muumandu	Mahanga	Wakawaka	Ikisaya	Makutano	Lenkisim	
Number of households in community	500	200	2000	250	394	94	Not defined since it is a pastoral community	
Number of (registered) enterprises in community	40	25	21	0	13	8	13	3
Average household income per month before programme instituted[6]	US $48	US $48	US $48	US $48	US $60	US $40	US $63	(Unknown)
Most recent available average household income per month[7]	US $60	US $60	US $60	US $60	US $75	US $50	US $156	US $63
Distance of community from nearest tarmac road	3 km	15 km	15 km	14 km	80 km	90 km	60 km	54 km
Distance of community from electricity grid	5 km	15 km	15 km	15 km	50 km	40 km	75 km	79 km
Estimated time travel from community to county capital	40 minutes	40 minutes	1½ hours	1½ hours	4 hours	4 hours	4 hours	4 ½ hours

[6] Data from National Bureau of Statistics, year 2008

[7] National Data from Kenya Population Census 2009. Note that these figures represent the publically available data on the basis of which the community selection was made. Household income levels derived from survey data in some cases differ substantially from these figures due to differences in granularity, catchment area and changes over the 5 years since the most recent national household survey

Hence by covering these different types of communities from different programmes, a range of end-users receiving services are included. Table 4b provides the details of the sample size of each of the 'control' and 'treatment' group in each of the four programmes. Details of the selected communities under each of the four programmes are provided in subsequent sections.

Table 4b: Sample size by programme

Community Type	Target Sample Size	Actual number surveyed				
		P1: Machakos Grid	P2: Access Energy	P3: Solar Transitions	P4: CAFOD Irrigation	Total
Beneficiary households	20-40	21	24	28	16	89
Non-Beneficiary households in Beneficiary community	10-20	10	2	7	7	26
Non-Beneficiary households in Non-Beneficiary community	10-20	14	13	15	9	51
Beneficiary SMEs	4-8	21	32	12	17	82
Non-Beneficiary SMEs in Beneficiary community	2-4	2	1	0	4	7
Non-Beneficiary SMEs in Non-Beneficiary community	2-4	6	14	12	10	42
Total		**74**	**85**	**74**	**63**	**296**

(Note SME numbers above include instances identified through household surveys where productive activities are undertaken within the home and accounts kept separately from household accounts)

3.1.3. Questionnaire

A 6-part, 600-question questionnaire was developed to enable the assessment of the electricity access levels of households and enterprises both at the time of survey and before the programme was implemented, and to measure some of the potential impacts of electricity access on households and enterprises. The questionnaire also included questions that sought to investigate the factors which encourage, or constrain, the take up and productive use of available electricity access.

The same questionnaire form was delivered to both households and enterprises, with some different sections being applied in different contexts. Data relating to enterprises and productive activities was gathered both at places of business, and via the interviewing of people in their homes who reported that they either owned or managed a business, or carried out a productive activity in their home.

3.1.4. Determination of Electricity Access Attribute Tier

The methodology for defining and measuring energy access under the SE4ALL Global Tracking Framework is still under development at the time of writing (September 2014). However, this analysis has used the various draft questionnaires and tier boundary definitions so far available to establish a methodology that follows as closely as possible the latest versions of the Global Tracking Framework. In cases of uncertainty, guidance from the World Bank-ESMAP team has been sought and followed as closely as possible considering the timeline of the study. When new information regarding certain aspects of the framework came to light towards the end of the research period, it was in some instances not possible to update the tier assessment because the already-delivered survey questionnaire was not compatible with the new tier assessment criteria. When such incompatibilities could not be resolved, the study continued to use the previous version of the framework.

Table 5 and Table 6 illustrate the tier definitions used.

The Global Tracking Framework is designed to assess energy access in all its forms, whereas the focus of this study has been solely on access to electricity. For this reason, it has been possible to simplify and rationalise some aspects of the Framework in order to facilitate the delivery of survey questionnaires and avoid unnecessary complication with respect to the analysis of survey data.

Table 5: Household Electricity Access: Tier Definitions[8]

Attributes			Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
t_1	**1. Capacity** Amount of energy required to support different levels of power loads	For grid, mini-grid or standalone generators:	< 1 W	1-50 W	50-500 W	500-2000 W	>2000 W	>2000 W
		For battery-based systems:	< 2 Wh/day	2-200 Wh/day	200 Wh/day – 1.2 kWh/day	> 1.2 kWh/day	see note[9]	
t_2	**2. Duration/Availability** Average duration during which the primary energy source is available compared to the average duration during which it is required.	Total Supply (Required: 24 hrs)	<4 hours		4-8 hours	8-16 hours	16-22 hours	>22 hours
		AND	*Select lowest tier indicated by Total Supply or Evening Supply*					
		Evening supply (Required: 4 hrs)	< 1 hour	1-2 hours		2-4 hours		4 hours
t_3	**3. Reliability** Unscheduled outages/breakdowns in energy supply	No more than three unscheduled outages or breakdowns per week of more than 30 min each				No		Yes
t_4	**4. Quality** (Voltage)	Drops or fluctuations in quality parameters are only minor and rare with little or no impact on energy operations			No			Yes
t_5	**5. Affordability** Ability to afford the use of primary source of energy for required applications	Ratio of monthly expense for a consumption package of 162kWh to monthly income		>10%				<10%
t_6	**6. Legality**	Energy supply is obtained through legal means (bill received or payment made)			No			Yes

[8] © International Energy Agency and World Bank, 2013.

[9] The highest tier that battery-based systems can achieve is Tier 3.

Table 6: Electricity Access for Productive Uses: Tier Definitions[10]

If the relevant application is needed but not used due to energy-related issues, the tier rating for that application is 0.

Attributes			Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
t_1	**1. Capacity** Amount of energy required to support different levels of power loads	For grid, mini-grid or standalone generators:	< 1W	1-50 W	50-200 W	200 W – 2 kW	2 – 10 kW	> 10 kW
		For battery-based systems:	< 2 Wh/day	2-200 Wh/day	200 Wh/day – 1.2 kWh/day	> 1.2 kWh/day	see note [11]	
t_2	**2. Duration/Availability** % of usage hours	Average time electricity source available divided by the average operating hours	Less than 25%	25%-50%	50%-75%		At least 75%	100%
t_3	**3. Reliability** Unscheduled outages/breakdowns in energy supply	Number of unscheduled outages per week Cumulative length of unscheduled outages per week						< 4 outages *AND* < 2 hours
		THEN	*If reliability does not meet Tier 5 criteria, assess tier using impact on business operations*					
		Impact of unscheduled outages on business operations			Severe impact		Moderate impact	Little or no impact

[10] © International Energy Agency and World Bank, 2013.

[11] The highest tier that battery-based systems can achieve is Tier 3.

Attributes			Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
t_4	**4. Quality** (Voltage)	Experience of situations in which appliances cannot be used or may get damaged because of low voltage or voltage fluctuations						Not experienced
		THEN	*If situations are experienced, assess tier using impact on business operations*					
		Impact of low voltage or voltage fluctuations on business operations			Severe impact		Moderate impact	Little or no impact
t_5	**5. Affordability** Ability to afford the use of primary source of energy for required applications	Ratio of monthly expense for a specified consumption package to monthly income			Cost is higher than 2 times the grid tariff		Cost is 1-2 times the grid tariff	Cost is less than or equal to grid tariff
t_6	**6. Legality**	Energy supply is obtained through legal means (bill received or payment made)			No			Yes
t_7	**7. Health & Safety** (electrocution, air pollution, burning risk, drudgery)	The electricity supply system has in the past or is likely to cause electrocution, pollution (fumes/smoke), burns or physical harm from drudgery		Solution has or is likely to cause **severe** damage		Solution has or is likely to cause **moderate** damage		Solution has not and is not likely to cause damage
t_8	**8. Convenience**	Obtaining fuel/batteries or maintaining the electricity source subtracts relevant time from the productive activity and reduces business productivity				Yes		No

3.1.5. Impact Indicators

The possible impacts of improved electricity access in terms of productive activities were investigated via a number of questions regarding the enterprise and its performance. The surveys were designed to probe the following impacts:

- Enterprise revenue, both current and past (if revenue has changed significantly since the programme was implemented)
- Enterprise profit, both current and past (if profit has changed significantly since the programme was implemented)
- Enterprise creation, by recording when the enterprise was started
- Employment, both current and past (if the number of employees has changed since the programme was implemented)
- Employee remuneration, both current and past (if the employee remuneration has changed since the programme was implemented)

In the communities in which the surveys were carried out, the number of enterprises employing people was very small. Most enterprises were family businesses, or people carrying out productive activities themselves in their homes. This meant that very little data existed with respect to the latter two impact indicators (employment and employee remuneration) and no conclusions could be drawn about the impact of improved electricity access, other than that it had not encouraged enterprises to employ people outside the family.

The possible poverty impacts of improved electricity access were assessed via the household surveys. Respondents were asked about the following:

- Household income, both current and past (if income has changed significantly since the programme was implemented)
- Employment status of the interviewee, both current and past
- If the household had any children, if there had been any change in the education that was available to them since the programme was implemented
- If there had been any change in the health care that was available since the programme was implemented

Both enterprise and household respondents were also asked to what degree they attributed any improvement in these indicators to improved electricity access for themselves, and for their wider community.

3.1.6. Data Analysis

The survey data was collated and analysed in order to establish patterns and relationships between electricity access (or the lack of it) and the selected impact indicators.

Electricity access tiers were first calculated by assessing the *attribute tiers* across the attributes defined by the Global Tracking Framework:

Household Energy: Capacity, Duration/availability, Reliability, Quality, Affordability, Legality

Productive Uses of Energy: Capacity, Duration/availability, Reliability, Quality, Affordability, Legality, Health and Safety, Convenience

For productive uses and enterprises, attribute tiers were calculated separately for as many of the six 'applications' covered by the Global Tracking Framework (lighting, ICT and entertainment, motive power, space heating, product heating and water heating) as were relevant to the enterprise and for which electricity was regularly used. Relevancy was assessed by asking whether the application was 'strictly necessary' in order to carry out the productive activity, or whether the business would suffer in terms of productivity, sales, costs or quality without that application.

The overall tier for households, or the application tier for enterprises, was calculated according to the Global Tracking Framework protocol by selecting the lowest attribute tier. The overall tier for enterprises was calculated by taking the average of the application tiers which had been assessed.

For productive uses of electricity, the numbers of enterprises using each of the six 'applications' covered by the Global Tracking Framework (lighting, ICT and entertainment, motive power, space heating, product heating and water heating) and the average tier achieved for that application were calculated.

For households and enterprises, and for each application where applicable, the numbers of respondents achieving each level for the attribute tiers were calculated in order to establish which attributes tended to constrain the household/enterprise's access level most frequently.

Electricity access tiers and indicators were calculated separately for beneficiaries and non-beneficiaries[12] of the programme. These two groups were compared both in terms of average access levels and indicators (and changes in access levels and indicators), and by correlating various measures of access levels and indicators.

All the four programmes studied provided the majority of their beneficiaries with the same level of electricity access. Furthermore, the majority of non-beneficiaries had no electricity access whatsoever, as did both groups before the programmes were implemented. This means that the electricity access data tended to be mostly binary (0 / 1, 0 / 2 etc.). The correlation coefficients calculated are a measure of the positive/negative nature of the relationship. However, the binary nature of the electricity access data means that it must be recognised that, rather than describing conformity to a linear relationship, the correlation coefficients are instead describing the spread of the impact indicators within each electricity access level.

[12] Non-beneficiaries could be from the Beneficiary Community (but did not themselves receive improved electricity access via the programme) or from the Non-Beneficiary Community.

Enterprises owned or managed by household respondents were considered to be Beneficiary regardless of their location.

The following boundaries were used to determine the significance of a correlation:

Pearson's Correlation Coefficient	R-squared / Coefficient of Determination	Strength of Correlation
0 – 20%	0 – 0.04	Negligible
20 – 40%	0.04 – 0.16	Weak
40 – 70%	0.16 – 0.49	Moderate
70 - 100%	0.49 – 1.00	Strong

3.1.7. Community Feedback Workshop/Focus Group Report

After the completion of the household and enterprise level survey, a focus group discussion or similar meeting was held with community members from the surveyed communities. The aim of the discussion was:

1. To inform the community members of the findings from the survey and to validate those findings;
2. To know more about the energy requirements of the community, and the extent to which they were presently being met;
3. To know more about the problems faced by them regarding electricity services and systems; and
4. To explore the changes to the current system that the community recommend in order to make it more robust and efficient

Feedback from these discussions has been included in the description of each of the case studies that follow in this section.

3.1.8. Reliability of Conclusions

Potential biases exist that may have affected the responses recorded from each individual interview and the conclusions drawn.

The research was based on examination of those who had and hadn't benefitted from pre-existing electricity access programmes, and thus unavoidably incorporated any inherent biases in the selection of those who were to benefit from these programmes. Electricity access and income/wealth may be related in both directions; it is often the case that electricity access will be provided to those communities that are better able to pay for electricity, or have better infrastructure, or that are judged to be more likely to make productive use of it. The same factors may influence which people or businesses obtain electricity access within a community. On the other hand, some donors and programme implementers deliberately target the poorest communities or the poorest members of society, and so a reverse bias may exist in some cases.

To mitigate these effects the field research component largely employed a 'difference-in-differences' approach, comparing changes in certain enterprise and poverty indicators across populations classified by their level of electricity access, or the change in level of electricity access that they had experienced. To support this,

surveys were carried out in paired beneficiary/non-beneficiary communities and respondents were asked for information about their past as well as present electricity access, incomes, enterprise revenues and profits etc. However, it is recognised that these approaches also have shortcomings. In particular:

a) Although non-beneficiary communities were selected to be as similar as possible to beneficiary communities in terms of location, pre-programme wealth and economic activity, there were still significant differences between the two communities in most of the programme pairs. The selection of a good 'control' community was especially difficult in India, where the majority of village centres have some level of grid electricity connection and it is mainly the hamlets that surround them that are the beneficiaries of off-grid electricity access programmes.

b) Despite efforts to reduce 'spill-over' effects by avoiding selection of community pairs in very close proximity, the need to choose pairs which are reasonably close (without which socio-economic comparability would have been difficult to achieve) mean that some such effects may remain.

c) There are limitations to the accuracy of data that can be gathered about past electricity access and the status of impact indicators relating to people's lives and livelihoods several years ago. Any findings relating to a change in electricity access or a change in an indicator must therefore be viewed with caution. Considering such findings alongside the patterns that exist in the more reliable "current situation" data can provide evidence to support or discount the "differences" findings.

d) While efforts were made to ensure those interviewed within communities were selected randomly it is also recognised that some systematic biases may remain regarding the selection of interviewees on, for instance, a geographic basis (ease of access, remoteness, type of land use) and a demographic basis (time of day, cultural, age and gender effects).

The enterprises surveyed included both standalone businesses and enterprises based on productive activities carried out within the home. They also spanned a range of businesses types across the agricultural, small-scale manufacturing and service sectors. It is recognised that different types and scale of enterprise will have different energy needs, and will vary in their impacts on the communities within which they operate. However, given the issues regarding sample size discussed later in this section, it was not considered practicable to differentiate within this study between the impacts of electricity access on different types of enterprise, or between the poverty impacts of different kinds of enterprise achieving electricity access.

The statistical significance of the quantitative results varies by data type and because the effective sample sizes differ for each relationship or characteristic under

examination. The quantitative results presented in this report may be classified into three types:

Type 1. Comparison of mean value for one subgroup among the sample with the mean value for another subgroup;

e.g. mean household income for beneficiaries in Community A compared to the mean household income for beneficiaries in Community B

Type 2. Comparison of the proportion of one subgroup that meets a certain criterion with the proportion of another subgroup that meets that criterion;

e.g. proportion of beneficiary enterprises that were created after the electricity access programme compared to the proportion of non-beneficiary enterprises that were created after the electricity access programme

Type 3. Correlation between two variables as recorded for each individual in the sample or a subgroup

e.g. correlation of productive use electricity access tier and enterprise profits within Community A

The field research in Kenya involved surveys of more than 290 households and enterprises. However, this sample size is significantly reduced when impacts are considered for subgroups of the overall sample. Some of the assessments were only valid when considered at the community (or community-pair) level because of differences between the programmes themselves and their social and economic contexts. In some cases data regarding a particular variable was only available for some of the respondents. For example, not all enterprises were in existence prior to the implementation of the electricity access programme in that community, and so the pre-programme level of electricity access could not be assessed. Likewise, not all households kept separate accounts for their household and productive activity's finances, meaning that impacts for them of the productive use of electricity could not be investigated. Much of the analysis compared beneficiary and non-beneficiary groups or beneficiary and non-beneficiary communities.

The statistical significances of results belonging to the first type (Type 1) were tested using the Students t-Test. Where differences in the mean values of certain indicators (from which possible causalities are inferred) are apparent, they do not always pass the test for 95% confidence. The lack of confidence can be attributed to small sample sizes (when working at a highly disaggregated level) but also to the large variation observed in most of the impact indicators. This level of variability was not anticipated at the research design stage. It is also possible that the true distributions for some of the indicators studied are significantly non-Gaussian, in which case the t-test confidence interval calculations would be invalid.

Results belonging to the second type (Type 2) were tested by calculating the standard error of the proportion. When the proportions differ by more than 1.96 standard errors, there can be 95% confidence that a true difference exists. Where apparent differences exist in the proportions of the subgroups that fulfil a certain

criteria, the statistical significance tends to be better than for the differences between absolute values. Nevertheless, not all results pass the test for 95% confidence because of the relatively small size of the subgroups after disaggregation.

The statistical significance of the quantitative findings has been assessed throughout this work and indication given regarding the confidence that may be placed in apparent differences between two groups. Where the sample size and spread of the data result in a confidence of less than 95%, the data is marked in this report with the symbol ▲ and a footnote detailing the degree of confidence.

The statistical significance of the correlation coefficients was also tested. In general, the small number of data points for which the correlations could be calculated[13] meant that the confidence intervals on the correlations reported were typically rather broad. For this reason, in general only limited confidence can be placed on the stated strength of correlation (negligible/weak/moderate/strong).

[13] The number of data points for correlations was often significantly below the sample size for the determination of the variables alone because of the exclusion of certain respondents (e.g. those enterprises which did not exist prior to the electricity access programme).

3.2. Grid Extension, Machakos County

3.2.1. Description

Background

This extension of the national electricity grid to the Kola area of Machakos County has been undertaken by the Kenyan Rural Electrification Authority as part of its mission to accelerate the pace of rural electrification.[14] This programme covered Kamuani, Katuaa and Katangi villages.

Kola is located about 40 kilometres from the Machakos County headquarters on the main road that connects Machakos and Makueni Counties in the former Eastern province. The main trading hub at Kola Market is a very busy market centre and this ready access to markets, and the economic opportunities it provides, is seen by residents as one of the key arguments for its electrification.

Programme cost and scale

The grid extension took approximately six months to build and was completed in 2012 at a cost of some US$176k. It currently serves some 65 households and 55 commercial customers

Impacts

As mentioned above the grid extension currently serves some 65 households and 55 commercial customers, and is estimated (based on average data for this area from the Ministry of Energy) to support a peak demand of 156kW and an average demand of 855 kWh/month. There are still many potential customers who are not yet connected to the grid.

Grid extension is regarded in Kenya as providing greater benefits than other forms of electricity provision. It is seen as a longer-term solution, and capital costs are subsidized by the government so the costs seen by end users are lower than other forms of access (such as mini-grids). Project stakeholders (including REA officials and local residents) believe that:

i. Reliable grid-supplied power is spurring economic growth and improving livelihoods.
ii. Grid-supplied electricity being relatively cheap for the end-user enables more people to benefit.

[14] The Rural Electrification Authority was established under Section 66 of the Energy Act, 2006 (No 12 of 2006) as a body corporate. It was created in order to accelerate the pace of rural electrification in the country, a function that was previously undertaken by the Ministry of Energy.

Factors facilitating/ constraining productive use of electricity access

Factors identified by stakeholders included:

i. Government subsidies which have reduced end-user costs and so enabled householders and enterprises to take up connection to the grid;

ii. The availability of loan facilities from some local banks in partnership with Kenya Power is encouraging take up of electricity access;

iii. Ready access to markets in the Kola area which is seen as a factor in enabling economic use of the electricity made available.

3.2.2. Community Feedback Workshop/Focus Group Report

A meeting was held with community members following completion of the household and enterprise surveys to gain their perspective on the grid extension programme. Key points highlighted in the discussion included:

- Connection to the main grid was seen as having spurred economic growth and increased business opportunities - as demonstrated by the case of Benard Musau (who had acted as the survey-team's community link on the ground). Access to grid electricity had enabled Benard to establish a flourishing welding business with clients coming as far as 50km and products selling in the Machakos County Capital. Benard now plans to open a community resource in the Kola market, as a social enterprise.

- As Benard's experience demonstrated, access to markets was seen as key in utilising electricity access productively

- The community members agreed that access to electricity has increased working hours in the area.

- New business ventures had been created as a direct result of improved access and other existing businesses, such as a maize mill which had previously been powered by a generator, had connected to the grid.

- Overall it was considered that electricity access had reduced costs of doing business while expanding economic opportunities for the residents.

3.2.3. Analysis of Survey Data

Electricity Access Levels

Data from the surveys has been analysed in line with the Global Tracking Framework to establish the respondents' levels and changes in level of electricity access for productive and household use.

Table 7 shows the average electricity access tiers for the **enterprises** surveyed, and the average increase in electricity access tier since before the energy centre was

established. Data is disaggregated to show the differences between *Beneficiary Respondents* (those enterprises which use a lantern rented from and charged at the energy centre) and *Non-Beneficiary Respondents*. Table 8 disaggregates the enterprise electricity access levels by application, showing which applications are most frequently used and the average tier achieved is for each application.

Table 7: Enterprise Overall Electricity Access Levels, Machakos Grid Extension

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	21	8	29
Average Electricity Access Tier	**1.4**	**0.0**	**1.3**
Number of enterprises for which change in electricity access tier can be calculated[15]	9	0	9
Average Increase in Electricity Access Tier since Programme Implementation	**1.1**	**-**	**1.1**

Table 8: Enterprise Application Electricity Access Levels, Machakos Grid Extension

			Beneficiary Respondents		Non-Beneficiary Respondents	
			Number of Users[16]	Average Application Access Tier	Number of Users	Average Application Access Tier
Application	tL	Lighting	12	1.3	2	0
	tI	ICT & Entertainment	12	1.4	2	0
	tM	Motive Power	1	2.0	0	-
	tS	Space Heating	2	0.0	0	-
	tP	Product Heating	2	2.0	0	-
	tW	Water Heating	2	1.5	0	-

Of the twenty-one Beneficiary enterprises surveyed, eight indicated that they did not need or use electricity for productive purposes (i.e. that they made only household use of their connection). Of the other Beneficiaries, the majority used electricity for Lighting and ICT with only a small number using it for motive power or heating. The level of access achieved through grid connection is surprisingly low at an average Tier of only 1.4. This is driven largely by low reported levels of capacity and duration of availability – leading to the suspicion that the relevant questions may have been

[15] Excludes enterprises started since programme began

[16] Enterprises from that category (Beneficiary/Non-Beneficiary Respondents) using electricity for this application

misinterpreted to mean the level of capacity and hours/day of supply they actually made use of, rather than the capacity level and duration available to them. Of those Beneficiary enterprises which were in business prior to the grid extension, the vast majority had previously had no access, though a small number were previously using standalone systems. The differences between beneficiaries and non-beneficiaries are statistically significant and are expected to prevail in the population at large.

All but one of the Non-Beneficiary enterprise respondents indicated that they had no requirement for electricity for their business. (That single respondent reported needing, but lacking, electricity for lighting).

Table 9 gives data on average tier and average increase in tier for **household respondents**, while Table 10 provides a count of the households assessed at each attribute tier for each of the six attributes of household electricity access, thus providing an indication of which attributes have been most influential in limiting the level of access achieved.

Table 9: Household Electricity Access Levels, Machakos Grid Extension

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	21	24	45
Average Electricity Access Tier	**1.3**	**0.2**	**0.7**
Number of households for which change in electricity access tier can be calculated	19	22	41
Average Increase in Electricity Access Tier since Programme Implementation	**1.2**	**0.1**	**0.6**

Table 10: Number of households assessed at each attribute tier, Machakos Grid Extension

(Only includes those households with any electricity access)

			Attribute tier					
			0	**1**	**2**	**3**	**4**	**5**
Attribute	**t1**	**Capacity**	1	13	12			1
	t2	**Duration/Availability**	2	5	7	8	1	3
	t3	**Reliability**				21		4
	t4	**Quality**			5			18
	t5	**Affordability**		12				13
	t6	**Legality**			1			26

Five Non-Beneficiary households use solar home systems (one of which has been installed since the grid extension), solar lanterns or rechargeable batteries and have been included in those who have electricity access, with levels of access between

Tier 0 and 2. Other Non-Beneficiary respondents have no form of electricity access and have accordingly been assessed at Tier 0.

The majority of the households with grid connection have been assessed at Tier 1 or 2, with the limiting attribute being in most cases, the capacity, affordability or daily duration of the supply. Three or four of the households report having had electricity prior to the grid extension, all at Tier 1.

The differences between beneficiaries and non-beneficiaries are statistically significant and are expected to prevail in the population at large.

Electricity Access and Productive Uses

Table 11 Enterprise Electricity Access and Impacts, Machakos Grid Extension

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	21	8	29
Impact: Creation of New Enterprises			
Number of Enterprises Surveyed Created Since Start of Programme	2	1	3
Impact: Enterprise Revenue			
Average Enterprise Monthly Revenue (KSh)	**60,625**	**9,713**	**46,079**
Correlation Enterprise Monthly Revenue : Electricity Access Tier			55% (moderate)
% Change in Enterprise Monthly Revenue	40% ▲	24% ▲[17]	35%
Correlation % Change in Enterprise Monthly Revenue : Change in Electricity Access Tier			-53% (moderate)
Impact: Enterprise Profit			
Average Enterprise Monthly Profit (KSh)	**11,439 ▲**	**5,706 ▲**[18]	**9,741**
Correlation Enterprise Monthly Profit : Electricity Access Tier			40% (weak)
% Change in Enterprise Monthly Profit	34% ▲	4% ▲[19]	24%
Correlation % Change in Enterprise Monthly Profit : Change in Electricity Access Tier			-63% (moderate)

[17] Low confidence (46%) that difference indicated in the sample exists in the wider population.

[18] Medium confidence (78%) that difference exists in the population.

[19] Medium confidence (71%) that difference exists in the population.

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Impact: Employment			
Average Number of Employees per Enterprise	1.70 ▲	0.63 ▲[20]	1.39
Change in Number of Employees per Enterprise	0.64 ▲	0.00 ▲[21]	0.45
Correlation Change in Number of Employees : Change in Electricity Access Tier			-44% (moderate)
Average Employee Remuneration	4,363	1,940	3,786
% Change in Average Employee Remuneration	17% ▲	3% ▲[22]	13%
Correlation Change in Average Employee Remuneration: Change in Electricity Access Tier			-65% (moderate)

Only two of the Beneficiary and one of the Non-Beneficiary enterprises surveyed had been created since the start of the programme, roughly in proportion to the numbers surveyed, giving little indication of electricity access being a catalysing factor in new businesses starting up.

Those enterprises which have secured grid connection have substantially higher revenues, and appear to have higher profits than those which have not connected to the grid. They also had higher revenues and profits prior to the extension. It seems likely that this simply reflects the extension of the grid being directed to areas where businesses most able to make use of access are located, and the ability of larger and more profitable businesses to take up grid connection when available.

Both Beneficiary and Non-Beneficiary enterprises have, on average, seen significant increases in revenues and profits since the grid was extended, and the increases even in percentage terms appear to have been larger amongst the Beneficiaries than the Non-Beneficiaries. This may indicate that those who have secured access have been able to use it to benefit their businesses, but it should also be noted that within the group there is a moderate negative correlation between increased access and increased revenue/profit (although all correlations in this section must be treated with caution due to the poor confidence suggested by statistical analysis).

Beneficiary enterprises seem to have also, on average, increased the number of their employees and the amount they are paid (implying a route, alongside increased prosperity of enterprise owners, for increased economic activity to lead to poverty reduction), while there has been no reported increase in employee numbers, and

[20] Good confidence (93%) that difference exists in population, but 95% confidence threshold not achieved.

[21] Medium confidence (85%) that difference indicated in the sample exists in the wider population.

[22] Good confidence (89%) that difference exists in population, but 95% confidence threshold not achieved.

only a much smaller increase in pay for Non-Beneficiary enterprises. However, amongst those enterprises which have achieved increased electricity access, the correlation between the increase in access and increased numbers or levels of pay for employees seems if anything negative.

Overall there is some evidence that the extension of the grid has impacted on economic activity in the area, and that this could have fed through to impact on local poverty, but it does not seem possible to establish a clear relationship between increased access and growth in the scale or profitability of individual businesses.

Electricity Access and Poverty Impacts

Table 12: Household Electricity Access and Impacts, Machakos Grid Extension

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	21	24	45
Impact: Household Income			
Average Monthly Household Income (KSh.)	67,600 ▲	8,696 ▲[23]	36,093
Correlation Monthly Income : Electricity Access Tier			17% (negligible)
Average % Increase in Monthly HH Income	139% ▲	74% ▲[24]	104%
Correlation % Increase in Monthly Income: Increase in Electricity Access Tier			6% (negligible)
Impact: Education			
% of HH with Children Reporting Improvement in Education Available	86% ▲	63% ▲[25]	73%
Correlation Increase in Electricity Access with Reported Improvement in Education			25% (weak)
% of those reporting improvement in education who attribute it in whole or part to improved electricity access	83%	100%	91%

[23] Good confidence (91%) that difference exists in population, but 95% confidence threshold not achieved.

[24] Low confidence (51%) that difference exists in the population.

[25] Medium confidence (81%) that difference exists in the population.

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Impact: Health			
% of HH Reporting Improvement in Health Care	67% ▲	71% ▲[26]	69%
Correlation Increase in Electricity Access with Reported Improvement in health care			-14% (negligible)
% of those reporting improvement in health care who attribute it in whole or part to improved electricity access	100%	100%	100%

Beneficiary households enjoy significantly higher incomes than Non-Beneficiary Households (and had higher incomes before the arrival of the grid). It seems likely that this reflects both that the grid was extended to the larger, wealthier community and that wealthier households will have been able to actually take up connection.

Both Beneficiaries and Non-Beneficiaries appear to have seen substantial increases in household incomes, with Beneficiaries' incomes rising more (even in percentage terms) than Non-Beneficiaries', although only low confidence can be attributed to this difference. If present, this difference would imply some relationship between energy access and income growth, but the level of correlation between reported income increase and electricity access increase within this group is negligible.

The majority of both Beneficiaries and Non-Beneficiaries report improvements in both education and health care over the programme period, with more Beneficiaries reporting education improvements and almost equal numbers reporting health care improvements. The vast majority of respondents attribute these improvements, at least in part, to increased electricity access, but with most respondents reporting improvements, there is no significant correlation between within the group between improvement in access and improvement in education or health. This is much as would be expected given that improvements in these services are likely to be community-wide more than household specific.

[26] Very low confidence (<40%) that difference exists in the population.

3.3. Access:Energy Mini-grid, Mageta Island

3.3.1. Description

Background

Mageta is a small, 6.6 km^2, island located in Lake Victoria, Nyanza Province. Fishing is the island's main economic activity and provides the majority of employment. The island's population peaks at about 15,000 people during fishing seasons, but goes down to 8,000 people during periodic government fish bans.

Access Energy, which implemented the programme, is a private sector Kenyan based company developing remote, village-scale, renewable energy mini-grids. This solar/wind hybrid mini-grid project utilises technology that allows remote control and visibility of the mini-grids, as well as cashless, mobile-phone based pay-as-you-go payment for energy services.

Programme cost and scale

The mini-grid took ~2 months to install, at a cost of ~$15k in 2012 and provides electricity to approximately 40 households and businesses.

Impacts

The main perceived impacts from the mini-grid project are;

i. Improved household lighting
ii. Increased working hours due to improved lighting

Factors facilitating/ constraining productive use of electricity access

It is the high cost paid by end-users, in the absence of financial incentives for private electricity provision and given the relatively high cost of mini-grid electricity, which is thought to constitute the main factor in discouraging both take-up of access and its productive use.

Key lessons from the programme

Lessons identified are that:

i. Private sector investment in electricity provision in underserved areas can be viable in appropriate circumstances
ii. The use of remote technology for service provision and payment can reduce administration overheads and ultimately costs to consumers.

3.3.2. Community Feedback Workshop/Focus Group Report

On completion of the surveys, a meeting was held with community stakeholders to capture their perspective on their electricity access position and productive use of electricity.

Access Energy's mini-grid is the only source of electricity for most on Mageta Island. Generators and standalone solar systems are technically viable but remain economically out of the reach of most residents. (Only 5 of the households we surveyed had standalone electricity access, compared with 26 who had connected to the mini-grid). Electricity from the mini-grid is still seen as costly, but a better alternative than relying on kerosene and generators.

There has been some productive use of electricity from the mini-grid, with small businesses such as those providing phone charging thriving as a result. Those in the community appreciate that the mini-grid provides more than just lighting, but limitations on the power available are seen as having restricted its productive use, with many of those, such as video halls, which have connected to it still relying on generators for back-up. The community is keen to see further generation developed to increase the extent and level of power available.

3.3.3. Analysis of Survey Data

Electricity Access Levels

Data from the surveys has been analysed in line with the Global Tracking Framework to establish the respondents' levels and changes in level of electricity access for productive and household use.

Table 13 shows the average electricity access tiers for the enterprises surveyed, and the average increase in electricity access tier since before the energy centre was established. Data is disaggregated to show the differences between Beneficiary Respondents (those enterprises which use a lantern rented from and charged at the energy centre) and Non-Beneficiary Respondents. Table 14 disaggregates the enterprise electricity access levels by application, showing which applications are most frequently used and the average tier achieved is for each application.

Of the thirty-two Beneficiary respondents, two had only household connections and did not report using electricity for their business. One, though connected to the mini-grid, reported that they did not need or use electricity in their business. A further respondent reported that though they used electricity it was not needed for their business. (The access level of these four respondents, in accordance with the GTF, wasn't assessed.) Six Beneficiary enterprises reported needing and using electricity access, but provided inadequate information for their overall access tier to be assessed. (These six respondents have been included in the numbers of those using lighting and ICT/entertainment, but not in the calculation of average access Tier).

Table 13: Enterprise Overall Electricity Access Levels, Access Energy Mageta Island Mini-grid

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	32	15	47
Average Electricity Access Tier	**1.3 ▲**	**1.1 ▲**[27]	**1.2**
Number of enterprises for which change in electricity access tier can be calculated[28]	15	5	20
Average Increase in Electricity Access Tier since Programme Implementation	**0.2 ▲**	**0.8 ▲**[29]	**0.4**

Table 14: Enterprise Application Electricity Access Levels, Access Energy Mageta Island Mini-grid

			Beneficiary Respondents		Non-Beneficiary Respondents	
			Number of Users[30]	Average Application Access Tier	Number of Users	Average Application Access Tier
Application	tL	Lighting	29	1.2	9	1.1
	tI	ICT & Entertainment	28	1.4	7	1.5
	tM	Motive Power	0	-	0	-
	tS	Space Heating	0	-	0	-
	tP	Product Heating	0	-	0	-
	tW	Water Heating	0	-	0	-

All the enterprises using electricity from the mini-grid were using it for Lighting and ICT/Entertainment alone, and reported access levels of Tier 0-2, giving an average of 1.27, with the primary limiting attribute being duration/availability of supply, closely followed by affordability and capacity.

Six of the Non-Beneficiary enterprises reported that they did not need or use electricity (and accordingly did not have an assessed level of access). Four reported needing but not having any form of access (i.e. Tier 0), while two used rechargeable batteries (Tier 1), two used solar standalone systems (Tier 2) and one had a standalone generator (Tier 3) – all of which were used for Lighting, ICT and Entertainment. Taken together these gave an average non-Beneficiary access level

[27] Statistically, the difference in means is not significant.

[28] Excludes enterprises started since programme began

[29] Low confidence (64%) that difference exists in the population.

[30] Enterprises from that category (Beneficiary/Non-Beneficiary Respondents) using electricity for this application

that is not statistically different from the access level achieved by the Beneficiaries through the mini-grid.

The majority of those enterprises now connected to the mini-grid had, prior to its installation, used some other form of electricity (rechargeable battery, standalone solar system, fossil-fuelled generator, or smaller informal mini-grid, presumably based on neighbours' generators). As a result the increase in access level achieved by these Beneficiary enterprises was relatively small – just 0.23 Tier points.

The average increase in electricity access achieved by Non-Beneficiary enterprises actually appears to be higher than that for Beneficiary enterprises. The apparent difference is reported with low confidence with respect to the wider population, being driven by the tier increases of two Non-Beneficiary respondents. One of these has had a solar home system installed while the other reports an increase in the time for which they have access to electricity each day from a standalone generator.

Table 15 gives data on average tier and average increase in tier for household respondents, while Table 16 provides a count of the households assessed at each attribute tier for each of the six attributes of household electricity access, thus providing an indication of which attributes have been most influential in limiting the level of access achieved. The differences between beneficiaries and non-beneficiaries are statistically significant and are expected to prevail in the population at large.

Table 15: Household Electricity Access Levels, Access Energy Mageta Island Mini-grid

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	23	15	38
Average Electricity Access Tier	**1.0**	**0.2**	**0.7**
Number of households for which change in electricity access tier can be calculated	20	15	35
Average Increase in Electricity Access Tier since Programme Implementation	**0.8**	**0.1**	**0.5**

Table 16: Number of households assessed at each attribute tier, Access:Energy Mini-grid

(Only includes those households with any electricity access)

			Attribute tier					
			0	**1**	**2**	**3**	**4**	**5**
Attribute	**t1**	**Capacity**	1	13	15	1		
	t2	**Duration/Availability**	7	2	5			15
	t3	**Reliability**				5		24
	t4	**Quality**			1			28
	t5	**Affordability**		17				8
	t6	**Legality**						30

Two Non-Beneficiary households use fossil-fuelled generators and two have solar home systems, while a fifth uses non-rechargeable batteries. However three of these households were assessed as having Tier 0 access (due to the limited duration for which they were able to use electricity each day) and all the other Non-Beneficiary households reported no form of access.

The majority of the households with connection to the mini-grid have been assessed at Tier 1, with the limiting attribute being in most cases, the capacity of electricity available, followed by affordability and the daily duration of the supply. Three or four of the households report having had electricity prior to the grid extension, all at tier 1.

Of the beneficiary households, about two-thirds report having had some form of electricity access before the mini-grid was installed (from a mix of fossil-fuelled generators, standalone household systems, rechargeable and non-rechargeable batteries), but the previous level of access was low with just six households assessed at Tier 1 and the remainder at Tier 0. Of the Non-Beneficiary households, three report having had electricity access (from a fossil-fuelled generator and two standalone home systems) prior to the mini-grid's installation.

Electricity Access and Productive Uses

Table 17 Enterprise Electricity Access and Impacts, Access Energy Mageta Island Mini-grid

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed[31]	32	15	47
Impact: Creation of New Enterprises			
Number of Enterprises Surveyed Created Since Start of Programme	4	1	5
Impact: Enterprise Revenue			
Average Enterprise Monthly Revenue (KSh)	8,930 ▲	6,464 ▲[32]	8,145
Correlation Enterprise Monthly Revenue : Electricity Access Tier			17% (negligible)
% Change in Enterprise Monthly Revenue	-5% ▲	-11% ▲[33]	-6%
Correlation % Change in Enterprise Monthly Revenue : Change in Electricity Access Tier			-63% (moderate)
Impact: Enterprise Profit			
Average Enterprise Monthly Profit (KSh)	5,370 ▲	4,286 ▲[34]	5,025
Correlation Enterprise Monthly Profit : Electricity Access Tier			8% (negligible)
% Change in Enterprise Monthly Profit	-3%	-2%	-3%
Correlation % Change in Enterprise Monthly Profit : Change in Electricity Access Tier			-60% (moderate)

[31] One outlier respondent for whom enterprise revenue/profit data is thought to have been entered incorrectly has been excluded from the analysis.

[32] Low confidence (58%) that difference exists in the population.

[33] Very low confidence (<40%) that difference exists in the population.

[34] Low confidence (43%) that difference exists in the population.

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Impact: Employment			
Average Number of Employees per Enterprise	1.90 ▲	2.92 ▲[35]	2.21
Change in Number of Employees per Enterprise	-0.13 ▲	0.17▲[36]	-0.05
Correlation Change in Number of Employees : Change in Electricity Access Tier			-34% (weak)
Average Employee Remuneration	1,103 ▲	1,176 ▲[37]	1,126
% Change in Average Employee Remuneration	-1%	1%	0%
Correlation Change in Average Employee Remuneration : Change in Electricity Access Tier			-17% (negligible)

Only five of the enterprises had been created since the programme began, with a disproportionate number starting amongst the Beneficiary group, possibly indicating a role for electricity access in supporting start-up of new enterprises (though with these small numbers it is doubtful if this is significant).

The average revenues of Beneficiary enterprises appear to be higher than those of Non-Beneficiaries (although confidence in this difference is low), but no notable relationship between revenue and electricity access amongst individual businesses is evident. (To the extent there is a relationship, it seems to be stronger for Non-Beneficiaries than Beneficiaries, possibly indicating that for Beneficiaries, the decision to take up connection to the mini-grid is driven more by proximity and the resulting opportunity becoming available, whereas amongst the Non-Beneficiary group it is largely an economic decision whether to purchase a standalone means of electricity supply.)

Profits, like revenues, are on average higher for the Beneficiary than the Non-Beneficiary group, but there is only low confidence in the difference existing in the wider population. Any correlation with electricity access however seems negligible (though stronger amongst Non-Beneficiaries than Beneficiaries).

Revenues and profits for both Beneficiaries and Non-Beneficiaries have on average fallen. This reflects the situation in an area dependent on fishing where fish stocks are coming under pressure and residents report having to travel further to catch fish, with limitations on the area where they can fish by the border with Uganda, and fishing bans being increasingly imposed in order to conserve stocks. In this situation there appears to be a moderately strong negative correlation between increase in electricity access and changes in revenue and profit.

[35] Low confidence (64%) that difference exists in the population.

[36] Low confidence (49%) that difference exists in the population.

[37] Very low confidence (<40%) that difference exists in the population.

Both average employment and employee remuneration appear to have risen marginally amongst Non-Beneficiary enterprises while falling marginally amongst Beneficiaries, but the effects are so small as to be negligible as is the (negative) correlation between these changes and increases in electricity access.

Overall, in a context where a number of enterprises already had some form of electricity access, and the community is facing increasing pressure on resources, the relationships between changes in electricity access and changes in the various indicators of enterprise activity seem if anything negative. It could be that enterprises have made decisions regarding securing electricity access which they have then been unable to use productively of in the face of falling fish stocks and community prosperity.

Electricity Access and Poverty Impacts

Table 18: Household Electricity Access and Impacts, Access Energy Mageta Island Mini-grid

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	23	15	38
Impact: Household Income			
Average Monthly Household Income (KSh.)	11,870 ▲	8,167▲[38]	10,408
Correlation Monthly Income : Electricity Access Tier			-2% (negligible)
Average % Increase in Monthly HH Income	-1%	-3%	-2%
Correlation % Increase in Monthly Income: Increase in Electricity Access Tier			13% (negligible)
Impact: Education			
% of HH with Children Reporting Improvement in Education Available	41% ▲	21%▲[39]	33%
Correlation Increase in Electricity Access with Reported Improvement in Education			-27% (weak)
% of those reporting improvement in education who attribute it in whole or part to improved electricity access	89%	100%	92%

[38] Low confidence (69%) that difference exists in the population.

[39] Low confidence (64%) that difference exists in the population.

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Impact: Health			
% of HH Reporting Improvement in Health Care	22% ▲	13%▲[40]	18%
Correlation Increase in Electricity Access with Reported Improvement in health care			-25% (weak)
% of those reporting improvement in health care who attribute it in whole or part to improved electricity access	60%	100%	71%

Beneficiary households appear to enjoy somewhat higher incomes than Non-Beneficiary Households (and had higher incomes before the arrival of the grid). It seems likely that this reflects the installation of the mini-grid in the larger, wealthier community and that wealthier households will have been better able to actually take up connection.

Both Beneficiary and Non-Beneficiary respondents have seen falls in household incomes (reflecting the pressures on fishing discussed above). While Beneficiaries' incomes have fallen less than non-Beneficiaries', the difference is not substantial, and there is little if any correlation between (rising) electricity access and (falling) incomes.

A minority of respondents, both Beneficiary and Non-Beneficiary, considered that access to education and health services had improved over the programme period, with more Beneficiaries than Non-Beneficiaries reporting this effect. However more of the Non-Beneficiaries than the Beneficiaries attributed this to improved electricity access and there appears, if anything, to be a weak negative relationship between improved access to electricity and to education/health care. This could indicate a community rather than an individual impact, or perhaps that the increase in electricity access which most Beneficiaries have seen is less important for education and health care than the move from no electricity access to some access, however limited, which some Non-Beneficiary households have achieved.

[40] Very low confidence (<40%) that difference exists in the population.

3.4. Solar Transitions Energy Centre, Kitui County

3.4.1. Description

Background

Ikisaya village is in Kitui County, a drought-prone and semi-arid area, representative of Kenya's arid and semi-arid lands (ASALs). Subsistence farming, charcoal burning and livestock keeping are the main sources of livelihoods in the area. The village has two primary schools, a small polytechnic school, six churches, a few retail shops selling essentials, a private pharmacy and one diesel-powered maize mill. Kerosene and dry cell batteries are the main sources of energy for lighting.

The Solar Energy Centre in Ikisaya is the result of a process aimed at identifying an approach to village-scale power supply and energy service delivery suited to local conditions. The project was conceptualised and implemented by a team of social scientists and practitioners from Kenya, India, Norway and Austria through the Solar Transitions project led by the University of Oslo[41].

Energy delivery model, including means and level of electricity access

The village energy centre model targets the provision of affordable and accessible basic lighting and electricity services for off-grid communities through an approach which houses all services in one centre close to the community. The energy centre is based on a 2.16 kW solar PV system that provides energy for a range of services including lantern charging, mobile phone charging and IT services.

Solar PV technology was selected because of the high availability of solar resource in the region, the modular nature of the technology and its minimal operational and maintenance requirements. These considerations were further reinforced by the fact that the solar market in Kenya is mature with high levels of awareness and good availability of products and services.

The energy centre building houses:

i. A charging station - where phones, lanterns and small batteries are received, charged and given out. Retail sales are also made here.
ii. An IT room - where photocopying, printing, typing and other IT related services are offered.
iii. A TV room - TV and video shows are screened here. This room can also be hired out and used for meetings and training.
iv. A back office and store – where most of the installed equipment (batteries, inverters and charge controllers) are kept.

[41] Muchunku C et al (2014); "The Solar Energy Centre: Approach to Village Scale Power Supply", University of Oslo, Norway. http://www.sv.uio.no/iss/english/research/projects/solar-transitions/energy-centre/index.pdf

Lanterns are rented out for two days at a time at a cost of KSh 20. Fees are charged for late returns, and a deposit is required. Other revenue streams for the energy centre include phone charging, IT services and TV/video screenings.

The lantern charging and renting service has evolved from a purely centralised model, where the lanterns and lantern charging system were all housed at the energy centre to a decentralised model with lantern renting services provided in neighbouring villages through agents. This evolution is due to demand for lantern renting in other villages around Ikisaya. The Ikisaya Energy Centre has 5 agents located in other trading centres (Endau, Malalani, Ndovoini, Kathua and Yiuku), which are 10 kilometres or more from the energy centre.

Commercial principles informed the design and operation of the energy centre to ensure financial sustainability while at the same time attempting to ensure that the services offered are affordable and accessible. The financial performance of the pilot energy centre so far indicates that the model is sustainable.

(It should thus be noted that the services provided by the project go well beyond the pure provision of electricity and this should be borne in mind when looking at impacts and comparative costs and so on).

Programme cost and scale

According to the implementers, the total capital cost of the Ikisaya installation, including the centre and the 450 lanterns which are rented out, was about KSh 4,730,000 ($57,000).

Impacts

The energy centre and lantern rental service are thought to have brought a range of benefits including:

- Improved communications with the ability to charge phones enabling residents to do business, keep in touch with relatives and use money transfer services, and better access to information through TV/entertainment services allowing the community keep in touch with wider political, economic and social changes events
- Access to better lighting making it easy for schoolchildren to study and small business to operate more hours
- Access to the IT services offered by the centre such as printing and photocopying and access greater employment opportunities

Factors facilitating/ constraining productive use of electricity access

The uptake of the services offered at the energy centre has been largely driven by the absence of other options (and in particular the option of connecting to the national grid).

The energy centre's status as community-owned asset, and the resulting sense of responsibility most local people feel for its success, are seen as key factors in the take-up of services.

A constraining factor on the productive use of electricity access is considered to be the distance between the main energy centre in Ikisaya and potential sites of productive use.

Key lessons from the programme

A portable structure (for example a modified container or prefabricated building), rather than the permanent structure used for the energy centre might have advantages - primarily ease of assembly and transportation – which might allow some of the current obstacles (see above) to using the centre to support productive uses to be overcome, and enable its re-location in the event of grid extension into the area.

3.4.2. Community Feedback Workshop/Focus Group Report

In post-survey discussions the chairperson and community members of Ikisaya village expressed the view that the energy centre had transformed the lives of the residents in the area. In particular they focussed on the benefits of improved communications, lighting and the availability of IT services (see Impacts under 3.4.1 Project Description, above) for personal lives, empowerment and employment opportunities.

There is now the prospect of connection to the national grid, and this is very exciting for the residents. However it's thought that the energy centre will remain relevant because not all residents will be able to be connected to the main grid and the community hopes to further improve and diversify the services the centre offers.

The development of the decentralised model, with agents serving satellite areas is considered another pointer to the importance of the energy services offered by the centre.

3.4.3. Analysis of Survey Data

Electricity Access Levels

Data from the surveys has been analysed in line with the Global Tracking Framework to establish the respondents' levels and changes in level of electricity access for productive and household use. It may be noted that this captures the

benefits of using solar lanterns rented from the centre and of using the facilities at the centre to recharge batteries, but not of energy dependent services, such as the printing and photocopying services offered at the energy centre, which are accessed outside the home or business premises.

Table 19 shows the average electricity access tiers for the enterprises surveyed, and the average increase in electricity access tier since before the energy centre was established. Data is disaggregated to show the differences between *Beneficiary Respondents* (those enterprises which use a lantern rented from and charged at the energy centre) and *Non-Beneficiary Respondents*. Table 20 disaggregates the enterprise electricity access levels by application, showing which applications are most frequently used and the average tier achieved is for each application. The differences between beneficiaries and non-beneficiaries are statistically significant and are expected to prevail in the population at large.

Table 19: Enterprise Overall Electricity Access Levels, Ikisaya Energy Centre

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	12	12	24
Average Electricity Access Tier	**0.5**	**0.0**	**0.5**
Number of enterprises for which change in electricity access tier can be calculated[42]	6	0	6
Average Increase in Electricity Access Tier since Programme Implementation	**0.7**	**-**	**0.7**

Table 20: Enterprise Application Electricity Access Levels, Ikisaya Energy Centre

			Beneficiary Respondents		Non-Beneficiary Respondents	
			Number of Users[43]	Average Application Access Tier	Number of Users	Average Application Access Tier
Application	**tL**	**Lighting**	12	0.7	0	-
	tI	**ICT & Entertainment**	0	-	0	-
	tM	**Motive Power**	0	-	0	-
	tS	**Space Heating**	0	-	0	-
	tP	**Product Heating**	0	-	0	-
	tW	**Water Heating**	0	-	0	-

[42] Excludes enterprises started since programme began

[43] Enterprises from that category (Beneficiary/Non-Beneficiary Respondents) using electricity for this application

None of the Non-Beneficiary Enterprises had any other form of electricity access and those enterprises which have benefited from the programme use it only for lighting. (It may be noted that the GTF for Productive Uses assesses only those applications which are regarded by the respondent as relevant to their business, and respondents in Ikasaya have identified lighting as their only relevant application, so their overall tier ranking is based on the access they have to lighting alone. It is recognized that this approach begs the question of what business activities might develop if electricity for other applications were available.) Of the twelve Beneficiary Enterprises, three report that though they need electricity and have access to a solar lantern, they do not regularly use it for their business and so have been designated as Tier 0. Two further enterprises have been assigned Tier 0 because of the short period of lighting they get each day, one (perhaps anomalously) achieves Tier 2 and the remaining six have been set at Tier 1 because of some combination of the capacity and duration of the electricity available to them.

Table 21 gives data on average tier and average increase in tier for household respondents, while Table 22 provides a count of the households assessed at each attribute tier for each of the six attributes of household electricity access, thus providing an indication of which attributes have been most influential in limiting the level of access achieved.

Table 21: Household Electricity Access Levels, Ikisaya Energy Centre

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	28	22	50
Average Electricity Access Tier	**0.6**	**0.0**	**0.4**
Number of households for which change in electricity access tier can be calculated	22	17	39
Average Increase in Electricity Access Tier since Programme Implementation	**0.8**	**0.0**	**0.5**

Table 22: Number of households assessed at each attribute tier, Ikisaya Energy Centre

(Only includes those households with any electricity access)

			Attribute tier					
			0	**1**	**2**	**3**	**4**	**5**
Attribute	**t1**	**Capacity**		19	14	1		
	t2	**Duration/Availability**	16	2	16			
	t3	**Reliability**				24		6
	t4	**Quality**						
	t5	**Affordability**		32				2
	t6	**Legality**						34

Five Non-Beneficiary households use non-rechargeable batteries, and have been included in those who have electricity access, but assessed at Tier 0. Other Non-Beneficiary respondents have no form of electricity access. Of those who had benefitted from the programme, a further seven households use rechargeable batteries and have also been assigned Tier 0, while of the twenty one households using solar lanterns, three have been put at Tier 0 because of the short period for which their lantern provides light each day, while the remained have been limited to Tier 1 by some combination of capacity, duration and cost.

Electricity Access and Productive Uses

Table 23: Enterprise Electricity Access and Impacts, Ikisaya Energy Centre

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	12	12	24
Impact: Creation of New Enterprises			
Number of Enterprises Surveyed Created Since Start of Programme	1	0	1
Impact: Enterprise Revenue			
Average Enterprise Monthly Revenue (KSh)	**26,583 ▲**	**14,792 ▲**[44]	**20,688**
Correlation Enterprise Monthly Revenue : Electricity Access Tier			9% (negligible)
% Change in Enterprise Monthly Revenue	0%	2%	1%
Correlation % Change in Enterprise Monthly Revenue : Change in Electricity Access Tier			-4% (negligible)
Impact: Enterprise Profit			
Average Enterprise Monthly Profit (KSh)	**10,502 ▲**	**6,250 ▲**[45]	**8,376**
Correlation Enterprise Monthly Profit : Electricity Access Tier			-16% (negligible)
% Change in Enterprise Monthly Profit	10% ▲	34% ▲[46]	20%
Correlation % Change in Enterprise Monthly Profit : Change in Electricity Access Tier			52% (moderate)

[44] Medium confidence (85%) that difference exists in the population.
[45] Medium confidence (81%) that difference exists in the population.
[46] Low confidence (63%) that difference exists in the population.

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Impact: Employment			
Average Number of Employees per Enterprise	1.25 ▲	1.36 ▲[47]	1.30
Change in Number of Employees per Enterprise	0.11 ▲	0.00 ▲[48]	0.06
Correlation Change in Number of Employees : Change in Electricity Access Tier			41% (moderate)
Average Employee Remuneration	2,561 ▲	2,840 ▲[49]	2,716
% Change in Average Employee Remuneration	2%	0%	1%
Correlation Change in Average Employee Remuneration : Change in Electricity Access Tier			41% (moderate)

Only one of the twenty-four enterprises surveyed had been created since the start of the programme and while this single enterprise is amongst the Beneficiaries this is scant evidence of any impact of electricity access on enterprise creation.

Average revenues and profits are higher for Beneficiary than for Non-Beneficiary enterprise respondents. This could be interpreted as indicating that access to electricity supports larger and more profitable businesses, but it could equally imply that such businesses are in a better position to pay for electricity access. There is medium confidence that this difference exists for the whole population.

The average reported increase in revenues is negligible for both Beneficiary and Non-Beneficiary enterprises, and there is no correlation indicated between increase in revenue and increase in access.

The average increase in enterprise profitability appears to be higher for the Non-Beneficiary than for the Beneficiary group in the population, yet there is an apparent correlation between increase in access and increase in profit amongst the beneficiary group. This apparently contradictory outcome presumably reflects the small sample size and the low level of confidence which can be placed in these results.

There has been a small increase in both employment and employee remuneration amongst Beneficiary respondents, with no equivalent increase, on average, amongst the Non-Beneficiary group, but the effect is so small that it is only slight evidence of a positive effect.

[47] Very low confidence (<40%) that difference exists in the population.

[48] Medium confidence (67%) that difference exists in the population.

[49] Very low confidence (<40%) that difference exists in the population.

Overall there seems to be little indication that the programme, and any productive use of electricity which it has enabled, have significantly supported growth in enterprises or their profitability.

Electricity Access and Poverty Impacts

Table 24: Household Electricity Access and Impacts, Ikisaya Energy Centre

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	28	22	50
Impact: Household Income			
Average Monthly Household Income (KSh.)	4,146	8,917	6,288
Correlation Monthly Income : Electricity Access Tier			-18% (negligible)
Average % Increase in Monthly HH Income	0%	0%	0%
Correlation % Increase in Monthly Income: Increase in Electricity Access Tier	No respondents reporting improvement		
Impact: Education			
% of HH with Children[50] Reporting Improvement in Education Available	96%	100%	98%
Correlation Increase in Electricity Access with Reported Improvement in Education			n/a
% of those reporting improvement in education who attribute it in whole or part to improved electricity access	100%	100%	100%
Impact: Health			
% of HH Reporting Improvement in Health Care	0%	0%	0%
Correlation Increase in Electricity Access with Reported Improvement in Health Care	No respondents reporting improvement		

The survey results indicate significantly higher household incomes for Non-Beneficiary than for Beneficiary Households. (This may reflect the policy adopted by the programme implementers in selecting Beneficiaries, or the community's view on solar lanterns, but this has not been confirmed). None of the households, Beneficiary or Non-Beneficiary, have reported any significant change in their incomes over the

[50] In this community pair, all respondent households had children.

programme period – in line with the finding above that only a very small number of enterprises have experienced any increase in revenues or profits. It would appear that improved energy access in this context has had little or no economic impact, despite the apparent social impact, as demonstrated by the consistent report across all (Beneficiary and Non-Beneficiary) respondents of improved educational opportunities.

3.5. CAFOD Community Solar PV Project, Kajiado

3.5.1. Description

Background

In 2011, CAFOD received funding from European Union under the 10th European Development Fund (EDF) for Africa Caribbean and Pacific (ACP)-European Union (EU) Energy Facility II towards implementation of a four-year Community Based Green Energy Project (CB-GEP). The project is being implemented in the districts of Kyuso, Mwingi, Mutomo, Kitui, Garbatula, Isiolo, Kajiado North and Kajiado Central in the Eastern and Rift Valley Provinces of Kenya. The overarching goal of the project is to increase access to modern, affordable and sustainable energy services for 407,792 households through 138 institutions and 69 rural community based groups in rural and peri-urban areas in Kenya.

The project beneficiaries are community groups and institutions that do not have access to sustainable energy source. They consist of:

- 90 schools (46 schools in Kitui, 30 in Kajiado and 14 in Isiolo)that are not connected to the national grid and are using generators, hurricane lamps or pressure lamps for lighting for extended learning;

- 48 health institutions (32 in Kitui, 14 in Kajiado and 14 in Isiolo)which do not have lighting and refrigeration systems in place or are using gas powered systems of refrigeration;

-69 community based groups with 56 green houses and water pumping systems, 5 water pumping systems for livestock and 8 ICT centres managed by youths.

While this programme description covers the entire programme, our study has focussed particularly on the elements implemented in Kajiado County and specifically the provision of solar water pumping systems and greenhouses which are targeted at increased productive use of energy, and it is to these that the survey and cost data collated relate. It should however be recognised that this forms part of a wider development effort and the impacts should be seen in this context.

Energy delivery model, including means and level of electricity access

The CB-GEP project has supported the installation of solar lighting systems in rural and peri-urban schools to improve the learning environment and enable extended learning hours. (In addition schools have benefitted from energy saving *Jiko* stoves. This has enabled the schools to produce meals for students in a more energy-efficient manner, cut down on firewood costs and contributed to reduced environmental degradation).

In addition the project has provided health centres with solar powered refrigeration, lighting systems and water purification plants, contributing to improved storage of drugs and water quality.

Eight community-based ICT centres with cyber cafes for internet access powered by solar power sources have been established. It is intended that solar commercial mobile phone charging stations and barber services will be incorporated into the ICT centres which are to be owned and managed by youth groups. The project will also provide affordable mobile charging at ICT centres to target rural communities.

Finally, and the focus of this study, the programme has supported women and youth groups by setting up green houses and solar water-pumping systems.

Programme cost and scale

To date 88 schools have received solar lighting systems,40 health centres have had solar powered refrigeration, lighting systems and water purification plants installed, and 33 solar irrigation systems have been established.

In Kajiado, 30 schools and 8 health centres have benefitted from the programme, and 14 water irrigation systems, each providing ~0.38kW power have been provided at a total cost of $100k, of which ~$20.6 k is estimated to relate to the solar irrigation systems.

Impacts

Improved lighting in schools has extended learning hours for 9,186 students, bringing marginalized children in these areas to an equal competitive footing with other children in grid-connected schools. There has been improved enrolment in schools and greater access to schooling and remedial learning is expected in the long run to lead to improved performance and hence better life chances for children from these communities.

Solar powered refrigeration, lighting systems and installation of solar powered water purification plants in health centres is contributing to improved storage of drugs and water quality leading to improved drug availability, improved clinical emergency response measures and improved health care services in the target areas and consequently improved health and reduced mortality rates in the rural communities served. 40 health institutions have benefitted and through these institutions, 104,555 patients have been received treatment and 1,422 children have been immunized.

Community-based ICT centres are expected to enable rural youths to gain skills in use of ICT facilities such as internet, mobile phone communication, banking and money transfer facilities, resulting in increased uptake of the information and communication technology in rural and peri urban areas, and hence greater interpersonal information exchange as well as creation of a conducive environment for rural institutional and business frameworks.

The practice of water efficient irrigation through solar water pumping systems installed in existing community rain water harvesting structures (the component of the programme examined in this study) is reducing costs of fuel for pumping water for agriculture and livestock use and supporting increased agricultural production, thus improving the livelihoods of off-grid communities. It has also given women more business opportunities.

Factors facilitating/ constraining productive use of electricity access

The inability to take electricity from the national power grid network, due to the remoteness of the community, was seen as constraining access to electricity.

Lack of a proper road network to the programme areas was also highlighted as a factor constraining uptake and productive use of electricity.

Key lessons from the programme

The main lesson taken from the programme was that, with high levels of insolation, solar-based systems represent a viable means of providing energy and water access provision in rural areas, and thus overcoming one of the major obstacles to empowerment of people in these communities. While initial installation of solar systems is expensive its long run maintenance is cheap compared to other forms of energy.

3.5.2. Community Feedback Workshop/Focus Group Report

Feedback from the community in discussions following the survey process focussed on the advantages of the programme looking at energy access within a wider context, bringing vulnerable community members together to confront their common problems and enabling them to access electricity through a community approach.

The benefits to schooling, health services and livelihoods were recognized, but these were seen in the context of community empowerment and a community approach which is also fostering unity and cooperation among community members while opening new ventures for business emanating from the project activities.

3.5.3. Analysis of Survey Data

Electricity Access Levels

Data from the surveys has been analysed in line with the Global Tracking Framework to establish the respondents' levels and changes in level of electricity access for productive and household use.

Table 25 shows the average electricity access tiers for the enterprises surveyed, and the average increase in electricity access tier since before the energy centre was established. Data is disaggregated to show the differences between Beneficiary Respondents (those enterprises which use a lantern rented from and charged at the energy centre) and Non-Beneficiary Respondents.

Table 26 disaggregates the enterprise electricity access levels by application, showing which applications are most frequently used and the average tier achieved is for each application.

Table 25: Enterprise Overall Electricity Access Levels, CAFOD Kajiado Solar Irrigation Programme

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	17	13	30
Average Electricity Access Tier	**2.8**	**1.0**	**2.2**
Number of enterprises for which change in electricity access tier can be calculated[51]	15	5	20
Average Increase in Electricity Access Tier since Programme Implementation	**2.0** ▲	**0.6** ▲[52]	**1.7**

Table 26: Enterprise Application Electricity Access Levels, CAFOD Kajiado Solar Irrigation

			Beneficiary Respondents		Non-Beneficiary Respondents	
			Number of Users[53]	Average Application Access Tier	Number of Users	Average Application Access Tier
Application	**tL**	**Lighting**	7	1.0	15	1.4
	tI	**ICT & Entertainment**	7	1.0	16	1.4
	tM	**Motive Power**	17	3.1	8	1.6
	tS	**Space Heating**	0	-	0	-
	tP	**Product Heating**	0	-	0	-
	tW	**Water Heating**	0	-	0	-

As would be expected, given the nature of the programme, all of the enterprise Beneficiaries are using motive power, and have achieved quite high levels of access (between Tier 2 and Tier 5, limited in the majority of cases by the period for which the access is available each day) in relation to this aspect. Several of the Beneficiaries are using other sources of electricity (solar lanterns and home systems) for lighting and ICT. (It may be noted that inclusion of these applications in the calculation brings down the assessed access Tier for these respondents). By contrast the majority of the Non-Beneficiaries are using solar lanterns and solar home systems just for lighting and ICT, though a small number are also using them for motive power. The overall effect is for the Beneficiary Enterprises to have a slightly higher average level of access than the Non-Beneficiaries.

[51] Excludes enterprises started since programme began

[52] Good confidence (94.7%) that difference exists in the population, but 95% confidence threshold not achieved.

[53] Enterprises from that category (Beneficiary/Non-Beneficiary Respondents) using electricity for this application

Table 27 gives data on average tier and average increase in tier for household respondents, while Table 28 provides a count of the households assessed at each attribute tier for each of the six attributes of household electricity access, thus providing an indication of which attributes have been most influential in limiting the level of access achieved.

Table 27: Household Electricity Access Levels, CAFOD Kajiado Solar Irrigation Programme

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	16	15	31
Average Electricity Access Tier	**n/a**	**0.2**	**0.2**
Number of households for which change in electricity access tier can be calculated	n/a	13	13
Average Increase in Electricity Access Tier since Programme Implementation	**n/a**	**-0.5**	**-0.5**

Table 28: Number of households assessed at each attribute tier, CAFOD Kajiado Solar Irrigation

(Only includes those households with any electricity access)

			Attribute tier					
			0	1	2	3	4	5
Attribute	t1	Capacity		2	7	2		
	t2	Duration/Availability	8	2	1	1		
	t3	Reliability				7		4
	t4	Quality			1			8
	t5	Affordability						11
	t6	Legality			2			

Unlike the other programmes considered in this study, the “Beneficiary” households have not received any increase in household electricity access as part of the programme, and the data gathered for them relates to their take up of solar irrigation systems, not their household access. About a third of the Non-Beneficiary households have no electricity access while the others report using solar lanterns and solar home systems. Even for those who have some form of access, levels are limited to Tiers 0 - 1 by the short period each day for which electricity is available, and/or the low capacity available. Interestingly access levels are generally reported to have fallen, presumably as systems have deteriorated over time – indicating poor maintenance or non-replacement of batteries.

Electricity Access and Productive Uses

Table 29: Enterprise Electricity Access and Impacts, CAFOD Kajiado Solar Irrigation

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	17	13	30
Impact: Creation of New Enterprises			
Number of Enterprises Surveyed Created Since Start of Programme	0	3	3
Impact: Enterprise Revenue			
Average Enterprise Monthly Revenue (KSh)	**10,176 ▲**	**12,846 ▲**[54]	**11,333**
Correlation Enterprise Monthly Revenue : Electricity Access Tier			-26% (weak)
% Change in Enterprise Monthly Revenue	80% ▲	50% ▲[55]	65%
Correlation % Change in Enterprise Monthly Revenue : Change in Electricity Access Tier			49% (moderate)
Impact: Enterprise Profit			
Average Enterprise Monthly Profit (KSh)	**4,147**	**7,885**	**5,767**
Correlation Enterprise Monthly Profit : Electricity Access Tier			-36% (weak)
% Change in Enterprise Monthly Profit	111% ▲	81% ▲[56]	96%
Correlation % Change in Enterprise Monthly Profit : Change in Electricity Access Tier			45% (moderate)

[54] Low confidence (54%) that difference exists in the population.
[55] Medium confidence (81%) that difference exists in the population.
[56] Low confidence (41%) that difference exists in the population.

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Impact: Employment			
Average Number of Employees per Enterprise	1.75 ▲	0.54 ▲[57]	1.21
Change in Number of Employees per Enterprise	0.00 ▲	0.29 ▲[58]	0.14
Correlation Change in Number of Employees : Change in Electricity Access Tier			-36% (weak)
Average Employee Remuneration	625 ▲	1,000 ▲[59]	793
% Change in Average Employee Remuneration	0% ▲	48% ▲[60]	24%
Correlation Change in Average Employee Remuneration : Change in Electricity Access Tier			-

A relatively small number of enterprises have been created since the programme started – just 3, all amongst the Non-Beneficiary group. The revenues reported by the Beneficiaries are higher than those for the Non-Beneficiaries and there is a weak negative correlation between revenue level and electricity access level, which is unsurprising given the social nature of the programme and its focus on women's groups - the members of which may be expected to be relatively disadvantaged. Beneficiary enterprises have seen substantial increases in revenue (80% on average) over the programme period. The average Non-Beneficiary revenue increase is somewhat lower (50%), and there appears to be a moderate correlation between increase in revenue and increase in electricity access.

Profits are on average higher amongst Non-Beneficiary than amongst Beneficiary Enterprises, but the % increase in profits over the programme period appears to have been higher for Beneficiary than for Non-Beneficiary enterprises, and there is a moderate correlation between increase in level of electricity access and increase in profit.

Neither average employment nor average employee remuneration is reported to have changed amongst the Beneficiary enterprises, though there has been some increase amongst the Non-Beneficiary enterprises, giving an apparent, though weak negative relationship with change in electricity access.

[57] Low confidence (65%) that difference exists in the population.

[58] Very low confidence (<40%) that difference exists in the population.

[59] Low confidence (53%) that difference exists in the population.

[60] Medium confidence (72%) that difference exists in the population.

Overall, the evidence is not conclusive, but the improved electricity access provided to micro-enterprises through this programme would appear to have had some effect in supporting growth of productive use and economic activity.

Electricity Access and Poverty Impacts

Table 30: Household Electricity Access and Impacts, CAFOD Solar Irrigation

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	16	15	31
Impact: Household Income			
Average Monthly Household Income (KSh.)	12,531 ▲	16,967 ▲[61]	14,677
Correlation Monthly Income: Electric Access Tier			-20% (negligible)
Average % Increase in Monthly HH Income	68% ▲	60% ▲[62]	64%
Correlation % Increase in Monthly Income: Increase in Electricity Access Tier			7% (negligible)
Impact: Education			
% of HH with Children[63] Reporting Improvement in Education Available	93% ▲	79% ▲[64]	86%
Correlation Increase in Electricity Access with Reported Improvement in Education			-38% (weak)
% of those reporting improvement in education who attribute it in whole or part to improved electricity access	100%	100%	100%

[61] Low confidence (69%) that difference exists in the population.
[62] Very low confidence (<40%) that difference exists in the population.
[63] In this community pair, all respondent households had children.
[64] Low confidence (60%) that difference exists in the population.

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Impact: Health			
% of HH reporting improvement in Health Care	88% ▲	60% ▲[65]	74%
Correlation Increase in Electricity Access with Reported Improvement in Health Care			-28% (weak)
% reporting improvement in health care who attribute it in whole or part to improved electricity	100%	89%	96%

As might be expected in a programme focussed on supporting disadvantaged and disempowered members of the community, the average household income of Non-Beneficiaries appears to be higher than that of Beneficiaries. Both Beneficiaries and Non-Beneficiaries have seen increases in income since the start of the programme, with the average percentage increase reported by Beneficiaries being higher than that reported by Non-Beneficiaries, but not significantly so. As discussed above, the programme has not affected Beneficiaries' household electricity access and any impact on household income will have been through Beneficiaries' access to energy for irrigation.

Both Beneficiaries and Non-Beneficiaries report improvements in access to education and health care (which it may be presumed have been delivered not only through the effects of the solar irrigation pumping elements of the programme but also through those elements targeted more specifically at electricity for schools and health facilities). While increases in household electricity access have not been assessed for the Beneficiaries, amongst the non-Beneficiaries there are if anything weak negative correlations between improved electricity access and improvements in health care.

[65] Medium confidence (81%) that difference exists in the population.

4. Factors Affecting Provision, Take Up and Use of Electricity for Productive Purposes

This Case Study has investigated the factors that affect the take up and productive use of electricity access in Kenya through the Policy/Regulatory Framework Review, Stakeholder Consultations and field research. The principal factors identified through these three exercises are discussed, and evidence presented regarding the relative importance of the factors, below.

4.1. Policy and Regulatory Factors

Energy policy and regulation can directly assist or hinder provision of electricity access and affect how straightforward it is for potential users to take up access (particularly connection to the main grid). In addition the wider legal and regulatory framework may affect users' ability to make productive use of electricity. Table 31 lists the key enabling and constraining factors identified through the Policy and Regulatory Review and Stakeholder Consultations.

Table 31: Enabling and Constraining Factors: Policy and Regulation

	Enabling Factors	Constraining Factors
Provision of access	Ambitious rural electrification targets, dedicated budget, institutional responsibilities and electricity access programmes are in place	Absence of will to achieve targets (as evidenced by progress to-date). FiT and Net Metering[66] Policies do not facilitate planning nor adequately encourage investment for small-scale and off-grid electricity provision. Policies lack focus on electricity for productive uses.
	The regulatory framework exists for private off-grid electricity provision	The process for securing consents is regarded by small developers as lengthy and unwieldy
	Off-grid electricity providers may charge higher-than-grid tariffs with the regulator's approval	Regulatory approval is often not forthcoming for small mini-grids to charge cost-recovery tariffs
	Quality and safety standards are in place for mini-grid and standalone electricity systems	Lack of provision for mini-grid developers in the event that grid is extended to cover area in which minigrid already established

[66] Net metering arrangements are still under development.

	Enabling Factors	Constraining Factors
Take up and productive use	Provisions exist for subsidisation of electricity access for those in remote areas and low income groups	Lack of equivalent subsidy/cross-subsidy arrangements for off-grid access
	Grid customers may pay connection fees in instalments	Lengthy process for households and enterprises to obtain grid connections

4.2. Non-Policy/Regulatory Factors

Quality/performance of electricity supply

The assessment of the performance of electricity supplies formed a major part of the field research analysis presented in Section 3. Using the SE4ALL Global Tracking Framework, the electricity supply received by each interviewee was assessed in terms of capacity, duration/availability, reliability, quality, affordability and legality. For enterprise respondents the health and safety features and convenience of their electricity supply was also assessed. These assessments have allowed a quasi-quantitative assessment of the attributes that constitute electricity access, and suggest the attributes that most severely constrain the level of access achieved by each household or enterprise.

In the communities studied, the assessed level of access for households appears to be driven almost entirely by capacity, availability and affordability, with many respondents being assessed at either Tier 0 or Tier 1 for more than one of these attributes as shown in Table 32.

Table 32: Number of households assessed at each attribute tier

			Attribute tier					
			0	**1**	**2**	**3**	**4**	**5**
Attribute	**t1**	**Capacity**	2	47	48	4		1
	t2	**Duration/Availability**	33	11	29	9	1	18
	t3	**Reliability**				57		38
	t4	**Quality**			7			54
	t5	**Affordability**		61				34
	t6	**Legality**			3			90

For enterprises, capacity and availability are the dominant drivers of the level of access, with affordability playing a much more minor role. This aligns with expectations given that energy costs typically represent only a small proportion of a small rural enterprise's expenditure. Reliability also emerges as a minor influencing factor.

These assessments indicate that the greatest constraints on the take-up and use of available electricity access are low capacity, poor availability and (for households) high cost.

However, the barriers as indicated by the tier assessment and the barriers/enablers as perceived by users themselves may differ. For example, comments from community members at the focus group held in Machakos (grid extension) suggested that they saw the reliability of the grid-supply as one of the factors supporting economic growth, while those in Mageta Island felt that limitations on the power available from the mini-grid had restricted its productive use. In a consultation interview, the national electricity regulator indicated that some consumers had reported poor service from off-grid mini-grid electricity suppliers, whether due to plant unreliability (fuel supply interruptions, equipment failures) or overloading of the system by users.

Costs and access to finance

As a barrier to electricity access provision in rural areas, stakeholders highlighted the high capital and ongoing running costs which result from the relatively large distances between households in rural areas and the frequent need to engineer off-grid systems that include power storage and/or back-up. Developers saw lack of access to credit and the high rates charged by commercial banks as limiting private sector expansion of electricity access projects/ programmes and also suggested that inability to access finance restricts local communities' involvement in projects and their ability to take up and make productive use of electricity access.

Particularly in the northern parts of Kenya, not only are population densities low but many communities are nomadic. The economic case for supplying electricity access to nomadic people is more challenging when portable solutions are involved, or when benefits can only be realised for a portion of the year.

For users in the communities surveyed, the cost of electricity and productive equipment and access to finance were identified as the most influential factors in their decision to take up and make productive use of available electricity access. Users must have sufficient income and/or access to finance to enable them to pay for connection, electricity and appliances and equipment for productive use if economic benefits from access are to be achieved.

From the users' perspective, those involved in extension of the grid to Kola in Machakos County regarded the low "lifeline" tariff (which applies to the first 50 kWh/month consumption) as one of the main factors in encouraging take up and use of electricity. Conversely, the relatively high cost to end users of mini-grid electricity was identified as the main factor discouraging take-up of access and productive use of electricity from the Access:Energy project on Mageta Island.

Knowledge, skills and capabilities

Interviewed stakeholders noted that local communities are often unable to benefit from the income-generating potential of off-grid electricity systems, because their limited technical and financial capacity restricts their involvement. Operation and maintenance jobs that could be done by local people are sourced elsewhere because the skills do not exist locally.

In addition, a reason for the limited take up of electricity for productive uses suggested by stakeholders is low awareness of potential income generating activities and a lack of training provision alongside electricity access provision that might begin to tackle this. This also ranked high in the factors identified by users as influencing their decisions whether to take up and use electricity access productively.

Access to markets, infrastructure and security

In the absence of access to markets, demand in rural areas is often constrained and unable to absorb additional production, leading to market saturation with new and newly electrified enterprises simply competing with existing and un-electrified firms for the same overall "pool" of value. As an example, those involved in the extension of the grid to Kola in Machakos County saw ready access to markets in the area as a factor in enabling economic use of electricity and a facilitator of benefits achieved by individuals.

The need for infrastructure to support productive use of electricity access was highlighted in the Kenyan context by the cases of the CAFOD Community Solar PV Project, Kajiado, where lack of a proper road network was flagged as a factor constraining uptake and productive use of electricity, and the grid extension to Kola in Machakos Country, where strong communication links were seen as one of the enablers for economic growth from the project. When basic facilities like roads, transport and communication are missing, people may not be able to access electricity nor the technologies needed to make use of it, and enterprises may struggle to obtain the inputs they need (raw materials, information) or reach buyers for their goods or services.

Stakeholders also highlighted the cost and uncertainty associated with transport of fuels and equipment (arising from poor infrastructure and poor security) as a barrier to the provision of electricity access.

Community engagement

For off-grid electricity access programmes community engagement is often a crucial factor for the success or failure of a project. Community engagement may also enable the take up of productive uses of electricity using equipment that individual people or enterprises are not able to afford on their own. For instance, the status of the Solar Transitions Energy Centre in Ikisaya as a community-owned asset, and the

resulting sense of responsibility most local people feel for its success, were seen as key factors in the take-up of services.

However, the need for community-specific engagement for each local project is seen as a barrier to the scale-up of electricity access initiatives by some stakeholders because of the cost and effort involved.

4.3. Relative Importance of Factors

Although the relative importance of the factors so far discussed in this chapter will depend heavily on the context, the research has gathered evidence of which factors were felt to be more influential by stakeholders involved in electricity access provision and by people living and working in communities touched by electricity access programmes.

The main influencing factors identified through stakeholder discussions were costs (both upfront and ongoing) and skills and capacity. The high costs of off-grid electricity access provision were seen as particularly problematic when both providers and users suffer a lack of access to affordable credit.

The factors that household respondents felt were influential with respect to their decision whether to take up improved electricity access were investigated via a series of survey questions. Figure 2 shows the percentage of respondents who reported that a particular factor has, or would, influence their decision whether to take up improved electricity access. This influence may be positive (encouraging the take up of electricity access) or negative (discouraging take up), and can be derived from the presence or absence of factors that may be perceived as “good” or “bad”. The data is weighted such that the opinions of the Beneficiary and Non-Beneficiary household groups have equal impact.

The percentages stating each factor as an influence are high, reflecting the numerous facets of electricity access and the enabling environment that people consider important, and the complexity of the decision.

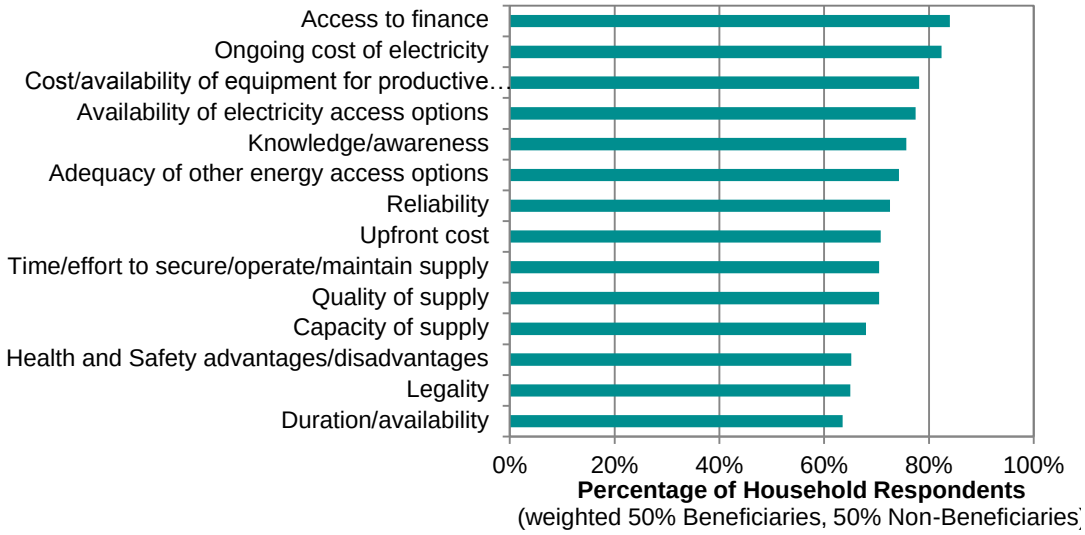


Figure 2: Household Influencing Factors (Taking Up Electricity Access)

Enterprise and productive use respondents were also asked about the factors that influence them to make productive use of electricity access.

Figure 3 shows the percentage of respondents who reported that a particular factor has, or would, influence their decision whether to make productive use of electricity access. The data is weighted such that the opinions of the Beneficiary and Non-Beneficiary enterprise groups have equal impact. Again, the percentages stating each factor as an influence are high.

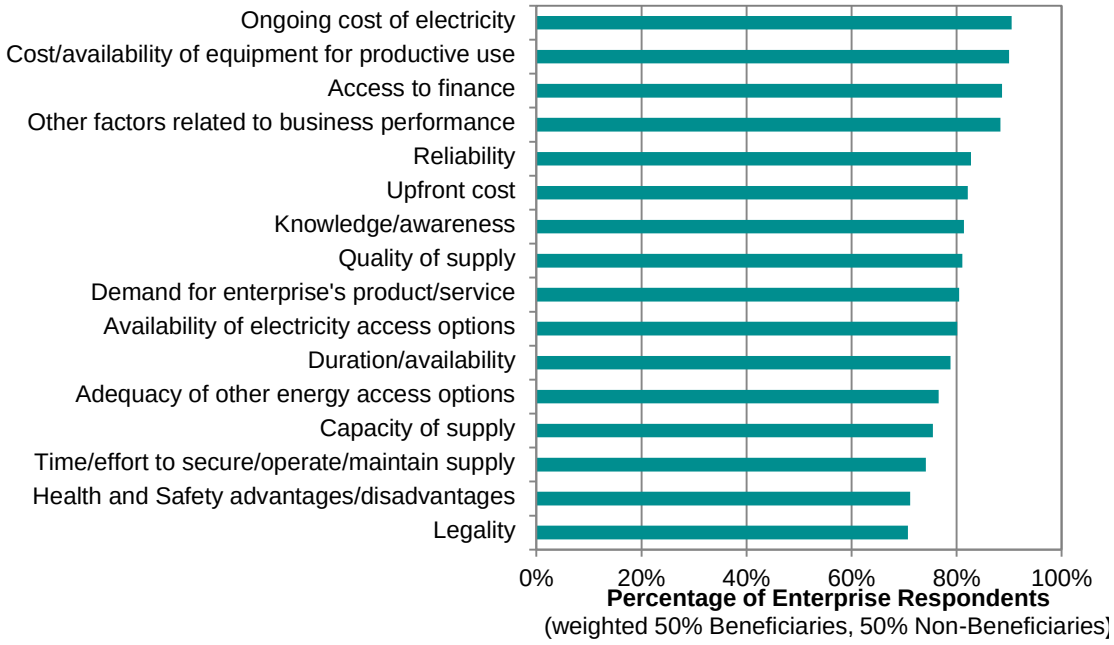


Figure 3: Productive Use Influencing Factors

For both households and enterprises, the top three influencing factors reported are:

- the ongoing cost of electricity
- the cost or availability of equipment needed for the productive use of electricity
- access to finance

Besides the ongoing cost of electricity, the other attributes assessed under the Global Tracking Framework (reliability, convenience, quality, capacity, health and safety, legality and duration) tended to influence household respondents least. Enterprises prioritised reliability, quality and duration slightly more often in their decision-making.

During the community workshops/focus groups, the main influencing factors identified with respect to the take up of improved electricity access were upfront and ongoing cost and capacity (Access:Energy). Although the importance given to cost factors agrees well with the survey responses in the figures above, capacity was not identified through the surveys as being one of the strongest influencing factors.

The focus groups also identified access to markets as a key factor influencing people's ability to make productive use of electricity access. This factor may be placed in a similar category to some of the factors identified as most frequently influential by the survey data: demand for the enterprise's product or service, and other factors needed to grow a business or start a new enterprise.

5. Value for Money

By comparing average through-life costs[67] in terms of $/user/year for each of the programmes (based on data provided by the programme developers, supplemented, where necessary by generic data) with the average level of access[68] they achieve, it is possible to arrive at some broad observations regarding the relative value for money provided by the various means of electricity provision.

Data provided by the programme developers supplemented with generic data was used to calculate the costs of providing electricity access under each of the programmes studied. The capital costs of the equipment (generating plant[69], distribution system, solar equipment etc.) and the costs of implementing the programme were brought together with operating and maintenance costs, fuel costs and administration costs, using a 15% discount rate, to derive an average annual cost of electricity provision per user for each programme. (These are costs of providing electricity and not the prices charged to users. They do not include costs, such as wiring or appliance costs[70], which will be incurred by end-users if electricity supply is to be transformed into electricity services.)

It should be noted that the costs derived may not be directly comparable or necessarily representative of the costs of the various forms of electricity provision in a wider context because:

- Programme development and ongoing overhead/administration costs, and the impact these have on average through life cost per user, will be very much affected by the scale at which the programme has been implemented.

- Mini-grid and grid extension costs in particular (but also costs of other forms of electricity) are highly location specific, being affected by geography (distance from the existing grid system), local topography, availability of primary energy resources for generation, size and population density of the community served. Thus it is highly unlikely that, for instance, the costs of a mini-grid installed in one location would align with those in another location.

- The electricity access levels also represent a combination of household and productive use tiers – which are not strictly comparable, as demonstrated by the solar pumping systems provided by the CAFOD programme in Kajiado,

[67] Costs are in 2014 terms.

[68] Arrived at by simple averaging of the average household and average productive use access level reported by programme beneficiaries

[69] For the Machakos grid extension programme, the cost of the grid extension itself was combined with average costs for generating plant, fuel and other operating and maintenance costs and administration derived from figures published by Kenya Power.

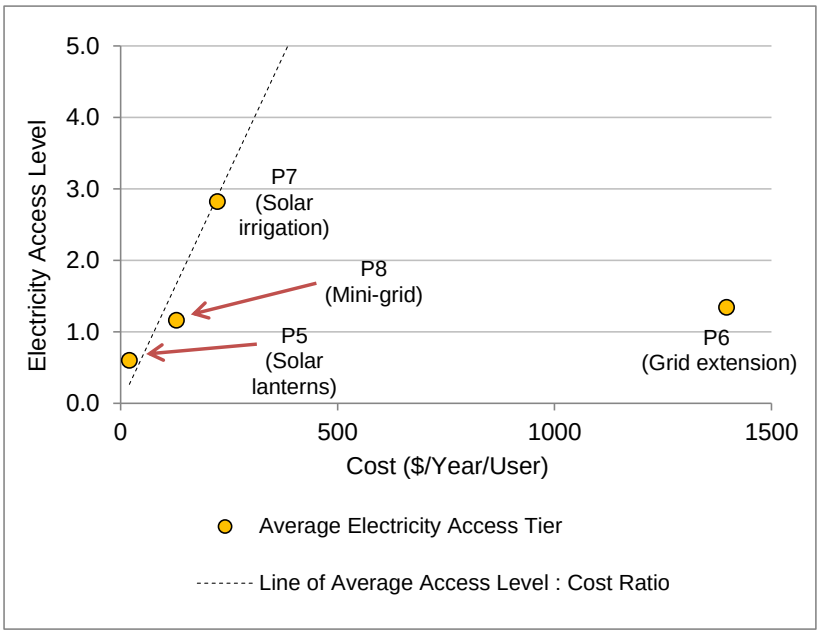
[70] With the exception of solar lanterns where the end-use appliance is not divisible from the means of provision.

which provide a relatively high level of access to electricity for motive power, but none other productive or other household uses.

Despite these limitations, by looking at how the resulting electricity access levels and impact on beneficiaries' household income compared with the cost of provision, some inferences could be drawn regarding the relative value for money provided by the alternative means of provision.

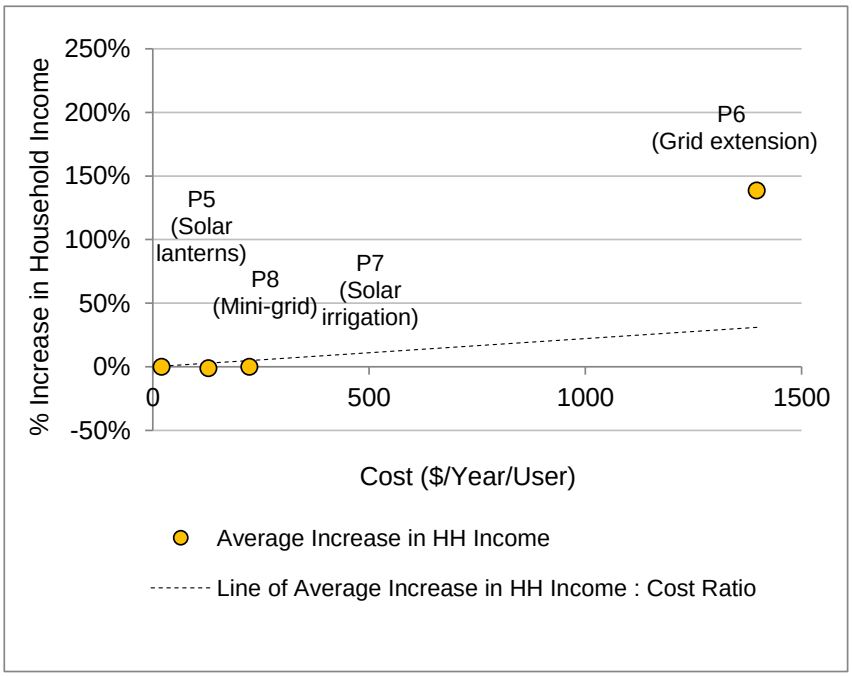
An initial observation (see Figure 4 below) is that while the grid extension programme achieves a higher level of access than either the solar lantern or mini-grid, (and a wider range of electricity applications than the solar irrigation programme) it is also substantially more costly, lying well below the line of average access level to cost ratio. The other three programmes all lie close to the average electricity access level to cost ratio line, indicating that they provide similar value for money in terms of electricity access level provided.

Figure 4: Average Electricity Access Level vs Cost (including Grid Extension Programme)



However, recognizing that electricity access is not an end in itself, but a means to enable poverty reduction, the costs of the various programmes have also been plotted against the average percentage increase in beneficiary household incomes:

Figure 5: Average Increase in Household Income vs Cost (including Grid Extension Programme)



Again the grid extension programme is an outlier, being the only programme in Kenya for which any significant increase in household income was seen, though at a significantly higher cost than the other programmes – and in these terms appears to have delivered the greatest value for money.

In light of the indications from the other elements of the research that the poverty impact of electricity access is dependent not only on the level of access but also on the social and economic context in which it is provided, great caution should be taken in drawing any general conclusions about the relative value of different forms of electricity provision from these specific cases – what provides the greatest value for money in one context may give very different results in another context.

6. Conclusions & Recommendations

6.1. Electricity Access Context

Access to and consumption of modern energy in Kenya is still very low. Kenya's per capita electricity consumption is less than a tenth of the global average and the number of Kenyans without access to electricity in 2011 was 34 million (IEA, 2013).

However, significant progress has been and continues to be made; the overall number of electrical connections has risen more than seven-fold since 1990. There is a stark discrepancy between urban and rural connection rates, although the gap is closing as the pace of Kenya's rural electrification accelerates. Nevertheless, the rate of expansion – and the addition of generation capacity that needs to accompany it - is still far below that which is needed in order to achieve the national utility's target of 40% rural grid penetration by 2020. Even at present, instances of demand exceeding supply cause frequent blackouts and necessitate scheduled power outages.

The Government of Kenya provides substantial subsidisation to domestic grid electricity consumers, but this subsidy is not well-targeted towards the poor it is intended to benefit. The process of applying for and receiving a new grid electricity connection can be lengthy and excessively bureaucratic for both households and enterprises.

The Kenyan government has recognised that off-grid electrification will be necessary in those areas that are remote from the grid or with dispersed or nomadic populations. Users of Kenya's 15 publicly-owned mini-grids (15MW capacity) are charged the same tariffs as grid electricity consumers. Privately owned mini-grids may with the approval of the regulator set their own tariffs, but small-scale electricity providers are often prevented from charging tariffs that allow full cost recovery. Private mini-grids are further hampered by the often-unwieldy permitting and licensing procedure mandated by the regulatory bodies.

All mini-grid and standalone renewable systems equipment is VAT and import duty-exempted. Minimum performance standards have been set for standalone Solar Home Systems. A Feed in Tariff policy is in place, but lacks provisions to facilitate planning and investment in off-grid renewable electricity and the 20 US¢/kWh tariff that applies to off-grid solar is not high enough to stimulate rapid uptake.

The setting of a grid tariff that is uniform across the country means that urban consumers effectively "cross-subsidise" rural grid consumers. There is no mechanism for cross-subsidisation of off-grid electricity supply, meaning that off-grid appears relatively much more expensive in rural areas with consequences in terms of attracting business activity.

A final disincentive to mini-grid development is found in the lack of regulatory provision for the protection or compensation of mini-grid developers/operators in the event that the national grid is extended to the area where a mini-grid has been developed.

6.2. Impacts of Electricity Access in Case Study Communities

The field research undertaken as part of this case study has allowed the direct examination of relationships between level of electricity access, productive use and poverty impacts, using primary data derived from surveys of households and enterprises in communities included in four electricity access programmes.

Creation of Enterprises – No significant difference was observed in the rate of enterprise creation between beneficiary and non-beneficiary communities, although the sample size under consideration is very small.

Employment and Time Use – Overall, the employment rate was broadly the same for both beneficiary and non-beneficiary groups. However, non-beneficiaries saw an increase since programme implementation in the number of respondents who were employed three times that seen by beneficiaries, with the large increase in employment among female non-beneficiaries accounting for much of the difference. This finding is contrary to what would be expected if household access to electricity enabled increased take up of employment though shifts in time use (particularly affecting women's time budgets). Nevertheless, feedback from the communities involved in three of the case study programmes (the Machakos grid extension, the Access:Energy Mini-grid and the Solar Transitions Centre), identified increased working hours and longer operating hours for small businesses as important impacts of electrification.

Correlations between the changes in the number of people employed by each enterprise and the changes in electricity access tier experienced by those enterprises ranged from moderately positive (Solar Transitions Centre) to moderately negative (Machakos grid extension).

Enterprise Revenue and Profit – Considering all four community pairs, the surveyed beneficiary enterprises enjoyed revenues that were on average more than twice those of non-beneficiary enterprises (driven largely by the six-fold difference observed in the case of the Machakos grid extension) but overall average increases in revenues were not significantly different. Beneficiary enterprise average profits were 22% higher than those of non-beneficiaries amongst those enterprises surveyed, but again the average increases in profits were broadly similar.

Within each community pair, correlations between the level of electricity access and revenues or profits were normally weak or negligible. Occasional moderate correlations were observed, sometimes in the direction expected (revenue and access tier for Machakos grid extension) and sometimes counter to expectations (changes in profit and revenue vs. change in access tier for both Machakos grid extension and the Access:Energy mini-grid). The inconsistency of both the positive and negative correlations suggests that many other factors are at play beyond simply the level of electricity access.

Poverty Impacts – The difference in average household income between beneficiary and non-beneficiary groups was not consistent across the programmes studied. In Machakos (grid extension), beneficiary households had incomes more than six times greater than non-beneficiaries. A significant difference also existed

among the households under the Solar Transitions Energy Centre, but for the two mini-grid programmes non-beneficiary households had considerably higher incomes. For the Machakos grid extension, beneficiaries had experienced considerably greater increases in household income than non-beneficiaries; however, for the other three programmes there was negligible difference. No correlations were found between the (change in) level of electricity access and the (change in) household incomes.

In every community pair, the beneficiary households with children were more likely to report that there had been an improvement in the education available to them. Almost all respondents attributed this in whole or in part to improved electricity access.

For healthcare, the results were not so clear; sometimes non-beneficiary households were more likely to report improvements than beneficiaries and the degree to which each group attributed the improvements to electricity access was variable.

Overall, the research has not revealed a consistent relationship between levels of electricity access and its impacts in terms of either productive activity or poverty reduction. In certain instances convincing patterns have emerged to support the assertion that improved electricity access can lead to enhanced levels of productive activity, although the subsequent link to poverty reduction is more difficult to observe. However, examination of other impact indicators has often discerned no relationship or found influence in the opposite direction to that anticipated.

6.3. Enabling/Constraining Factors

The main influencing factors identified through stakeholder discussions were uprfront costs (linked to access to credit), ongoing costs and skills/ capacity. Upfront costs, ongoing costs and access to finance were also the top three influencing factors amongst the households and enterprises surveyed and consulted during focus group sessions.

High upfront costs for off-grid electricity access provision often relate to the relatively large distances between households in rural areas and the frequent need to engineer off-grid systems that include power storage and/or back-up. From the evidence of the programmes examined in this case study, it would appear that lower level, off-grid, electricity access solutions provide the greater value for money in terms of the access tier achieved but that grid extension may offer the best value for money in terms of an increase in beneficiary household incomes.

The same factors are also responsible for high operating costs for off-grid systems. Coupled with the need for investors to recover the upfront costs, the tariffs that developers may wish to charge can be prohibitively high for end users (and may not be acceptable to the Kenyan electricity regulator). Off-grid supplies in rural areas do not receive the same financial support through cross-subsidisation as grid supplies. Costs can therefore be a barrier to electricity access provision and the take up and productive use of electricity access.

Besides the ongoing cost of electricity, stakeholders highlighted poor reliability as a barrier to the take up and use of electricity. The other attributes assessed under the Global Tracking Framework (convenience, quality, capacity, health and safety, legality and duration) drew less attention from both the stakeholders and the households/enterprises interviewed, even though capacity and duration were the attributes that most frequently limited the electricity access tier of the households and enterprises assessed in the field research.

6.4. Recommendations for Policy Makers and Programme Developers

To improve the enabling environment for electricity access and its productive use in Kenya, it is suggested that policymakers:

- Develop policies which prioritise electricity for productive use alongside basic electricity access for households;
- Establish detailed provisions to facilitate planning and encourage investment in off-grid areas within the existing Feed-in Tariff policy;
- Ensure that mini-grid developers and operators are able to charge cost-recovery tariffs which reflect the genuine costs of provision in small communities and remote areas;
- Seek to equalise support and subsidy arrangements between grid and off-grid electricity access (recognising the cross-subsidies inherent in grid systems);
- Develop streamlined, light-touch, regulatory regimes to minimize obstacles to small-scale mini-grid development;
- Establish regulatory provision to deal with the position of any previously established mini-grids within an area into which the national grid is extended;
- Develop “standard” models for community engagement which could be adopted by project developers;
- Make efforts to speed up and simplify the process for users to secure connection to the grid;
- Link policies and plans for electricity access with policies aimed at overcoming other barriers faced by rural communities in relation to access to markets, poor infrastructure, resource supply and inadequate skills.

To increase the poverty impact of electricity access, it is suggested that programme developers seek to:

- Incorporate provision for productive use in programmes alongside basic electricity access for households;
- Consider the productive use opportunities available to communities and tailor electricity access provided to meet those productive needs;
- Link electricity provision with wider development efforts to tackle the barriers to enterprise development that would otherwise constrain its productive use and hinder poverty reduction - poor infrastructure, inaccessible markets, skills shortages and lack of access to finance;
- In the context of grid extension, installing or retro-fitting separate feeders for agricultural and non-agricultural users (as practiced in India) might bring benefits.

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APPENDIX 1: Electricity Legislation, Policies and Programmes

Energy Act, 2006

The Government of Kenya established the Rural Electrification Authority (REA) under section 66 of the Energy Act, No.12 of 2006 to accelerate the pace of rural electrification in the country. The objective was to streamline the implementation of the rural electrification programme so as to facilitate the achievement of national development goals. To achieve this objective, the Authority has the mandate of extending electrification services to rural areas, developing rural electrification master plans, managing the rural electrification programme fund, mobilising resources for rural electrification and promoting the development and use of renewable energy. The mandate includes but is not limited to small hydro, wind, solar, biomass, geothermal, hybrid systems and oil fired components, taking into account the specific needs of certain areas including the potential for using electricity for irrigation and in support of off-farm income generating activities. In addition, GoK targets to achieve 100% connectivity by 2020.

The Energy Act 2006 Part III Section 79 empowered the Minister responsible for Energy to establish a fund to be known as the Rural Electrification Programme Fund to support the electrification of rural areas and other areas considered economically unviable for electrification by licensees.

The Energy Act 2006 Part V Section 103 on 'Promotion of Renewable Energy and Energy Conservation' empowers the Minister to promote the development and use of renewable energy technologies. This includes promoting the utilisation of renewable energy sources for either power generation or transportation, and promoting co-generation of electric power by sugar millers and the sale of such electric power through the national grid directly to consumers.

Energy Bill, 2014

The Energy Bill, 2014 is a bill integrating the Energy Policy set out in Sessional Paper No. 4 of 2004, The Energy Act No. 12 of 2006, the Geothermal Resources Act No. 12 of 1986 and the Petroleum (Exploration and Production) Act, Cap 308 into one, which will exclusively define the role of the National and County governments and its supremacy, besides the consolidation of relevant government agencies under the Energy Bill, 2014.

The Energy Bill, which is in its final stages of review, devotes two of its several objectives to (i) access to energy services and supply, and (ii) secure and reliable supply of energy. The Bill mandates the Cabinet Secretary to develop national energy plans in respect of fossil fuels, renewable energy and electricity which shall be published every three years.

The Energy Bill contains several statements of commitment regarding increasing energy access. Section 8 of the Energy Bill states that the government shall endeavour to facilitate the provision of affordable energy services to all people in all

areas. Section 9 requires that the government shall take such measures as may be necessary to provide for basic domestic energy needs by making available affordable energy services to all areas of the country which have no access or limited access to modern and commercial energy services. Section 10 states that in its effort to provide energy services in all areas in accordance with section 8, the government shall adopt measures that provide for access to appropriate forms of energy or energy services for all the people of Kenya at affordable prices.

Under section 3.13.2, the Bill proposes to establish an inter-ministerial Renewable Energy Resources Advisory Committee (RERAC) composed of members representing ministries in charge of energy, finance, environment and natural resources, the National Electrification and Renewable Energy Authority (NERA), the Attorney General (AG), the National Electricity Regulatory Commission (NERC), the GDC, KenGen and the relevant County Governments to advise the Cabinet Secretary on criteria for the allocation of renewable energy licenses, the management of multi-purpose projects such as dams and reservoirs for power generation and the management of energy resource areas, such as regions with good wind, hydro, tidal and wave energy potential.

Under the same section, the Bill further proposes to transform the Rural Electrification Authority into the National Electrification and Renewable Energy Authority (NERA) to be the lead agency for development of renewable energy resources other than geothermal and large hydro. This transformation is supposed to be done by 2018. NERA shall be the “one stop shop” for information and guidance to investors on renewable energy projects. Revitalise the existing MoE&P Energy Centres and establish others to cover all 47 counties with a view to promote renewable energy use.

Still under the same section the Bill proposes to develop a tariff for net-metering for electricity generated from renewable energy sources by electricity consumers. This is foreseen to complement the Feed-in-tariff policy and attract more private sector investments into electricity generation.

Least Cost Power Development Plan (LCPDP)

The Least Cost Power Development Plan (LCPDP) for the period 2013–2033 was updated, and thereafter the medium term committed projects were aligned with the plan to commission an additional 5,000MW generation capacity by 2017. The Plan seeks to ensure development of a diversified portfolio of power generation assets that is expected to shift over time from high dependency on increasingly unpredictable hydropower and fuel price-sensitive thermal options, to greener, cheaper, more dependable and sustainable sources such as geothermal and firm regional hydropower imports. Subsequently, the new capacity will be developed by KenGen, GDC, and Independent Power Producers (IPPs) mainly from sources such as geothermal (646MW), natural gas (1,050MW), wind (630MW), and coal (1,920MW).

Vision 2030

This development blueprint identifies the development projects proposed will increase demand on the country's energy supply. It stipulates that Kenya must generate more energy at lower cost and increase efficiency in energy consumption. It further states that the government is committed to continued institutional reforms in the energy sector, including a strong regulatory framework, encouraging more private generators of power and separating generation from distribution. New sources of energy will be found through exploitation of geothermal power, coal, renewable energy sources and connecting Kenya to energy surplus countries in the region. This will go a long way to reducing the cost of electricity in the country to make it more competitive regionally.

Rural Electrification Master Plan

The Rural Electrification Master Plan offers a longer-term vision for rural electricity access and considers both on- and off-grid electrification as the means to achieve the 100% connectivity target. To meet the increased electricity demand due to new connections and enhanced economic activities in rural areas, various generation sources have been considered for further exploitation. The Master Plan suggests targets of 5,110MW from geothermal, 1,039MW from hydro, 2,036MW from wind, 3,615MW from thermal, 2,000MW from imports, 2,420MW from coal and 3,000MW from other sources. The investments required for generation, transmission and distribution to meet this demand will be enormous.

EAC Strategy to Scale Up Access to Modern Energy Services

The East African Community (EAC) Strategy, developed with the aim of enabling the Partner States (Kenya, Uganda, Tanzania, Rwanda and Burundi) to achieve the Millennium Development Goals (MDGs) and poverty reduction, has four targets of which two concern electricity access. Target 2 aims to provide access to reliable electricity to approximately 7.4 million households in Kenya's urban and peri-urban areas, with particular attention given to the poor. Target 3 aims to provide access to electricity for all schools, clinics, hospitals, and community centres. The Strategy was adopted in 2006.

A Country Baseline Report and Work Plan was developed for Kenya. A total of US$ 3.3 million was required to implement the short term plan. Capacity building and review of the existing policy and regulatory framework were key thrusts of the plan, which also specified:

- Mainstreaming the East Africa Community Energy Access Scale-Up Programme (EAC-EASUP) into national development strategies
- A detailed update of energy access data
- Identification and development of innovative business models and pilot-testing these models, as well as implementing at least one pilot project under each target.

- Supply chain development efforts; targeted market awareness campaigns; needs assessments; training of service providers; and training community groups – all with particular emphasis on off-grid energy access.

Scale-Up Renewable Energy (SREP) Programme Investment Plan

This multilateral assistance programme proposes the development of solar, wind, hydro, biomass, geothermal and transmission line projects. The hybrid mini-grid component of the plan proposes to increase the proportion of renewable energy (solar and wind) in existing and planned mini-grids to 30%. The government has initiated the incorporation of solar PV and wind systems into existing off-grid diesel-based power plants in arid and semi-arid areas to reduce consumption of fossil fuels. SREP funds are being used to enhance on-going and planned hybrid projects. The government intends to construct 27 additional isolated mini-grids with an installed capacity of 13 MW; it is proposed that renewable energy be incorporated into these systems (hybridisation) once they have been constructed. The private sector will be invited to participate in the hybrid projects under the Feed-in Tariff mechanism so as to complement government efforts in the programme.

It is estimated that about 1,000 MW of small hydro is economically viable for exploitation in Kenya. To this end, feasibility studies for various sites across the country have been completed and 12 sites identified. SREP-funded interventions would lead to the development of these 12 small hydro project sites with a capability to generate approximately 22 MW. Another feasibility study is on-going for a further 14 sites.

To further promote exploitation of the vast geothermal resource potential in the country, government and SREP funding will be utilised for drilling appraisal and production wells and power evacuation.

National Energy Policy, Final Draft, 24 February 2014

The overall objective of the energy policy is to ensure affordable, competitive, sustainable and reliable supplies of energy to meet national and county development needs at least cost while protecting and conserving the environment.

The policy proposes to use the most affordable, competitive, reliable and easily accessible sources of energy, especially for electricity generation. More coal exploration is going on in other parts of the country and is expected to provide about 1,900 MW of electricity generation by 2016 and 4,500 MW by 2030.

To enhance exploitation of the vast geothermal resources that Kenya is endowed with, the policy states that the government will continue to fund the Geothermal Development Company (GDC) so as to manage the geothermal exploration risk and attract investors. Further, the government will encourage investment in the geothermal sub-sector so as to achieve at least 1,900 MW of geothermal electric power generation by 2016 and 5,500 MW by 2030, and enhance direct uses of the resource.

In order to provide affordable and competitive electrical energy to transform the Kenyan economy, a roadmap to raise the generation capacity by at least 5,000 MW from the then 1,664 MW (now 1,765 MW) to slightly over 6,700 MW by 2016 is proposed. Through this roadmap the generation cost is projected to reduce from US¢ 11.30 to 7.41, while the indicative end-user tariffs are projected to reduce from US¢ 14.14 to 9 for commercial/industrial customers and from US¢ 19.78 to 10.45 for domestic customers.

Sessional Paper No. 4 of 2004

The government recognises that renewable energy sources have potential to generate income and employment, over and above contributing to the electricity supply and diversification of generation sources. The National Energy Policy as enunciated in Sessional Paper No.4 of 2004 and operationalised by the Energy Act No. 12 of 2006 encourages implementation of these indigenous renewable energy sources to enhance the country's electricity supply capacity. The Sessional Paper incorporates strategies to promote the contribution of the renewable energy sources in generation of electricity.

Section 103 on 'Promotion of Renewable Energy and Energy Conservation' empowers the Minister responsible for Energy to promote the development and use of renewable energy technologies. Section 6.3.2 states that the government is committed to promote cogeneration in the sugar industry and other establishments where the opportunity exists to meet a target of 200 MW by 2015. Section 6.4.1 (i - iv) requires the government to undertake pre-feasibility and feasibility studies on the potential for renewable energy sources and for the packaging and dissemination of information on renewable energy sources to create investor and consumer awareness on the economic potential offered by other renewable sources of energy.

APPENDIX 2: Donor-led Rural Electrification Programmes

World Bank Group

The Government of Kenya has sought World Bank assistance for rural electrification under the proposed Kenya Electricity Modernization Project (KEMP). It is intended that KEMP will include an *Off-grid Electrification Component* that will support greenfield mini-grid investments to be undertaken by the private sector in partnership with the public sector. The mini-grids are likely to serve communities where there are public sector facilities, businesses and industrial loads as well as households. Mini-grids will typically include between 200 and 3,000 connections with the majority of the customers being households.

In addition to the above project, Government of Kenya has received US$ 18 million from the World Bank for the development of off-grid hybrid power stations with mini-grid networks in rural Kenya. These funds will be channelled through the Kenya Electricity Expansion Project (KEEP) which is itself jointly funded by the International Development Association (IDA, World Bank Group) and the Scaling-up Renewable Energy Programme[71] (SREP). The funds will go towards promotion and use of renewable energy technologies for off-grid power supply and the design and construction of hybrid mini-grid systems in the country.

The Investment Climate Advisory Services of the World Bank Group is implementing the Africa Investment Climate Project (Africa IC Power Project) in Sub-Saharan Africa. The Africa IC Power Project is focused on:

- ensuring that private sector principles are embedded in energy and electricity policy;
- addressing information and regulatory barriers to private entry or participation in the power sector; and
- developing fiscal and non-fiscal incentives to increase energy access and promote renewable energy generation.

To this end, IFC is supporting Kenya's REA and ERC to identify opportunities for commercially sustainable mini-grids, estimate the level and structure of any required financial support, and identify key legal and regulatory requirements for private participation in the sector. The overall scope of work of the Project will include four components:.

1. Barriers assessment
2. Nationwide market analysis
3. Evaluation of financial support structure
4. Identification of policy barriers and drafting of off-grid policy/regulations

[71] SREP is funded through the Climate Investment Funds (CIF)

German International Cooperation (GIZ)

GIZ is implementing a Results Based Financing (RBF) programme that targets market creation for private sector-operated mini-grids. The programme aims to facilitate access to power for off-grid communities through payment of incentives to private sector developers. Funded by DFID, the RBF funding is intended to reduce or mitigate commercial market failures by providing financial incentives ex-post to private sector developers to overcome typical, but temporary, market development risks. GIZ's RBF component explicitly targets small mini-grids with up to 50kWp installed capacity. It aims to entice the first private sector investments in mini-grids in Kenya.

French Development Agency (AFD)

AFD is heavily involved in the financing of rural electrification in Kenya. Phase I of the financing programme delivered €10 million for rural electrification in western Kenya. Phase II of the project saw electrification in six other provinces at a cost of €30 million. This credit line, which was channelled through Kenya's Co-operative Bank, was intended to promote private investment in renewable energy and energy efficiency.

The Agency is also supporting institutional reforms undertaken by the government in the rural electrification space. AFD intends to set up a revolving fund of €40 million to be accessed by Kenya Power, with a portion of the loan to be advanced to consumers to facilitate their connection to the grid. Moreover, the project will support the financing of the provision and distribution of efficient light bulbs to limit the impact of new connections, and the installation of 1,000 substations distribution at medium / low voltage. AFD is also involved in the financing of geothermal development in the country. AFD has granted a sovereign loan of €50 million to the Kenyan government to improve the security of electricity supply in Nairobi thus promoting the city's social and economic development.

Moreover, AFD is working with DfID to help improve rural access to electricity in Kenya through the promotion of investments in green mini-grids involving the private sector. This technical cooperation programme aims to encourage these investments by undertaking further analysis in support of green mini-grid feasibility, incentives, implementation arrangements and financing schemes. Design of the logical framework of this technical cooperation programme in terms of specific objectives, activities to be implemented and monitoring tools is anticipated to take six months. This will then be followed by implementation of mini-grid projects in the identified areas.

The Dutch Ministry of Foreign Affairs

The Dutch government, through its Ministry of Foreign Affairs and in collaboration with ETC/Enclude, is implementing a 'Sustainable Energy Services Africa' (SESA) programme in five African countries. The SESA programme aims to contribute to the development of markets for community- and household-level sustainable off-grid energy products in rural and peri-urban areas, with a focus on the poor (i.e. households with annual incomes in the range of US$1,000 – 1,500). This initiative is

a public private partnership between the Ministry of Foreign Affairs and Philips BV. It has three components (consumer lighting, community lighting and cookstoves) and aims to stimulate market development of affordable, appropriate and sustainable off-grid energy services. It aims to provide access to modern energy to 250,000 people by 2015. All three components are to be implemented in Kenya.

The community lighting component focuses on light and power generating centres developed by Philips. A Philips 'Light Centre' is a 1,000 square metre area lit by four poles, each 8 meters high, using solar LED technology. These centres enable life in off-grid areas in the evening, and provide room for community activities. The poles have been placed near schools, market places, other community buildings or areas, which are central to the local community. Hotpoint was contracted and has already installed three community lighting centres in Kiambu, Nairobi and Kisumu Counties. The power is delivered to a local community at a local kiosk/container through a solar system. From this kiosk/container, a portfolio of sustainable energy services are provided.

The German Development Cooperation

Through KfW (Financial Cooperation) and GIZ (Technical Cooperation), German Development Cooperation intends to assist the Government of Kenya in promoting the development of new medium-sized hybrid mini-grids (PV/Wind-Diesel). The delivery will focus on nascent small and medium-sized growth centres with an expected load of up to 1MW. In addition to this, they will provide institutional support to the REA, MoE&P and ERC. Moreover, technical assistance will be made available to explore the viability of private sector engagement in rural electrification. This project will be supported by the German Development Cooperation as part of the German Climate Technology Initiative (DKTI). The main objective of the project is to contribute to cost-effective, reliable and sustainable power supply in rural growth centres thus fostering efficient and sustainable use of power. The project design will determine the technical, financial and economic viability of the proposed hybrid mini-grid schemes, including an assessment of alternative delivery and management models.

Department for International Development (DfID)

A study conducted by Innovation Energie Développement (IED) for DfID aimed to identify the gaps in knowledge and to build the evidence base on low carbon mini-grids. Although the study focused on Africa, the fieldwork was carried out in Kenya and Mozambique. The study forms a preliminary part of a DfID initiative to promote Green Mini-Grids (GMG) in Africa through the International Climate Fund (ICF), with the study's objectives being to provide guidance and recommendations for DfID intervention and programme implementation.

The UK will provide support totalling £75 million from the International Climate Fund (ICF), of which £60m will support project preparation and leverage private investment in Green Mini-Grids (GMGs) in Kenya and Tanzania. The remaining £15m will support a regional facility for market preparation, evidence and policy development, and prepare for wider scale-up of GMGs across Africa. Funding will commence in 2014 and run until 2019.

United States Agency for International Development (USAID)

Through the Power Africa Programme, USAID is supporting the development of the energy sector through financing, grants, technical assistance, and investment promotion. Power Africa is working to mobilise over US$1 billion in private investment for electricity to accelerate geothermal and wind projects. Additionally, Power Africa is providing technical experts to identify the least expensive and most effective ways to better integrate clean renewables into Kenya's energy mix. Through feasibility studies and pilot projects, Power Africa is also helping to advance major infrastructure investments and is demonstrating the effectiveness of U.S. technological solutions.