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Scaling up by cutting down?

A study of a solar power pilot project
and the attempts of going from pilot to scale in rural Kenya

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Summary

Solar power is increasingly being used to electrify off-grid areas in developing countries. The implementation typically starts with a pilot project, but often these never make it to the up-scaling phase. This master thesis is studying the research project “Solar Transitions” model for implementing solar power in the Kenyan village Ikisaya, and thereafter the attempts to up-scale or replicate this model to selected villages in Turkana county. I follow the projects' process of developing a model for solar power supply in four steps, or *translations*. First, I look at where the model came from, thereafter I study the model in the Kenyan village Ikisaya, to understand what factors were important for the model to work here, and how it continues to develop after implementation. Finally, the attempts to up-scale the model in Turkana county are studied, to see what happened to the initial model in this process and the impacts this has on how the model works. The purpose is to understand what actually happens when technology travels, and what makes it work in the different contexts. An important finding in this study is that what makes the Ikisaya model work is not easily transferable to the up-scaling phase and that care and follow up is important not only in the pilot phase but also in the up-scaling process.

The empirical data for the thesis was primarily gathered during six of field work in Kenya autumn 2013.

Theoretically this thesis is inspired by Science and Technology Studies (STS), and uses a framework consisting of the concepts script, flexibility, care and translation as analytical tools.

Acknowledgements

So this is it.

It has been a bumpy ride, but I have learned a lot along the way. Six weeks of fieldwork in Kenya gave me insights and an experiences for life that go beyond the research topic. I'm grateful I got the chance.

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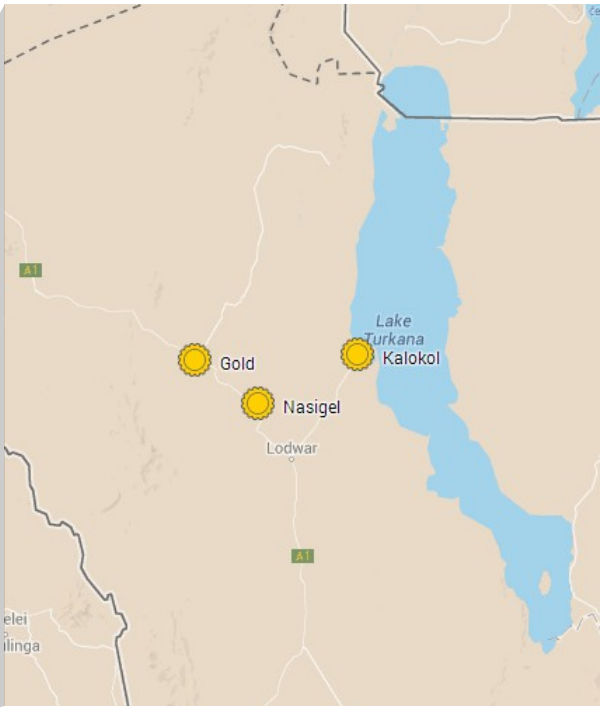
Abbreviations and acronyms

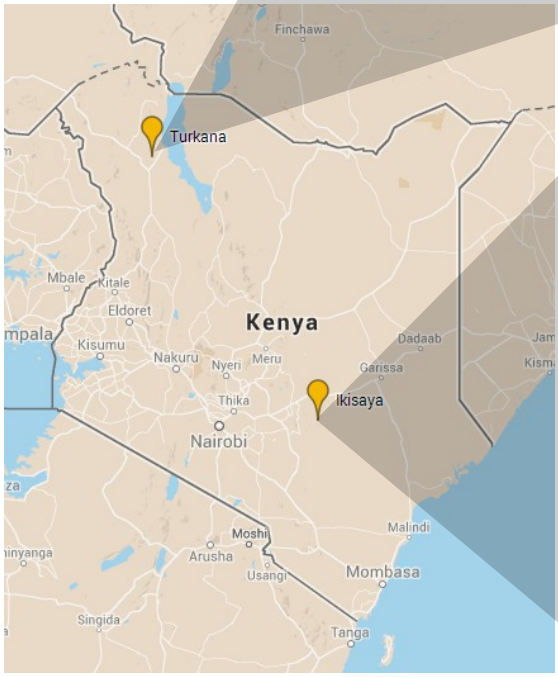
ANT	Actor-Network Theory
CBO	Community Based Organisation
IEC	Ikisaya Energy Centre
IEG	Ikisaya Energy Group
NGO	Non Governmental Organisation
PV	Photovoltaic
R&D	Research and Development
SERC	Strathmore Energy Research Centre
ST	Solar Transitions
SHS	Solar Home Systems
STS	Science and Technology Studies
UNFCCC	United Nations Framework Convention on Climate Change
WBREDA	West Bengal Renewable Energy Development Agency

Maps

Source: Wikimedia Commons. Scale: 1:100 mill.



Source: Google Maps Engine. Scale: 1:2 mill.



Source: Google Maps Engine. Scale: 1:12.5 mill.

Source: Google Maps Engine. Scale: 1:300 000

1 Introduction

Access to clean energy is crucial for global development. Some 1.3 billion people have no access to electricity. Innovation and technological change are often held to be part of the solution to both environment, energy and development challenges in the south (UNIDO, 2013). Transfer of technology and knowledge is also a key pillar of the international response to global climate change and development, as acknowledged in the United Nations Framework Convention on Climate Change in 1992[1]. The development, transfer and application of technology has been one of a few main topics in all major agreements since, resulting among other things in a yet-to-be implemented technology mechanism that is supposed to enhance and facilitate technology transfer between the north and the south.

The long trail of white elephants[2], in the history of aid, a term used to describe failed technology investments (Rockstroh, 2007, p. 5) shows that technology transfer is not an easy straightforward process of moving an artefact from A to B. This is now recognized by actors like the United Nations, governments, organizations and companies (NORAD, 2012; UNEP, 2003). The demands for technology transfer are higher than ever, with an ever increasing focus on implementing renewable energy technologies both in the global north and the south. Still, no matter how much you try to succeed, failure and breakdown might be unavoidable. Reports concerning the topic tend to be focused on questions related to Intellectual Property Rights (IPRS), the role of investments and R&D from both public and private sector (Bennet, 2002; UN-DESA, 2008). These are of course important framework conditions, but the devil is often in the details. To understand why a new technology works in a new context or not, one must pay attention to what happens on the ground, how the users interact with the new artefact, and the relationship between these micro and macro-factors.

Technology transfer is also about scale. Testing of new technologies or trying them out in a new context typically starts with a pilot project. But what happens with the knowledge gained from the pilot? Often pilot projects become isolated experiences that fail to develop into

1 http://unfccc.int/resource/docs/convkp/conveng.pdf. Especially article. 4.
2 A white elephant is an idiom for a valuable possession of which its owner cannot dispose and whose cost (particularly cost of upkeep) is out of proportion to its usefulness or worth. http://www.princeton.edu/~achaney/tmve/wiki100k/docs/White_elephant.html. Read June 9th 2014.

something more (Romijn et al., 2010; Simmons et al., 2007).

The relationship between technology transfer and up-scaling and why it is so challenging to achieve is thus an interesting and highly relevant topic. I have therefore decided to study a project working with implementing solar power in different contexts, by following the activities of the international and interdisciplinary research project “Solar Transitions”, lead by the Department of Sociology and Human Geography at the University of Oslo. This project implemented a solar energy centre in the village Ikisaya in Eastern Kenya in 2012, based on experiences with solar power on village level in India. The goal of the project is to find suitable models for solar power supply in off grid villages, that are viable in the long run, and contribute to social and economic development[3]. The impact of such energy access on social and economic development have been studied both by the project, and two Master's degree students conducted field work in the village autumn 2012. They emphasised the need for a follow up study when the centre had been operative for a longer period of time (Berg, 2013; Mosberg, 2013).

This energy centre has also triggered activities in other places in the country, among these Turkana county in northern Kenya. Here, solar power is currently being introduced in several villages with partial contribution from the mentioned research project, as an attempt to up-scale the experiences from Ikisaya. This study will look at both projects; the pilot project in Ikisaya, and the attempts to up-scale this project in Turkana county. I thus joined the project at an interesting phase, between pilot and up-scaling, which allows insight into how the knowledge(s) and experiences are first created and then sought to be transferred, and how the conditions for the technology to work change in this process.

1.1 Research questions

This study will shed light on what happens when technology travels, by following the Solar Transition-team's research and attempts on finding a suitable model for energy supply. I will study the translations the model goes through as it travels from India to Kenya, then look at what makes it work in Kenya and what happens to the model as it travels again from Ikisaya to Turkana.

3 http://www.sv.uio.no/iss/english/research/projects/solar-transitions/. Read March 23rd 2014.

The overarching research question is thus:

What makes the Ikisaya model work, and what happens when it is attempted up-scaled in Turkana?

These questions will be explored through the four following sub-questions:

1. *Where did the Ikisaya model come from?*
2. *Which factors were important for the model to work in Ikisaya?*
3. *Which translations happened after implementation?*
4. *Which negotiations does the Ikisaya model go through as it is attempted up-scaled in Turkana?*

One might ask how to operationalise how something "works". What makes something work is an empirical question, depending on who you ask, and for whom it should work. The "working" can for instance be understood in relation to technical performance, the goals of the project, economic targets, user satisfaction and the relationship between these. What works for a user may not be what works from a business model perspective and so on. Whether something works is thus relative, but in this thesis it is understood as what keeps the model going from day to day, as opposed to breaking down.

1.2 Rural electrification and solar power in Kenya

To understand the context in which these models for solar power are developed, I will provide background information on the motivations for rural electrification and why solar power often is perceived as an appropriate technology for that purpose.

As already stated, 1.3 billion people worldwide lack access to electricity, and low levels of rural electrification is perceived as a serious obstacle to socio-economic development. The alternative; dependency on bio-energy and kerosene, has social, economic and environmental costs (Ahlborg & Hammar, 2014, p. 117). Kerosene is an important source for lighting in many rural but also urban households in Kenya and Sub-Saharan Africa in general. It causes indoor pollution and smoke that is painful for the eyes. It is also expensive, and many poor families spend a large proportion of their income on kerosene. Highly flammable and poisonous, kerosene accounts for 60 % of paediatric poisonings in Kenya (Hui et al., 2009, p.

700). This has led the Kenyan government to act, and in 2012 they launched the five year programme “Kerosene free Kenya” with support from the Norwegian government, with ambitious goals of replacing kerosene with clean lighting technologies. Solar powered lanterns thus seem to be an appropriate technology in this respect, as 68 % of the Kenyan population is currently using kerosene for lighting. So far the programme has lead to removal of import duties and taxes on solar equipment. The target is to replace kerosene with solar in 200,000 households within the first two years of the project. The Kenyan government’s Vision 2030 also identifies reliable, clean and affordable energy as a foundation for Kenya’s long-term economic and social development (MFA, 2012, p. 2). Clean lighting is thus being translated into improved health, income and education.

Solar power is increasingly being used to provide energy solutions in off grid areas in developing countries. It is being praised as a flexible, sustainable and scalable technology. Institutions like the World Bank, the Global Environment Facility (GEF) and UN are promoting it, but there is now a shift from a donor oriented approach to a business approach (Jacobson, 2007, p. 145). Rural electrification in developing countries often takes a two way track, with one centralized, government track focused on grid extension, and one decentralized NGO/entrepreneur lead track focusing on off-grid, mini-grid and small scale solutions. While the grid extension is often limited because of rural customers' ability to pay, the commercial viability of the decentralized track has proved to be a challenge (Tenenbaum et al., 2014, p. 1). Although the Kenyan government works to replace kerosene with solar, the off grid solutions studied in this thesis represent the decentralized track. The Rural Electrification Master Plan (REMP) of the Kenyan government defines how rural electrification should be done, though it does not state when and by whom. It is the responsibility of the government to provide electricity services to its population, but this is often done through the private sector in Kenya (Kenny, ST-team member, personal communication). The off-grid energy solutions in Kenya are primarily market driven or funded through non-governmental organizations and aid agencies, though the policy and framework conditions are laid by the government.

1.3 Solar PV technology and off-grid alternatives

The technology used for rural electrification with solar energy in developing countries is predominantly solar photovoltaic (PV), a technology that converts solar radiation into direct current electricity (Lahimer et al., 2013, p. 320). The technology can be applied to different artefacts and devices. These range from lighting gadgets like torches and lanterns, to solar home systems (SHS) and big photovoltaic power plants producing electricity for a hundred thousand households. A drop in prices recent years has increased the possibilities in low and middle income markets[4]. The fact that it is also a renewable energy technology makes it an environmentally friendly alternative to other energy sources in off-grid rural areas, like petrol or diesel generators, firewood and kerosene. Solar PV thus seems to be an appropriate technology for rural electrification both from a development, environment and businesses perspective. It seems almost irrational to be against solar power.

The sites of my study, both Ikisaya and Turkana, are located in areas that are not served by the national electricity grid. I will give a brief explanation below of what solar PV technology is, and the most common ways of organizing solar PV in an off-grid Kenyan context.

What is solar PV?

Solar photovoltaic cells convert sunlight directly into electricity. PV gets its name from the process of converting light (photons) to electricity (voltage), which is called the PV effect. When sunlight hits a cell, 7-17 % of the sunlight energy is transformed into electricity[5]. One PV cell alone does not provide much energy, but when linked with other cells, they form a solar module, or panel. These may again be linked together to form an array[6]. The size of the module or array thus determines the capacity of the system. In off-grid areas, most of the electricity produced is being used in the evening, but to exploit this energy a battery has to save this energy during the day. This makes stand alone systems or mini-grids more expensive than grid-connected systems (Ulsrud, 2004, p. 16) I will introduce three popular options for off-grid electrification with solar PV below.

Solar mini-grid

A mini-grid is a power system where the produced electricity is fed into a small distribution

4 http://www.mckinsey.com/insights/energy_resources_materials/the_disruptive_potential_of_solar_power. Read April 19th 2014.
5 http://inventors.about.com/library/inventors/blsolar3.htm Read May 16th 2014
6 http://science.nasa.gov/science-news/science-at-nasa/2002/solarcells/ Read May 16th 2014

network that provides a number of end-users with electricity in their homes. Mini-grids are primarily used in areas that may not be served through the regular electricity grid (Franz, 2013). Mini-grids are often hybrid solar and diesel to ensure stable supply. Mini-grids are suitable in areas where the population is centralized, as power lines have to be extended to each house. The Solar Transition project studied a solar mini-grid project on the Sundarban Islands in India, and considered it for replication in Kenya. This process will be analysed in chapter four.

Solar home systems (SHS)

Solar home systems or stand alone systems are used to lighting and to power smaller appliances like a TV in households or off grid health centres and schools. The system must have a rechargeable battery in order for the system to provide electricity after dark and on cloudy days[7]. In Norway, SHS are typically found in cabins, but they are increasingly being purchased in developing countries. Kenya is a good example of this, where 200,000 households have become owners of a SHS, and the annual sales are between 10,000-15,000 units (Muchunku, 2013, p. 9). These have been unsubsidised, over-the-counter purchases, and being able to watch TV is the main motivation for acquiring the system (Jacobson, 2007, p. 146; Muchunku, 2013). With prices around $160 for the smallest systems, it is not the poorest who become SHS owners. The users targeted by the Solar Transitions project cannot afford these systems, and SHS remain a product for middle income households and public facilities.

Solar lanterns

Solar lanterns provide only lighting, but they have become a popular gadgets targeting the poorest population as a replacement for kerosene. A solar lantern cost between $10-50 each, and the Kenyan market is currently packed with around 20 distributors and 80,000 purchases (Muchunku, 2013, p. 9). This amount may still be a significant capital investment for poor households. Innovative business models with renting/ selling electricity as a service have been developed as alternatives. The Solar Transition project is offering lantern rental in rural areas, but similar solutions can also be found in Nairobi slums.[8]

7 http://www.ashden.org/solar Read May 16th 2014
8 http://www.theguardian.com/sustainable-business/selling-energy-service-meeting-needs-of-poor. Read May 15th 2014.

1.4 Clarification of key terminology

This thesis studies models for organizing energy supply with solar PV technology. The model piloted in Ikisaya is referred to as the energy centre model by the project (Muchunku et al., 2014) but in interviews it was also referred to as the Ikisaya model. I will use these names interchangeably.

The energy centre in Ikisaya was often referred to as a pilot project. A pilot project can be defined as a test or experiment, often small scale, that takes place prior to a possible full scale operation[9]. This thesis will also study a process of up-scaling or replication of a solar power project. These terms can have different meanings depending on the context, but generally replication means doing something again in the exact same way, while scale refers to the size or level of something, especially compared to something else[10]. However, the difference between the two can be vague, and the terms were used interchangeably by several of my informants. Up-scaling in this thesis is referring to the process of replicating the Ikisaya model or elements from this model elsewhere, and not to sizing up the model locally.

1.5 Structure of the thesis

This thesis is organized in eight chapters. The introductory chapter sets the context and presents the research questions. Chapter 2 introduces the theoretical framework, presenting the field of Science and Technology Studies (STS), a scholarly field that this thesis is inspired of. Then the selected theoretical framework for analysing technology transfer is introduced, discussing the concepts of translation, script/domestication and care. Chapter 3 introduces my methodological approach, how I gathered and analysed data, ethical reflections and justifications for choices made in the process. Chapter 4 is the first analysis chapter where the context for the project is set, and the first operational question concerning where the Ikisaya model came from will be addressed. Chapter 5 will study the Ikisaya model closer, and address the second research question on which factors were important for the model to work. In Chapter 6, the developments of the Ikisaya model after implementation are dealt with, where the energy centre develops into a decentralized model with agents. Finally, in Chapter

9 http://dictionary.reference.com/browse/pilot Read April 18th 2014

10 http://www.pacific-iwrm.org/rsc/third-meeting-documents/16-Replication-Scaling-Up-Mainstreaming-cp.pdf Project document for clarification of the terms up-scaling/replication in the the SOPAC/ UNDP/UNEP/GEF project on “Implementing Sustainable Water Resources on Wastewater Management in the Pacific Island Countries”. Read April 18th 2014.

7, we will see what happens when the Ikisaya model is attempted up-scaled in Turkana, and how it becomes a whole different project in this phase, and how this in turn influence the model works. In the conclusion chapter the whole study is summarized and linked to the overarching research question, and related to ongoing societal and theoretical debates concerning the topic of research.

2 A theoretical framework for technology transfer

As stated in the introduction, this thesis will study a process of technology transfer and the process of replicating and up-scaling a pilot project. To answer my research questions, I need a set of analytical tools that can help me limit the scope when gathering data, and to analyse the data afterwards. In the following, I will present my framework for analysing technology transfer, while the limitations of the framework will be discussed critically in the concluding chapter of the thesis.

A scholarly tradition that provides useful analytical resources to analyse a process of technology transfer and making technology work in new contexts, is the field of science and technology studies (STS). This chapter will therefore start out with saying some words about the STS tradition, before the theoretical framework is introduced.

2.1 Science and Technology Studies (STS)

Science and Technology Studies (STS) is a broad, cross-disciplinary field that deals with the relationship between science, technology and society. The approach started out as a critique to how science and technology, that had long been perceived as neutral, was indeed social and political. Events like the atomic bomb and the use of the pesticide DDT called for the necessity to reformulate the relationship between science, technology and society (Moser et al., 2007, p. 10). A common assumption in the STS field is that the social and technical cannot be separated:

> There is no science on the one hand, and society or values on the other, these are dividing lines only found in our imagination. Instead we should follow the actors and study how they create reality through the diversity of their practices and material resources. (Moser et al., 2007, p. 8)

Different traditions within the STS field has developed since the beginning, one of these is Actor Network Theory (ANT). ANT holds that everything in nature and culture is emerging from the web of relations within which it is situated. Human and non-humans engage in such networks, which are made and remade, they are not stable once and for all, of which my study is a good example. Whether we want to or not, we contribute in sustaining networks or

develop new ones (Elam & Sundqvist, 2011, p. 248). This study will draw upon resources from this tradition, where translation is a central concept. I will however not carry out a fully-fledged ANT- analysis.

STS researchers often deal with "how" questions, and study how science and technology is constructed (Hackett, 2008, p. 13). Bruno Latour (1983) and Collins (1975; 1981) have been studying scientists at work. By studying science in the making closely, they show that scientists disagree, and that there are both politics and social elements in the production of science and technology even down to the micro-level.

When studying the Solar Transition project's work of developing a model for village scale solar power supply, the STS approach is useful as it allows for studying and describing the relationship between both technical and social elements in detail. STS can thus be seen as a way of seeing the world, and understanding the relationship between technology and society. The concept of translation and the focus on technology transfer were important prior to the data-gathering process, but when I analysed the collected material afterwards, I added new concepts that turned out to be relevant, like care and maintenance. I put together selected concepts that turned out to be useful in understanding how the Ikisaya model worked and how it changes as it travels in a theoretical framework consisting of translation, script/domestication, fluid and mutable technologies and care. The framework will be introduced below.

2.2 What is technology transfer?[11]

"When ultrasound travels, it becomes both a changeable object and an object that brings about change – it is, so to speak, "world making" (Rockstroh, 2007, p. 3). This quote from Müller-Rocstroh's research on the transfer of ultrasound technology from Europe to Africa brings out the essence of an STS-approach to technology transfer. The technology will itself change as it moves to a new context, where it will also bring about change – and this shows how interwoven the technical and the social spheres are. Technology transfer implies moving a technology from one context (where it works, that's why it is being transferred in the first place), to a place where it has never been before. It however not a given that the technology

11 Parts of the following paragraphs about technology transfer, script and flexibility are based on my essay handed in as the home exam in the course TIK4011 "Science and Politics in Controversies on Nature" spring 2013. The purpose of the essay was to develop a theoretical framework for the master thesis, and I have kept the elements that were relevant, although they are developed further.

will work right away in the new context. To make a technology fit its new surroundings can be conceptualised as *translation* (Elam & Sundqvist, 2011, p. 248).

History has shown that technology transfer often fails, and the translation concept emphasise how networks matter for whether a technology is successfully transferred or not:

> To survive, an invention must forge new relations, and enter into worlds where it currently has no place. [...] To become real and avoid stillbirth, any invention – be it an alternative hairstyle; an electric car; a medical vaccine or a geological repository for nuclear waste – must be communicable and translatable. (Elam & Sundqvist, 2011, pp. 248-249).

So a new technology, be it new to the market or to the place such as in technology transfer, it must be able to establish new relations or it will disappear. Networks are thus one element of technology transfer, and because of this, John Law argues that it is impossible that a technology that travels stays the same, it lies in the term translation: “A technology does not originate at one point, and then spread out, it is passed, from hand to hand. And as they pass they are changed. Become less and less recognizable” (Law, 1997, p. 5).

He takes it further by arguing that there is no such thing as technology transfer, because the networks the technology is composed of are so transformed in the process. Akrich's story of the compact waste machine that was transferred from Sweden to Nicaragua can serve as an example. For the technology to work in the new context, it went through several stages of *negotiation*s. In Sweden, the machine made briquettes out of forest waste. In Nicaragua, it used cotton. But then a problem arises. In Nicaragua, there is an insect that destroys the briquettes, and new ways of storing the briquettes have to be found. While the briquettes were used by the industry in Sweden, the industry in Nicaragua doesn't want to buy cotton briquettes. The technology transfer could have failed here, but luckily, it turns out that private households are very interested in buying the briquettes. Voilà,a successful technology transfer has taken place (Law, 1997, p. 2).

This shows that a technology transfer is as much a technology translation. And for a technology to be successfully translated it goes through stages of negotiations. This concept is thus very useful for the overarching research question of this thesis, of what makes the Ikisaya model work and what happens when it is attempted up-scaled in Turkana. In each of the analysis chapters, we will follow a new stage of translation of the solar power technology.

2.3 Script and domestication – on design and users

As the last paragraphs on translation shows, technology and the networks it is composed of and compose, are changing as it is travelling. Whether an artefact will work depends on whether it succeeds in establishing new networks, and to be relevant in the new context. This also has to do with the intentions and work of the designer of the product, and the end user. It doesn't help if the product has won a prize for innovative design, if fails in the market because it is not well adapted to the user.

2.3.1 Script

Madeleine Akrich refers to the designer-user dichotomy as “script”. The designer of a technology defines the user and the world by inscribing their visions into the artefact. Their beliefs about what the world should be are materialized in the product. “Thus, like a film script, technical objects define a framework of action together with the actors and the space in which they are supposed to act” (Akrich, 1992, p. 200).

For a technical artefact to work in a new context, the designer must have projected the user right. If the visions inscribed into the artefact don't fit with reality, the technology will probably fail. This is often the case in failed technology transfers between the north and the south. To illustrate such an example, Akrich (1992) describes a photo-electric lighting kit that was attempted transferred from France to Africa (she doesn't mention which country). This lighting kit seemed quite simple: there was a panel for producing electricity, a storage battery and a lamp that consumed the electricity. When meeting its real users in Africa, it becomes apparent that the script of this lighting kit has failed: The tube between light and battery was fixed in length, and could not be adjusted to different room sizes. Spare parts for the product were not available locally, which was inconvenient when replacement of parts and repair had to be done regularly. The local electricians were not allowed to handle the lighting kits in the case of a problem, as there was a risk they could break something.

The device therefore became disconnected. It does not fit the needs of the user, and it is not connected to local repairers, suppliers and markets, it lacked being part of a network that sustained it. Here the script approach can be linked to the translation concept. When there is a mismatch between the projected user and the real user, the product cannot be successfully translated, unless innovative solutions or negotiations make it work – just in a different way than expected, which was the case with the compact waste machine. It should also be added

that while it is easy to blame the designer when a technology transfer fails (they did not design a good product), the design did make sense from the designers point of view: it was designed for direct current because is is cheaper, the length of the wire had to be limited for the product to work, and watertight batteries selected so that the user would not interfere with and damage the kit (Akrich, 1992, p. 211).

In the case of a mismatch between the projected user and the real user, the designer and user tend to blame each other: the designer argues that if something doesn't work technically, it is because it has been misused, socially. While the user argues that it didn't work socially, because it was misconceived technically (Akrich, 1992, p. 220). This is interesting, because it shows how interlinked technical and social aspects of a technology are.

The script approach is relevant for my research questions too, as it is not given that the technical artefacts like lanterns and the model tested for organizing the energy supply will work in practice. How is the energy supply organized in Ikisaya, is it developed together with the users? How is the technology being tested and used? Are there ways of overcoming the script challenge, when there is a mismatch between projected user and the real user? The script approach is thus useful both for analysing the relationship between the different components of the Ikisaya model, like the solar lanterns and the users, as well as the design of the whole model and the users. This is essential in understanding how the model worked in the different contexts.

2.3.2 Domestication

While the script approach uses the designer as the point of departure when analysing a technology in use, the domestication concept focuses on the users and how they make the technology theirs. The integration of technological objects into daily life happens in stages. The first phase, appropriation, occurs when individuals or households become owners of the technology while the last stage, incorporation, occurs when the technology is used in daily routines, and becomes natural and taken for granted (Oudshoorn & Pinch, 2003, p. 14). When applying a cultural concept such as domestication, we go beyond the view of the designer as the one in charge of the use of the technology, and failed technology transfer as a mistake of the designer who had not projected the user correctly. The user may be free to use the artefact in the way s/he wants, and may not follow the script of the designer. This view breaks down the divide between design and use, and Oudshoorn and Pinch (2003, p. 16) cite Marx to illustrate this, by saying that “consumption is production” – design and domestication are two

sides of the innovation coin. On the other hand, I would argue that in the case of a considerable mismatch between the designer's projection of the user in the real word (like in the case of the lighting kit Akrich describes) the technology won't become domesticated either(Stokke, 2013, p. 3). It is useful to keep both perspectives in the analysis of what made the Ikisaya model work and what happened when it moved to Turkana. The users cannot be separated from the technology, and the relationship to the designers in this case both means the technology itself, but also the model for supply that has been developed by the Solar Transitions-team.

It can be argued that the domestication approach gives the user more power than in the script approach where the designer is “dictating” the user. The user can be free to shape the use of the technology in new and unexpected ways–but within certain boundaries. Looking at the relationship between user and designer alone is however a too narrow focus to understand what makes a technology work, hence the next concept of flexibility and fluid technology.

2.4 Flexibility: Fluid and mutable technologies

The concept of flexibility or fluid technologies is related to the script concept. It has to do with the design of the artefact, and the relationship between the projected user and the real user. The mutability or flexibility concept is however broader, and encompass an adaptability of the device itself to its surroundings and all kinds of both expected and unexpected situations and challenges that it may be confronted with. An important point is that this adaptability is built into the artefact itself.

De Laet and Mol (2000) use “The Zimbabwe Bush Pump” to illustrate a technology that has the best preconditions to travel. The bush pump is a water pump that seems to be working everywhere, and it works even if some of its parts are missing: The pump is a solid, mechanical device, but, the authors argue, “its boundaries are vague and moving, rather than clear-cut and fixed “(de Laet & Mol, 2000, p. 225). This is what makes it a fluid technology, and this fluidity is what makes it relevant for other villages, too.

> We have argued that the Zimbabwe Bush Pump is a fluid actor. It brings a lot about, but its boundaries and constitution vary and its success and failure, instead of being clear-cut, are a matter of degree. Although one knows a Zimbabwe Bush Pump ‘B’ type when one sees it, we claim that the technology has no core. (de Laet & Mol, 2000, p. 248)

The fluidity of the pump is not a matter of the mechanical design alone. The designer of the

water pump believes that its success also can be owed to the fact that the pump is a public domain in the sense that it is not patented or owned by a private firm. The installation of the pump depends on involving the users, and gives thus room for local knowledge and needs. The authors argue that if not, the pump is bound to fail like other pumps introduced by aid agencies. It is the community that decide where to drill the borehole, and they do it themselves with a mechanical tool. In other words, the bush pump is an appropriate technology to transfer because of its flexibility (fluidity) and how it is depending on the local community to work optimally. It is not a stranger, unlike the non-user producing photo-electric lighting kit described by Akrich (1992).

A fluid or flexible technology is not hard to maintain. If a leather seal is broken, it could be replaced with a seal made from an old tyre, and if some of the bolts are missing, it could still work (de Laet & Mol, 2000, pp. 233-240). This is an important point, because it is often here technology transfers fail. When something is broken and there are no spare parts available or no one with knowledge of how to repair it, one realizes that the technology is part of a network, and that work is necessary to keep the network stable (Star & Bowker, 2006, p. 237).

The concept of flexible or fluid technology will be useful in analysing how the solar power supply in Ikisaya and Turkana works, as it contributes to understanding how an artefact interacts with and adapts to its surroundings, how much it demands from its users and how much maintenance is required:

> When travelling to unpredictable places, an object that isn't too rigorously bounded, that doesn't impose itself, but tries to serve, that is adaptable, flexible and responsive – in short a fluid object – may well prove to be stronger than one which is firm. (de Laet & Mol, 2000, p. 226)

Although it is easier to transfer a technology that requires little maintenance, some maintenance must be taken into consideration in all technology transfer. This leads us to the next concept of care and maintenance.

2.5 Care and maintenance

Technology is often a means for making lives easier for people, or at least attempting to do so. Technology can be used in care-related activities, but technology also needs to be taken care of. Care is therefore not necessarily other to technology:

> During the twentieth century it was commonly argued that care was other to technology. Care had to do with warmth and love while technology, by contrast, was cold and rational. Care was nourishing, technology was instrumental. Care overflowed and was impossible to calculate, technology was effective and efficient. Care was a gift, technology made interventions. Much of the resistance to squeezing care into technological frameworks is informed by this line of thought. It wants to keep care pure: each pole of the dichotomy should be al-lowed its own domain. (Mol et al., 2010, p. 14)

Care is not only about care in a motherly way, neither is it so that the one caring is active, while the one receiving care is a passive recipient. When a technology is tested, be it a wheel chair or a solar PV system, practices of exploring, testing, touching, adapting, adjusting, to pay attention to details and change them are involved (Mol et al., 2010, p. 16). This happens through tinkering and maintenance. People adapt technology to a context, or the situation to a technology, in a constant process of tinkering and maintenance. Maintenance and tinkering cannot be distinguished from the technology itself, because without it it will die and disappear, as discussed in the paragraph about flexibility and mutable technologies. This is also linked to the translation concept, because maintenance and tinkering activities are closely related to establishing and upholding networks.

One can argue that the importance of maintenance could be addressed without mentioning care. While maintenance sounds merely technical, the care concept allows for understanding maintenance as a social activity as well. Routines and follow-up is for instance integral to repair and maintenance, but doesn't necessarily involve a technical component. It can be a phone call from a colleague, asking how things are going. Since I in this thesis study a technology transfer process that involves both a team of researchers and practitioners, a community and technical artefacts, it is natural to have analytical tools that can describe maintenance as both a technical and social process.

While maintenance can be thought of as a necessary evil, Graham and Thrift (2007, p. 1) hold that it is the constant process of maintenance and repair that keep modern societies going. The authors' point is that the significance of maintenance work is that it is invisible – until something is not working. It is in the event of a power cut or when there is no hot water in the shower, you realize that the service you are missing, be it electricity or hot water, is made up of networks. To fix the problem, there must be a worker trained in solving that kind of problem, for them to be trained there must be education available, and if they are to do their job, there must be technical equipment available. The failure of establishing or upholding such networks are often described as the reason why technology transfers between the north

and the south fail.

According to Graham and Thrift (2007, p. 5) this is natural. It can have positive consequences for society too. It is through breakdown and failure that problems are being solved, that's how society learn and innovate: “disconnection produces learning, adaptation and improvisation” – “maintenance is learning”.

When a new technology is made, or introduced to a place where it has not been before, it is maybe too much to expect that it should “work” perfectly right away. This is again where the tinkering process and mutual adaptation between designers and users and the surroundings comes into play. Networks must be established and upheld. And this takes time. New technologies may therefore not work properly, following Graham and Thrift:

> “Thus, for at least 80 years, auto-mobiles were susceptible to breakdown on a regular cycle, even with all the labour of servicing that might be put into maintaining them. Whole generations had to become experts at changing oil, mending broken fan belts and replacing spark plugs as well as makeshift roadside repairs” (Graham & Thrift, 2007, p. 10).

So while much of the literature concerned with aid and development focus on the role of learning in technology transfer projects (to avoid failure), it is ironically failure that makes us learn. We don't see the drawbacks before the technology is put into practice.

Star & Bowker (2006, p. 231) see this process of constant repair and maintenance as infra-structuring, where the infrastructure itself cannot stand apart from the people who design, maintain and use it. This is similar to the translation concept, in the sense that it understands technology as something composed of networks that must be held stable through a constant process of work performed by the involved actors. This is why Latour (2005, p. 132) prefers to use the term “worknet” instead of network. That some people in rural Kenya start to use solar lanterns for lighting may not sound very complicated, but as will be shown, many actors are actively working to make this service exist.

Because there is so much work involved in setting up infrastructures, it is common that new infrastructures build on old ones, Thomas Hughes mention that the early electricity networks were built on networks developed from the previous gas networks and canal networks before that, and that both economic, political and social elements may hinder the development of technology or a technological system, so called reverse salients (Star & Bowker, 2006, p. 232). Reverse salients blur the lines between the micro and macro level, for instance if the macro level problem is the cost of a certain material in a technology, this problem can be

solved by finding a cheap substitute, for instance through research in a laboratory (Mac Kenzie, 1987, p. 196).

This point of reverse salients will not be used as separate concept in this thesis, but more as an aspect of care and maintenance. It may be useful in understanding the process of scaling up pilot projects and technological experiments, as the macro factors become relevant when one moves from the safe haven of the pilot to the "world out there". Although reverse salients may hinder a technological development, not all small successful projects can be up-scaled, even though there is broad societal support. Sometimes local successes depend on rare specific conditions, scarce skills or innovative business models which may not be (easily) transferable to other places (Jolly et al., 2012, p. 6).

2.6 Summary: a theoretical framework for analysing technology transfer

What should be clear at this point is that technology transfer is not just moving an artefact, a device, solar panels, cables, lanterns from A to B and voilà, a successful technology transfer is accomplished. Technology is composed of a network of relations, and this must be recognized if we are to understand how a technology can be successfully transferred, or understand why it fails.

The STS field provides analytical resources that are useful when studying the relationship between technology and society. I have selected four concepts that provide insights into what a technology transfer is, and which elements are important for a technology to work in a new context. These concepts are translation, mutable/fluid technology, script/domestication and care.

Technology transfer can be understood as *translation,* where several *negotiations* take place in the process of adapting to the new context and establishing networks. A technology both changes and brings about change in this process. A technology that is *flexible* or *fluid* to use de Laet and Mols words, is more likely to travel, because it is able to adapt to the local context and user, rather than the other way around. The theoretical discussion has also shown that the designer, user and the relationship between them matter for a technology transfer to be successful. The concept of *script* is thus relevant for understanding how the Ikisaya model works in practice. Finally, *care and maintenance* are maybe not the most visible aspects of a

technology, but nevertheless integral to make it work over time.

This framework does not encompass everything that makes a technology transfer work, but it does enable this study of a particular case. This study is inductive and empirically driven, and the chosen concepts in the framework are thus tools for analysing my findings. The concepts will however be relevant in different ways in the analysis chapters, and will therefore not employed symmetrically, but used when relevant. The weaknesses and limitations of the framework will be discussed in the conclusion of this thesis, as they become clear when the findings from the field are analysed.

3 Methodological approach

In this chapter I will explain and reflect on how the research for this master thesis was carried out. I will describe the field work conducted in Kenya, methods used for data collection, analysis, challenges, ethical considerations as well as assessing the quality of the study. It is the research questions that define what kind of methodological approach is the most appropriate. I need a flexible approach that allows me to follow both technical and social elements as they travel between India and Kenya and within Kenya, and I'm therefore methodologically inspired by ethnography, although my study as such can be conceptualized as a case study.

3.1 Case study research

Yin (2009, p. 18) provides the following widely used definition of a case study:

> A case study is an empirical study that investigates a contemporary phenomenon within its real-life context, when the boundaries between the phenomenon and context are not clearly evident, and in which multiple sources of evidence are used

Choice of case study

I was familiar with small scale solar PV technology from an internship with a Togolese environmental NGO prior to entering this master program. I had then noticed that it was often hard to make people interested in the technology, and although the solution seemingly was good, the demand was low. When I came across the Solar Transition project in the autumn 2012, it was the usage of solar PV technology in a developing country context that first sparked an interest, based on what I had seen in Togo. As I got to know the project better, I got interested in how the technology changed and worked in different contexts. This study can thus be characterized as an intrinsic case study, which is undertaken because the researcher wants a better understanding of that particular case (Punch, 2005, p. 144). This study of the Ikisaya model and the up-scaling process is interesting in itself, but the insights gained from studying this particular case may also be relevant for other similar projects, and not restricted to solar PV only, although the generalisability of case studies is contested (Baxter, 2010, p. 93). I will get back to the issue of generalisability of qualitative research towards the end of

this chapter.

3.2 Ethnography

Much research in the STS field is inspired by anthropology, where ethnography or field work is a common method. Ethnography is useful when studying something new, different and unknown, as it gives insights into a culture or social process (Punch, 2005, p. 154). It is characterised by research taking place in a natural setting rather than a setting constructed by the researcher, the research design is unstructured (an open-ended approach) and the analysis involves interpretation of meaning, function and consequence of practice and the implications of these (Hammersley & Atkinson, 2007, p. 3). My research questions are open, and this study is more of an inductive study since I did not have a rigid theoretical framework when I started the field work. It is thus methodologically inspired by the ethnography field, although the field work was short (six weeks) and I carried out semi structured interviews as well.

While traditional ethnography was focused on a single site, ethnographers have recognized that this is not enough when studying complex phenomena or processes. How to define a field when you study technology transfer? Marcus' (1995) concept of multi-cited ethnography acknowledges that the researcher has to follow the research object, this is also a point made by the central STS scholars and Actor-Network theorists Bruno Latour (2005) and Michel Callon (1986). This is necessary in my study, where I follow the continuous developments of a model for solar supply from India to Ikisaya and then to Turkana.

3.3 Conducting field work

Most of the empirical data were gathered during six weeks of field work in Kenya from September 17th to October 30th 2013. I spent two weeks in Ikisaya, six days in Turkana (see map), and the remaining period in Nairobi. In Nairobi I was lucky to get a desk at the Strathmore Energy Research Centre (SERC) located at Strathmore University, where I could go through my material in peace and quiet. The empirical material in this thesis is primarily based on qualitative interviews and to some extent observation and document analysis.

3.3.1 Getting access to the field

I got in touch with the Solar Transition project team leader in the autumn of 2012, when I first

caught an interest in the project. I contacted her and asked about the possibility to make a contribution to the ongoing research. She linked me up with relevant partners from the project team, and I was introduced to other people working with the project at an energy conference in April 2013[12], which was helpful in getting started with field work preparations. The project team leader also assisted with practicalities such as housing and solving the challenge of transportation from Nairobi to Ikisaya and with getting around in the village. In the preparation phase I was also in touch with two previous master students who had conducted field work in Ikisaya the year before, who shared their experiences with me and gave me valuable advice. For the practicalities in Turkana, it was Kenny from the Solar Transition team that arranged for me a driver, interpreter and a suitable hostel both in Lodwar and Kalokol. I was however harder to prepare for the stay in Turkana than in Ikisaya, as there was less information available in advance.

3.3.2 Being in the field

I arrived in Nairobi on September 17th, and spent a couple of days there before going to Ikisaya. Ikisaya is a full day drive from Nairobi, and I went there with one of the ST-team members who originally come from the village, and my interpreter, who was also my driver. I was accommodated by the family of the ST-team member, who had been housing ST-team members before. Staying with a family was definitely an advantage, both from a research point of view and for being safe and comfortable while staying in the village. I enjoyed nice meals and conversations every day, and the seven year old daughter of my host kept me busy when I wasn't working. I gained insights into every day life in Ikisaya, and got a better understanding of the context in which the project I study is a part.

The first day in the village, the primary activity was to greet people. I was introduced to the energy centre by the staff, met the sub-chief, local shop and café owners, and villagers in general that had errands at the market place. This was important to establish good relations with the community, and it was easier to collect data when people had an idea of what my role was. My driver and interpreter was important in getting to know the field. He came from Kitui county and spoke the local Kamba language fluently. He was not from Ikisaya village, but knew the village well from earlier visits with the ST-team. This was an advantage – he was

12 Two days interdisciplinary seminar with the title: Development and implementation of technology, a focus on solar energy. Organized in collaboration between MILEN research school, the Solar Transition project and Centre for Materials Science and Nanotechnology (SMN) at the Universty of Oslo.

not a complete stranger, but at the same time he was not a local that was involved in potential family matters or conflicts. I got the impression that he was liked and respected in the community, and it was easy to get in touch with potential informants through him. There are also challenges associated with using an interpreter, which I will get back to later in this chapter.

The settlements are scattered in Ikisaya, so I collected data from different places in the area. Still, the Ikisaya market where the energy centre is located, served as a base for the data collection. The staff were welcoming and it was not difficult to establish good relations with them. They were very helpful in assisting me with the information I needed. The fact that I used the services at the centre myself during the stay, made it natural to visit the centre on a daily basis in order to charge my phone and the solar lantern. After the opening of the energy centre, agents with solar energy services had opened in neighbouring villages. I visited all these villages, and interviewed the agents and users in each sub-location. I spent two weeks in Ikisaya, so the stay was quite intensive, with long days of data collection. Before I continued to Turkana, I spent a couple of days in Nairobi, where I conducted an interview with one of the ST-team members.

In Turkana, entering the field was more challenging than in Ikisaya. I was collected by a driver at the airport who took me to the first village, Kalokol. I was accommodated in the only guest house in the centre of the village. The heat was extreme, and there was no electricity to have a fan in the room. I could therefore only manage a couple of nights in Kalokol. The location of the guest house was however perfect, as one of the solar agents I studied was located there, and the two others within walking distance. I was also using an interpreter in Turkana, this time a young woman from Kalokol, but she did also come accompany me in the other villages that I visited, Nasigel and Gold. Many of my informants in Kalokol spoke English fairly well, but the company and assistance of the interpreter was still very useful in understanding the local context. The scene around the guest house was busy and hectic, which made it more challenging to get to know people like I did during the first days in Ikisaya. People questioned my presence, and many people took me for an aid worker. This influenced the data collection in two ways. First it was harder to create a good interview setting, and secondly it was harder to get hold of users of the services. I still managed to conduct interviews, though the main weight of my data from the users is from Ikisaya.

An interesting coincidence while in Kalokol, was that a Japanese business man who was

setting up pilot projects with solar lanterns happened to be in the village. I was invited to join him for the installation, which gave additional insights into how rural electrification with solar power is done, by an actor who did this from a mere business perspective.

After my stay in Kalokol I moved to a guest house in Lodwar, the regional capital of Turkana county. Gold and Nasiger, the remaining two villages, were about 45 minutes drive from Lodwar. There was no suitable accommodation in these villages, and this was a practical challenge that forced me to be pragmatic in the data collection. Hiring a driver was expensive, and there were no buses I could take to go the villages. I spent one full day in Gold village, interviewing three agents, and half a day in Nasiger, interviewing one agent. Ideally I should have spent more time in these villages, but I gathered sufficient data to make a comparison to Ikisaya. The atmosphere in Gold village was also different, and I got the impression that my presence was provoking to some people. Many people asked for money, and when my interpreter explained to them that I couldn't give anything, angry discussions between the interpreter and villagers arose on a few occasions. This did not happen to the same extent in Kalokol and Nasiger, but the climate for doing field work was generally more challenging in Turkana than in Ikisaya, where I had a bigger network, I was not a stranger and the sun was not so fierce. Despite these challenges in Turkana, I still find the data collected sufficient to make a comparison to the data collected in Ikisaya. The agent model for solar supply studied in Turkana was also less comprehensive compared to the Ikisaya model.

On my return to Nairobi, I spent a couple of days relaxing, before I started to go through my material. A challenge was to find a place to work that was quiet and with stable internet access. This was solved through an other master student who was doing research at Strathmore University, and I got an office desk at Strathmore Energy Research Centre. I used this as a base for my last two weeks. I also conducted interviews with ST-team members based in Nairobi during this period. Staying at SERC gave me insight into other relevant research and projects in the field of rural electrification with solar energy, and I was supposed to visit a UNDP lead project with solar energy in a community outside Nairobi before returning to Norway. Unfortunately I got sick that day, and I did not get a second chance before my return.

The six weeks in Kenya were very rewarding, and despite the challenges in Turkana and that I missed the trip to the UNDP project, I gathered sufficient amounts of data, and got valuable insights that go beyond my research topic.

3.4 Methods for data collection

Methods used for data collection were qualitative interviews and observation and document analysis. I will elaborate on how I selected my informants and the mentioned techniques for data collection below.

3.4.1 Selecting informants

The informants in this study were selected because they had relevance for understanding the development and functioning of "The Ikisaya model", and how the model changed as it travelled. My informants thus belonged to three different categories. An obvious category was members of the Solar Transition project team. I interviewed four out of a total of ten members from this group that all had a central role in the activities in Ikisaya and/or Turkana. They can thus be considered as core members of the team. Another group of informants crucial for answering my research questions are the users and non-users of the solar powered services. Their accounts are necessary to understand how the model worked. I tried to collect a varied sample of users (age, sex, socio-economic status, clan and so on). The final group of informants were the staff at the energy centre, and the solar agents both in Ikisaya and Turkana. These were important because they were handling the technology on an everyday basis, and their experiences, attitudes and knowledge were thus very relevant to understand how the model worked in each context, but also how it differed between contexts.

This method for selecting participants is known as criterion sampling, as the informants are selected because they meet a criterion, in this case of being linked to the project either as a user, project team member or someone handling the technology on an everyday basis(Yin, 2009, p. 75).

3.4.2 Qualitative interviews

An interview is a data-gathering method where there is a spoken exchange of information (Dunn, 2010, p. 102). This may sound neutral and straightforward, but it is a social process that is influenced by power and the attitudes of both the researcher and the informant. Collecting data in Kenya where the language and culture are different, there were more possible sources for miscommunication than if I had conducted the interviews at home. I tried to minimize these by using easily understood language, and instructing the interpreter(s) to translate what the informant said directly, and not to make a summary based on their own

perception of what was said.

I decided to conduct semi-structured interviews, since this allows the conversation to flow freely and to elaborate on topics that the informant brings up, but it is also possible to put the interview “back on track” when necessary. The interview guides used are available in the appendix.

3.4.3 Interviews with the users

I wanted to interview a number of users to map different experiences and opinions on the newly arrived solar technology in the villages. Since I don't speak Kamba or Swahili and most people lacked a basic knowledge of English, I relied on a translator to get in touch with potential informants and to conduct the actual interviews. In Ikisaya, I approached potential informants in two ways: Firstly by talking to random people near the energy centre or the agents, also known as convenience sampling since the informants are selected on the basis of immediate access (Bradshaw & Stratford, 2010, p. 75). Secondly, by doing a follow up interview with people that had been interviewed prior to the opening of the energy centre. This survey was conducted by the ST-team, were the respondents had been asked about their expectations to the project. The reason I chose to do follow up interviews with these users, was that I would save time, as the sample already provided people with various background (different clans, socio-economic status, different settlements and so on). It was also possible to compare the answers they gave me with the answers they had given prior to the opening of the centre. I conducted a total of 39 interviews with users and non-users in the Ikisaya region. This number stands out compared to the rest of the informant groups. I conducted more interviews with this group than necessary, because of the previous survey.

In Turkana, the number of inhabitants were much higher than the number of lanterns, and the solar services were quite new and not yet well known among people. It was therefore not likely that a random person in the street would be a user. To get hold of users, I had to go through the agents, who would help with identifying users in the area. It is therefore a risk that they would pick users they assumed were happy with the services. I also did interviews with random people in Turkana, but they were all non-users. Their contribution was nevertheless valuable in understanding why they didn't use the new technology in the village. I conducted interviews with 12 users/non-users in Turkana. The reason why the number is lower compared to Ikisaya is that the majority of people were non-users. It was also a more challenging environment to walk around and talk to random people, as mentioned earlier.

I used the same interview guide for the users in Turkana and Ikisaya. If a person was a non-user, I would ask why. The informants would normally be interviewed right where I asked to do the interview, for instance on a bench under a tree, at a local hotel[13], in the shade behind a house etc. I always made sure that the interview was conducted at a certain distance from other people so that they could not influence the conversation. Still, sometimes other people would come over because they were curious, and start to answer the questions or discuss. I would then explain that I'd like to interview one person at a time, but that I could interview him or her later. I opened each interview with explaining who I was, why I wanted to do the interview, what I would use the information for, and how long it would last. I also explained that if I quoted them in my thesis, I would not use their real names. The informants were often eager to get started with the interview, because they were busy with other activities. I chose a pragmatic approach where I focused on establishing a good relationship with the informants, and concentrated on a short introduction.

I emphasised that I was not a part of the Solar Transition project, but a master student doing an independent study. There is a risk that this was not very convincing, since I was accommodated by the same family that had been hosting other team members, and by being Norwegian and familiar with the project, the distinction between me and a team member was not very clear. This may have influenced the answers I got, for instance reluctance to criticize, or the opposite – being critical in order to bring about change as I was seen as someone who could forward the message to the project. On the other hand, the users had given critical responses to the previous master students and other team members, which makes it more likely that they would be honest with me too. Their familiarity with the project can also be seen as an advantage, it made me not a complete stranger and made people more willing to talk.

I conducted most of the interviews right away when possible, but I made appointments to do some of the interviews at the informant’s home on a few occasions. This was however more time consuming, and making appointments can be difficult when you operate in an environment where you don't really use a watch.

I had prepared an interview guide, and I initially wanted to conduct semi-structured interviews with the users. I tried to use easily understood language, avoid leading questions and ambiguity. The user interviews however turned out to be more structured, as informants

13 Hotel: local name for a small café where you could get tea and something to eat.

often gave short answers and did not follow up with questions. This was also a consequence of using an interpreter for the interviews, as this interrupts the flow of the conversation. As a consequence, I recorded only a few user interviews because the answers could easily be written in a notebook. The user interviews were quite short, and lasted on average between 10-20 minutes. I did record all the interviews with the project partners, staff at the energy centre and the agents, and transcribed them word by word.

3.4.4 Interviews with the staff at the energy centre and the agents

The staff at the energy centre in Ikisaya were English speaking, which was a great advantage with respect to the quality of the data. I conducted several interviews with them during my stay there, both formal interviews and informal talks. I also did an interview with each of the five agents in Ikisaya, and the seven agents in Turkana. Some of the agents were English speaking, and the interviews with these were by far the most fruitful, and it was more likely that the informant would elaborate more on the questions or bring up additional themes. All the interviews were carried out while the informants were at work at the energy centre or in the shop where the solar agent was located, and the interviews were sometimes interrupted by costumers. We would then make a pause and continue after the customer had left. I repeated the last question to reduce the risk of losing important information due to the interruption. I still think it was the best location to carry out the interview, as the informant was in his/her working environment and could show me the technical equipment and their books with sale records. The interviews with the agents/staff at the IEC lasted between 30 minutes to 1.5 hours.

3.4.5 Interviews with the ST- project team members

I conducted interviews with ST-team members in Ikisaya, Nairobi and Oslo. The interviews were carried out in the office or the home of the informant, or in a cafe. They all spoke English or Norwegian fluently, so the conversation could flow easily. The interviews lasted for around an hour, and I did follow-up interviews with two of the informants. All the informants had extensive experience and knowledge from the field of rural electrification with solar power, and knew the project very well. The interviews were thus crucial to get detailed information about the project. I found the informants to be willing to share their experiences with me, although it was difficult to lead the conversation to where I wanted on a few occasions. While I first found that to be disappointing, the informant bringing up different

topics was also a finding in itself, and my attitude changed as I realized that the material was valuable – the problem was as much me being biased to begin with.

Overview of informants	
Informant group	Number of informants
ST-team members	4
Staff IEC, agents Ikisaya	7
Households in Ikisaya	39
Households in Turkana	12
Agents in Turkana	7
Total number of informants	69

Table 1: Overview of informants in this study, organised after informant group

3.4.6 Observation

Part of the data collection was also based on what I saw. According to Yin (2009, p. 110), this can add new dimensions in understanding a phenomenon. In the literature, there are various forms of observation listed: complete observer, observer as participant, participant as observer and complete participation (Kearns, 2010, p. 246). My role can be seen as an observer as participant, since I used the lanterns and services at the centre in Ikisaya myself, and the proximity to these technologies also made it easier for the informants to show me and explain their experiences with the artifacts. This enhanced my understanding of how the technology worked in the different contexts.

3.4.7 Document analysis

I completed the interviews and observational activities by reading project documents such as internal field reports and minutes, a documentary, film clips as well as part of the PhD draft of the project team leader. The documents do reflect the team members point of view, and must therefore not be read as literal recordings of the past events, as emphasised by Yin (2009, p. 103). Reading and interpreting the documents were helpful in getting insights into how the team reflected on the process prior to my field work, and were therefore valuable both when

preparing the field work and in the analysis process. The list of documents analysed can be found in the appendix.

3.5 Assessing the quality of the research

Social research is evaluated after the criteria *validity*, *reliability* and *generalisability*, although qualitative research has been criticized for not being able to ensure validity and reliability (and is therefore not trustworthy). Kvale (1997, p. 159) argues that the concepts should rather be understood as "craftsmanship quality", where method and findings are continuously checked and interpreted throughout the research process.

Validity or trustworthiness in qualitative research refers to whether the study is investigating what it set out to investigate (Kvale, 2007, p. 122). I have put together a theoretical framework with concepts from the STS field, which has a long tradition of dealing with questions related to social studies of science and technology. By conducting fieldwork I got to study the relationship between technology and users in their natural context, which enhances the validity of this study. So does the deployment of different methods used for data collection, such as interviews, observation and reading relevant project documents. The oral accounts from an informant could be checked against documents or oral accounts from other informants. The fact that I interviewed different groups such as users, project partners and agents also allowed for different perspectives in analysing how the "Ikisaya model" changed and worked in different contexts.

Another criterion for trustworthy research, is *external validity*, or *generalizability*, which is about defining the domain to which a study's findings can be transferred to other contexts (Baxter, 2010, p. 93; Yin, 2009, p. 43). Statistical generalizations is not a goal in qualitative research, but analytical generalization can be made. Analytical generalizations are based on argumentation that is theoretically informed, and is the most common form of generalization in qualitative case studies (Kvale et al., 1997, p. 161). This is a study of one particular project, but as mentioned in the introduction, the accounts may still be useful to the discussion of other similar studies of technology transfer and the phase between pilot and up-scaling.

Reliability is linked to the trustworthiness of the study, how it is conducted. This can be achieved through openness about the research process (Thagaard & Lindegård Henriksen, 2010, p. 190). By describing how the research was done, it can more easily be checked and

evaluated by others, and thus become more trustworthy. Yin (1994, p. 44) holds that another researcher should get the same results if repeating the study the same way. I have sought to provide a detailed account of how I conducted my field work, and how challenges and limitations met along the way influenced the data gathered. The interview guides and overview of informants and secondary data documents can be found in the appendix.

An important reliability challenge in my study is the fact that I was depending on an interpreter for many of the interviews in Turkana and Ikisaya. I instructed my translator to translate directly, word by word what the informant was saying, and it was up to me to do the "interpretation" of what it meant. If the informant said a lot, I asked for a pause so that the translator could translate what had been said so far. In the beginning we had some challenges with this aspect, and I remember one episode where I heard the informant answering "yes" in the Kikamba language to my question, while the translator added some extra information. I then repeated the importance of not interpreting, but repeating what the informant had said. When using a translator there is a higher risk that questions could be misinterpreted. I experienced this a couple of times, where the answer I got did not fit the question asked. Then we would start over again. In this way I tried to minimize the risk of error or missing important information, although there is no doubt that using a translator has a significant impact on the interview setting. I found the interviews I did myself in English to be much more fruitful as the conversation could flow more easily without interruption. Although there are drawbacks to using a translator, I could not have communicated with most of the users and many of the agents without one. Also, they mattered for my cultural adaptation. In addition to speaking the local language, they knew local people and customs, and I felt more safe and comfortable with them around. For instance, in Ikisaya my translator said "now go and greet those old mamas over there, or they may perceive you as arrogant". I would not have thought of that as rude myself, if my translator had not given me that insight. In Turkana, when many people asked for money, my translator there helped me out of those situations. All in all, the translators were crucial for conducting a successful fieldwork, despite the challenges.

Another reliability challenge is that of project affiliation. Studying the activities of a project I am receiving support from, and where the team leader also was my co-supervisor is something that may influence the trustworthiness of the research. I have tried to minimize this challenge in different ways. I approached the project on my own initiative, and decided myself what I wanted to study within the project. The team leader also emphasised that it was in the interest of the project to get more knowledge and other perspectives. I got feedback on

my texts from the project team leader and co-supervisor. While it has been a form of validation of the research that someone who knew the project so well could give me more information and details when necessary, I have been very conscious about distinguishing between factual details and opinions. I have not felt obliged to write in a way that pleased the project, although critical comments were discussed with the team leader.

A way to strengthen the validity and reliability is to *triangulate*. This is a process of checking your data with other sources of evidence. By using different methods for data collection, for instance interviews, observation and document analysis, you can be more certain about your findings than if you rely on one single source. Triangulation can also be done in the analysis process, where the interpretations and findings are discussed with supervisors and colleagues (Bradshaw & Stratford, 2010, p. 77).

Informants are people who may forget, be mistaken, or sometimes also be dishonest, so what an informant tells you must not be taken as absolute fact. It is of course important to distinguish between factual information (the meeting was on Friday) and personal opinions and feelings. The information I got from my informants was discussed with others, for instance issues brought up by users could be discussed by team members or the agent/staff, and the other way round. By discussing my findings or interpretations with the project team members during field work and afterwards, I got additional information that gave a more holistic view of the context. I also contemplated the information I got from interviews with studying project documents and observation.

3.6 Analysis

Ethnographic data are often unstructured, which means that the information gathered is not organised in a finite set of categories. The fieldwork process is also demanding, but processing and analysing the data can also be a challenging task (Hammersley & Atkinson, 2007, p. 161). Analysis takes place throughout the whole research process, from the field work preparation to the final write-up of analysis chapters. As mentioned in the theory chapter, I had a set of theoretical assumptions in mind when I left for field work, but these were later adjusted as I found new themes through the data I collected. During the interviews I listened to which topics the informant brought up, and was open for new themes that could be relevant. I kept a field work diary during my stay in Kenya, where I took notes every evening. This helped me analyse and discuss my findings from day to day, and it was also a way to

clear my head in a sometimes chaotic context.

After the fieldwork I wrote down my first ideas of what my findings were in a tentative analysis document. I transcribed all the interviews myself, word by word, which also helped me map topics of interest, as well as reading my field work notes and the notes from the interviews I did not transcribe several times. I alternated between doing this and developing the theoretical framework and the research questions. The material was then coded after the concepts of the theoretical framework, in categories such as translation, script and so on. I had some of the categories in mind prior to coding, while new ones were discovered when going through the material, such as the concept of care. To organise the empirical material of the study in four chapters based on different translations was for instance a choice made during the analysis process, and not during the data gathering process. This way, the theoretical concepts, research questions and analysis chapters were gradually developed and adjusted to each other.

3.7 Research as an incomplete process

In social research there will always be limitations to how much knowledge the researcher can obtain – even if I had spent a whole year or more in the village. A limitation to this field work is that it was rather short. I still gathered sufficient amounts of data, but it is important to be aware of the fact that my data represent a very limited time period in the villages. A consequence is that the topics that people bring up in the interviews represent what concerned them at that time. If the data had been collected a couple of months earlier or later, it may have been different. For instance, many of the users brought up the issue of battery quality and fading light of the lanterns in the interviews. As I write this the batteries have been replaced, and the informant would maybe have brought up other issues if interviewed today.

3.8 Ethical dilemmas

It was usually easy to get interviews with the people I wanted, both users, agents and project partners. The users would however often ask if I could give them something. I had decided not to give anything to my informants, for several reasons. Firstly, giving something in return could influence the motivation to participate, and the answers given by the informants. Secondly, in a poor community, giving something could make people too eager to participate

so that the situation could get out of hand, and thirdly, it could have a negative impact on future research in the area if it becomes the norm that researchers should give something. Finally, as a master student, I had limited resources for expenses on gifts to all the informants.

Even though I made my choice on the basis of these arguments, it is not ethically unproblematic. Social researchers have been criticized for exploiting, getting degrees and building careers on other people's backs (Hammersley & Atkinson, 2007, p. 217). It can be argued that people devote their time and give information to the researcher without getting anything in return. Ikisaya is a community where researchers and master students have been visiting regularly, and I was more than once mistaken for being a previous master student. A woman asked me about what was going to happen with the problems she had been telling the other students about. I had to explain that the information they gave was used for research, but that there was unfortunately no causality between research and the local social improvement. The answer was accepted, but it was definitely a reminder that social researchers in poor communities does bring about hope that things will improve, but without the ability or means to follow up with practical action, and that people over time may get tired of having all these wazungu[14] coming and going. People would often ask me when I will be back, and that I had to come visit. They would also ask for the other researchers, and how they were doing. When doing field work in a small village and you involve yourself with the local community, it can seem cynical to just get your data and leave, never to return again.

Anonymity of informants and places

I told my informants that their real names would not be used in the thesis. My research topic was not very sensitive, but it was still important to stress this point so that people could speak their mind. Although some of my informants from the project team can be traced, changing the names of informants prevents them from being directly connected with this master thesis, in google searches for instance. I also anonymised the name of the energy company where one of my informants was employed, because he wished so. Hammersley and Atkinson (2007) suggests that places be anonymised as well, in order to protect informants or the area from for instance negative stereotypes. Since this thesis is done with support from a research project that openly uses the name of the places, I decided to do the same. I don't deem the topic of technology transfer and the implementation of solar power to be very sensitive or potentially harmful to the community.

14 Swahili for white people (plural), *mzungu* (singular).

3.9 Summary

In this chapter I have described the methodological approach for this master thesis, which I characterize as an intrinsic case study, inspired by ethnography. I have provided a detailed account from my field work and elaborated on the data collection process. The techniques used for data collection were semi-structured qualitative interviews, observation and to some extent analysis of project documents. This chapter has also provided reflections concerning the quality of the research, challenges met in the process and ethical considerations

4 First translation: From India to Kenya

Solar power has come to the Kenyan village Ikisaya, in the form of an energy centre. The purpose of this chapter is to provide the context in which this energy centre model is developed, and in this way answer the first operational question: *where did the Ikisaya model come from?* This will be done by introducing the Solar Transitions project and the initial efforts in finding a suitable model for village scale solar power supply. The concept of translation will be an important analytical tool in this chapter, while the data sources are primarily project documents and interviews with the project leader, as the focus will be on a process that took place prior to my field work.

4.1 The Solar Transitions project

The backdrop for this master thesis is the research project "Solar Transitions". This project studies ways of implementing solar power in developing countries that are viable in the long run and contribute to economic and social development[15]. The project started on April 1st 2009 and was completed on April 1st 2013. India and Kenya were selected as case studies because they are leading countries using solar PV in off-grid areas. Theoretically, the project is founded on the approach of socio-technical systems, which holds that technological change must be understood as a social learning process, where there is co-development between technology and society (Kemp, 1994; Ulsrud et al., 2010, p. 295).

This understanding of technology as embedded in society and the other way around is central when studying what the project wants to do. Society and technology cannot be separated and there is a constant co-evolution or development between the two. Since implementing a new technology is understood as a learning process, practical experimentation with the actual technologies is central in being able to implement and adapt the technology to the local context (Ulsrud et al., 2011, p. 295). The project has gone from theory to practice by actually implementing solar PV technology in a village, as this is the only way to truly learn from a socio-technical systems perspective.

The project is thus not a typical social science research project, both because of the strong

15 http://www.sv.uio.no/iss/english/research/projects/solar-transitions/. Read January 22nd 2014

technological components and the practical orientation. This created challenges for the team in getting funding for the project as most funding for social science projects do not give support to technical equipment (ST-team leader, personal communication). The project was supported by a grant of 19.3 million NOK (€2.4 million) from the Norwegian Research Council, but this was not sufficient for all the technical equipment. The team leader therefore mobilised private resources for the project as well, with donations coming from family, friends, other team members and herself.

4.1.1 The Solar Transitions team

The strong practical and technological components of the project were also reflected in the composition of the Solar Transitions team, which is both interdisciplinary and international. The ten core members come from Kenya, Norway, India and Austria, and they have backgrounds ranging from anthropology to technical engineering, representing organisations, companies and research institutions.[16] Diverse teams are considered to be an advantage in achieving technological change from a socio-technical systems perspective, and the team members had been picked so that they could complement each other. Although the members are based in different countries, the decision making within the team was described by the project team leader as collective, and consensus based, and happened "in a combination of negotiations and creative work" (Ulsrud, forthcoming, p. 5).

The team leader told me that the team had a strong common vision from the outset of the project, that a mini grid was to be tried out in Kenya and that they would study a model on the Sundarban Islands in India first. The higher vision for the team was a better and greener future, where solar power could play a part. The passion about solar power as a means to improve the world was also expressed to me in interviews with the team members.

4.1.2 Learning from solar mini-grids in India

An important phase in the project was the initial "study-tour" to India in 2010, where the whole Solar Transition team and invited guests with diverse backgrounds participated. Some of the members also conducted some weeks of field work after the tour. The purpose of the trip was to study an example of a successful project with solar mini grids on the Sundarban islands. India is one of the more progressive countries in the world when it comes to solar power and it has installed a large number of off-grid PV systems with support from a national

16 http://www.sv.uio.no/iss/english/research/projects/solar-transitions/people/. Read May 2nd 2014.

demonstration programme (Ulsrud et al., 2010, p. 52). Of all examples in India, the Sundarban islands was the most interesting to the team because it appeared to be the most successful, it had been operative for 15 years, and the team assumed they could benefit from all the learning that had taken place during these years. This is expressed clearly in the proposal for the ST project:

> Through the years of experience with the implementation and social organization of solar power plants on the Sundarban Islands, a considerable amount of learning has undoubtedly taken place. This project aims to contribute to the understanding of success factors and lessons learnt in this process of implementation and use of these solar power plants, as well as how such experience can be transferred and adapted to other communities and countries, developing their solar energy sector as well as their distributed energy provision in general. (Ulsrud et al., 2010, p. 53)

Here we become aware that it is not only technology that should be transferred to other places, but also experiences and lessons learned. In a short documentary about the project's activities in India, the project team leader stated that the “learning and exchange goes in all directions. Between all the partners the project was a platform for exchange of knowledge and mutual creation of new ideas and solutions” (Vognild & Ulsrud, 2010, 5 min. 33 sec.).

The solar energy on the Sunderban Islands was organized in a mini-grid that provided energy to people's homes and local businesses. It gave enough energy for each household to have basic electricity services: lighting, a fan and maybe a TV. The mini grids on the Sundarbans were implemented by West Bengal Renewable Energy Development Agency (WBREDA).

The ST- team members were excited to study what they described as pioneering efforts by WBREDA. The success of the agency's installation of solar energy in the Sundarbans was partly owed to a strong drive and motivation from key individuals within WBREDA. Such motivation is rare and this could be an obstacle to replication of the success. The team did, however, point out that individuals with entrepreneurial spirit can also be found elsewhere, and that such people did also participate on this study tour (Ulsrud et al., 2010, p. 52). The study tour was important for the rest of the work the team did together. It was here they came together as a team to learn and to get inspired – “seeing is believing” as was said in the already mentioned documentary(Vognild & Ulsrud, 2010, 4 min. 9 sec.) The tour was also, as expressed to me by the ST- team leader, a platform and a point of reference for the way forward (ST-team leader, personal communication).

Important lessons from the Sundarbans were that the success had to do with including local groups in the process and using a business model that ensured affordable electricity to poor

people. However, they also highlight the flexibility and willingness among the implementers to changing practices along the way through trying and failing (Ulsrud et al., 2010, p. 56). Finding the balance between affordability for the customers and economic sustainability of the model was a challenge, and this aspect was also dependant on factors beyond the local level like available government funding and technical capacity.

4.2 What is being transferred from India to Kenya

After the study tour in India, the work with developing a model for a Kenyan village started. It was not a given that the project was to end up in Ikisaya village at this point, the team was considering three villages with different characteristics that were visited in the process. The village they were looking for had to fulfil certain criteria. For instance, it should be implemented in a place where it was unlikely that the national electricity grid would reach in the next 10 years, the conditions had to be sunny and the community had to be interested in the project. The local conditions also mattered. The most deprived areas were to be avoided because it could be too challenging to implement a project there. It was considered hard enough to succeed with such a project in a "normal" village (Ulsrud, forthcoming).

There were also certain criteria for what a suitable model should be like. It should among other things ensure broad access to energy where it was being implemented, the model should be economically self-sustaining, and it should be practical so that operation and maintenance was easy. Gender and local context had to be taken into account so that the model would suit the needs of the community. The investment level should be kept as low as possible, and finally the model should be possible to replicate elsewhere by other actors, like NGOs or governments (Ulsrud, forthcoming).

4.2.1 A place that fits the model, or a place in need of a model that fits?

The model for energy supply studied on the Sundarbans was a solar mini-grid, and it is the experiences with this model that is being described in the report from the study tour and the research done by the team in India (Ulsrud et al., 2011). As already stated, the team wanted to learn from WBREDA's 15 years of experience with mini-grids, and then transfer it to Kenya. When the process of developing a model for the socio-technical experiment in Kenya started, there were discussions in the team on how this should be done. A fundamental question was raised, on whether they should choose a place that suited the model, or pick place in need of a

suitable model?

The project team leader told me that the team knew from the start that Ikisaya was not the most suitable village if they were to replicate a solar mini-grid model. In fact, one of the other villages considered for the project fitted much better a mini grid, but still they did not pick that one. This had to do with another purpose of the project, which is to offer affordable energy to people in off-grid areas. Ikisaya represented an area typical for the semi-arid landscape that covers up to 88 % of the areal in Kenya, and inhabits 25 % of the population (Muchunku, 2013, p. 6). Many people in these areas are lacking services and are living below the national poverty line. People also live scattered in these areas, which is not ideal for a mini-grid model (Ulsrud, forthcoming).

Here, the first set of negotiations between the mini-grid in India and the meeting with the Kenyan context takes place. The characteristics of the ideal Kenyan village in need of electricity supply don't fit the mini-grid model. The mini-grid is thus abandoned, and the researchers have to develop a different solution.

At this point, it is not a given what the alternative to the mini-grid would be. The team had decided from the outset of the project that the details about the model had to be developed with the community, so that the services offered were based on their needs and wishes. The idea of installing an energy centre instead had developed gradually, and it was not even called an energy centre in the beginning (ST-team leader, personal communication). One team member said that there are big differences between the Sundarbans project and the project in Ikisaya, and that they (the ST-team) had to think for themselves as much as transferring ideas and knowledge from India when developing the energy supply in Ikisaya. Although the team was prepared for the fact that they would have to adapt the mini-grid model to the local conditions and needs, the difference between the Indian power supply and the model developed through action research in Kenya became larger than the team had expected (Ulsrud, forthcoming). The ST-team got ideas from different places and had to adjust and add as they went. One informant from the team explains:

> We picked ideas from different places, we said OK, the light is an important part of this, but are there any other services we can provide, you know in Kenya for a long time solar business is driven by TV, most people buy solar PV to watch TV, but of course in a place like Ikisaya the size of the system required is smaller, so why not offer a service and people can pay a small fee and watch TV when they want. So then I came OK, lets see how that goes. (Maurice, ST-team member, interview)

The result is what gradually becomes known as an “energy centre”, and is referred to as the “Solar Energy Centre Model” in the project report, but is often referred to as the Ikisaya model within the team, and that's how I got to know the model. The development of the energy centre was a process where ideas gradually developed, according to the team leader. How this centre could be constructed was debated within the team. To save costs, it could be made from a container, but this material would make the heat unbearable for the staff. The building would instead be made of wood, and constructed from scratch. This was not just related to the physical parts The social infrastructure required to run the centre, such as a community based organisation (CBO), was established to run the centre and staff were hired and trained. Both the social infrastructure and the services to be offered were developed in cooperation with the Ikisaya community. It was, for instance, the community that had suggested that they wanted a CBO to run the centre (ST-team leader, personal communication).

The level of services which were to be offered at the energy centre were restricted by the project budget and the technological limitations. The project could afford a 2.16 kW solar PV system. While some people in the village wanted a fridge for medicine storage at the centre, this was outside the capacity of the system if lighting and phone charging services were to be offered as well. It was eventually decided that the services which could be offered would be- lighting services through rental of solar powered lanterns, phone charging, a TV room for news, education and entertainment purposes, and an IT room with typing, printing and photocopying services.

The decision to offer lantern *rental* as a service, instead of retail, was also a result of research activities done parallel to developing the model. Community meetings were complemented with interviews with women and marginalised groups The team leader told me that this way they got information that more people could benefit from the services through a rental based model. The customer doesn't have to pay the initial investment or be responsible for repairs, and can rent when s/he can afford it. The outcome of these negotiations between the team, the community, the technology available and the budget was rental of solar lanterns, phone charging, IT services and a TV room.

I tried to map who was doing what in this process, but even though the team members had different backgrounds and brought in different perspectives and experiences into the project, there were no clear cut boundaries between who did what and how. In the interviews with

project team members, I asked them about their contributions to the project, and the answer I often got was that decisions were made as a team, that they discussed different versions or options and then went ahead. “The team” were doing things, not the individuals: “I was contributing with ideas, discussing with the team. It is simple. We go and we sit and what's the problem. Then we discuss, we have this, can we try that, can we do this way, you know, and we agree, this is the way forward, and back again, how did that go” (Maurice, ST-team member, interview).

This doesn't mean that they did not have special task domains. One of the team members was in charge of the training of the staff in Ikisaya, while another had a special interest in testing different lanterns and applications and therefore took more responsibility for that. But all the discussions and cooperation along the way blurred out these initial responsibilities, and this mattered for the establishment of the new infrastructures in Ikisaya. Introducing a new technology is not only about what you are introducing, but also how you do it. The team were doing research but discussing, listening and follow-up was a vital part of the process of developing an appropriate model for energy supply in Ikisaya. Both in interviews with me and others, team members have expressed the importance of being a team: “The beauty of this project is that we are learning together”[17].

This team spirit must have influenced the process of developing a model for energy supply in Kenya. It has already been highlighted that it is not obvious what they took from India to Kenya, but they are still a team of dedicated researchers and practitioners of whom many had an entrepreneurial spirit and a passion for solar power. The fact that the team decided to make a model for a place in need of it, instead of doing what would seem like the easiest way, namely to implement a mini-grid in a village fit for the model, also shows a keen interest to help more people too. The goal is not merely about making a technology work, but as much about how solar power can solve a problem (lack of energy access in rural communities) and to do so there must be several models. The energy centre is thus one example.

The Ikisaya energy centre opened on March 20th 2012, and it looked like this:

17 http://www.forskningsradet.no/prognett-indnor/Nyheter/Brighter_village_life_with_solar_energy/1253992358969/p1253954776596. Read May 2nd 2014.

Illustration 1: Ikisaya Energy Centre. Photo: Kirsten Ulsrud

The services offered were lantern rental, phone charging, IT services (printing, photocopying and typing) and TV-watching in the multi-purpose room. How the actual model worked, however, will be discussed in the next chapter, where we will see what happens when the ST-team goes from theory on socio-technical systems, to the practical implementation of the centre above. The energy centre was also being referred to as the Ikisaya model in the interviews.

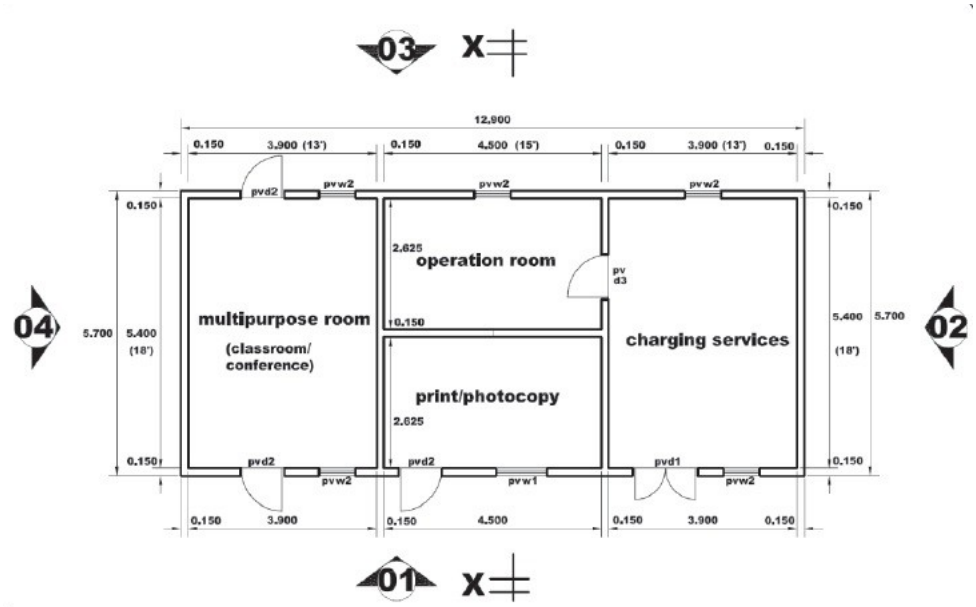


Illustration 2: Ground floor plan of Ikisaya Energy Centre. Source: ST-team

4.3 Discussion

As the empirical material shows, it is not easy to pin point where the Ikisaya model came from. It was being developed along the way, and not a mere blueprint of the mini-grid. I will in this section use the concepts of translation and flexibility to discuss this further.

Translation

This chapter has shown that an important negotiation took place as the team decided to develop a model for a place in need of one – instead of implementing the mini-grid they had studied so closely in India, as one team member said: “we had to think as much for ourselves as transferring knowledge and experiences from India”. If the mini-grid is not transferred from India to Kenya, what is then being transferred?

Following John Law (1997), a technology that travels changes. Something is gained, something is lost, in the process of making it fit the new surroundings and actors and he therefore argues it is more accurate to talk about technology translation instead of transfer. He takes it even as far as saying that there is no such thing as technology transfer. The project’s work on transferring knowledge and ideas from India to Kenya, is so far just in line with this argument. It has, in fact, become a whole different project that doesn't even look like the example studied on the Sundarbans. So where does it come from?

In interviews and reports, the project team consisting of dedicated actors, experienced with solar power, put emphasis on their collective process in developing a model, through discussing, listening, testing and learning together. This was probably more important than the model studied on the Sundarbans when developing the Ikisaya model. This doesn't mean that the study tour was irrelevant, it was referred to as a point of reference and an inspiration for the team. The team did, however, not develop the model all alone either. The local community of Ikisaya was invited to shape the model and services offered, and insights from the research activities shaped the services offered, for instance that lantern rental would make lighting services available to more people than if the customer had to buy the lantern.

To sum up, the Ikisaya model is, thus, the outcome of the negotiations both between the Indian context and the Kenyan context, the ST-project goals, technological and economic limitations as well as negotiations within the team and between the team and the community

in Ikisaya.

Flexibility and fluidity

That the Ikisaya model turned out to be so different from the model studied in India may also be explained by the flexibility of the solar PV technology. Following de Laet and Mol (2000, p. 226): “when travelling to unpredictable places, and object that isn't too rigorously bounded, that doesn't impose itself, but tries to serve, that is adaptable, flexible and responsive, in short a fluid object – may well prove stronger than one which is firm”. That solar PV can be organised as a grid, as a lantern or an energy centre, shows that solar PV technology can be adapted to different contexts and needs. Offering lantern rental service as opposed to purchase is a flexible approach to service provision that gave more people access to lighting. One might argue that this is more an aspect of how the technology is organised rather than a built in aspect of the technology itself, but making technology work might as well be to find the right way to organise it socially – which blurs out the actual difference between the social and the technical. In a poor community like Ikisaya, people have unstable incomes. The fact that ordinary people didn't have to invest and could rent when they could afford to showed that flexibility was built into the model.

Solar PV technology is flexible in the sense that it can be scaled up and down and organized in many different ways but the fluidity of solar PV can be debated. The demand for repair and maintenance are also aspects of fluidity and how much they demand from users and technical know-how in this process. This point will thus become more apparent in the following analysis chapter, where the factors that made the Ikisaya model work will be studied closely.

4.3.1 Conclusion

This chapter has sought to answer the first operational question: *where did the Ikisaya model come from?* This was done by introducing the Solar Transitions project and the activities that led to the implementation of a solar energy centre in Ikisaya, Kenya. The analysis of their activities has shown that the Ikisaya model was the result of several negotiations in the process of translating a solar mini grid from the Sundarbans in India, to the Kenyan village of Ikisaya, in line with John Laws argument that there is no such thing as technology transfer. That these adaptations or translations were even possible can be owed to the fact that solar PV technology is flexible enough to be organised in different models, both technically (scaling/size) and socially (rental *vs.* ownership).

5 Second translation: From theory to practice

I arrived at Ikisaya village late in the evening, after a whole day of driving from Nairobi. The last hours we had been on a bumpy forest road, I was half asleep, only waking up when the team member or driver wanted to tell me jokes or scary stories. But all of a sudden we are finally there: "Maria, look! look! The lanterns, see!" One of the team members pointed out of the window. And right, suddenly in the dark I spotted small houses with light inside. Not very strong light, but it is clear and bright. We had arrived at the first cluster of houses that were being served by the energy centre in Ikisaya, and the field work was about to begin.

In the previous chapter we got to know the ST-project and how solar power came to Ikisaya. As discussed in the theory chapter, a technology transfer is as much about making something new as transferring something – and we have so far got to know that that the mini-grid from India was not translated into a new mini-grid in Kenya, but an energy centre. In this chapter we will get to know both Ikisaya village and the energy centre better. I will describe the different components of the model and discuss what made the model work in practice in answering the second operational question: *Which factors were important for the model to work in Ikisaya?* The concepts of script/domestication and care will be used as analytical tools. The data sources are both data collected during field work and project reports.

5.1 Ikisaya village

The village of Ikisaya is located in the dry-lands of eastern Kenya, 300 km east of Nairobi (see map). The correct name for the Ikisaya region is Syou sub-location, which is an administrative unit that belongs to the Kitui district. People tend to refer to the village and its immediate surroundings as Ikisaya, so I will do so too in this thesis. The population of about 2000 lives scattered over the 129 km^2 areal of the village (Kirubi, 2011). The population are all of the Kamba people, and the families/households are organized in clans. Which clan you belong to determines your socio-economic status and access to power. The biggest clans tend to be the most powerful and resourceful, but with 58 % of the population below the national poverty line, the majority can be characterised as poor (Owuor et al., 2011, p. 46).

Life in Ikisaya is rough. The area is semi-arid and drought prone, with two dry seasons and two rainy seasons a year. With most of the population depending on subsistence farming and livestock keeping, drought has serious impacts on people's livelihoods, and aid relief from the government is sometimes necessary. Studies done by previous master students and researchers from the ST-team state that people are vulnerable to climate change and have few alternative income sources (Berg, 2013; Eriksen & Lind, 2009; Mosberg, 2013). The ST-project hoped that provision of basic electricity services from the energy centre could help improve people's living conditions. Before the energy centre opened, only 6% had access to electricity through private solar panels. The rest used kerosene lamps or torches. Ikisaya village will be connected to the national electricity grid in 2014, and the construction work was almost complete at the time of field work. It is, however, expected that many people will not be able to afford the connection fee.

The village is governed by a chief, appointed by the government. There are also other traditional leaders in the community as well, like the elders council. The settlement clusters in Ikisaya has an elder each that represent their location. The council meets regularly to solve local disputes and community matters (Eriksen & Lind, 2009). Most of the households are organised in different self-help groups, and the market place and the churches serve as important meeting places for people.

5.2 The Ikisaya Energy Centre

How can I introduce and describe the Ikisaya Energy Centre? As my theoretical framework suggests, technology is composed of both technical and social components in heterogeneous networks. Some components in such networks are less visible and obvious than others but, nevertheless, crucial for having a functioning technology, like the infrastructure for maintenance. With this starting point, it becomes less obvious what exactly the Ikisaya Energy Centre is, where its boundaries are, what is inside this model for energy supply, and what is outside. I will start out by describing what I saw when I first came to Ikisaya, and the physical infrastructure and the services offered, and then describe other organisational aspects of the model. By the end of the chapter I will discuss how the model worked by using the concepts introduced in the theory chapter. When analysing how the model worked, the interplay between the different components of the model become important. So what the Ikisaya model is and what it is composed of will become visible throughout this study.

5.3 A normal day at the centre

The Ikisaya Energy Centre was at first sight a building constructed for the purpose of housing basic electricity services in Ikisaya. I had read and heard a lot about the energy centre before I came to Ikisaya, and I was excited to finally see it for myself. Located centrally at Ikisaya market, it stood out as a beautiful building, as it was new, painted in yellow and green, and with flowers by the entrance. I was also met with a board advertising a football match to be screened there the same day. The roof of the centre was covered by solar PV panels, and the rest of the technical equipment was located inside of the building. As illustration 3 shows, the centre has 4 rooms, offering lantern rental and charging, phone charging, computer services and a TV/video room.

Illustration 3: The lantern and phone charging room. Photo: Author.

The opening hours were from at eight in the morning to six or seven in the evening. The mornings were normally quiet, but the IT clerk and manager had often typing work to do. She preferred to do this work in the morning before it got too hot, because the IT room tended to get very hot due to poor ventilation. The typing work could be school assignments for secondary school pupils or university students that were hand written, but had to be machine written in order to be submitted. As the day started people gradually started to come by the energy centre, returning their lanterns and phones for charging. People would often hang out

at the centre and just chat when they were returning their lanterns, some would maybe watch TV. Watching TV was not supposed to be a free service, and costed 5 KES. It was often a challenge to make people pay for it, since many just dropped by without necessarily sitting down to watch. The busiest time of the day was the last two hours before closing, when people came to collect their lanterns before going home. All the users were issued with hand written receipts. A copy of the receipt was left in the record book. The record books were sent to auditing in Nairobi to ensure that things were done correctly, once per year.

5.4 Lantern rental and phone charging

The most important and popular service was the lantern rental and charging. This was also the most visible service in the village, as people came in the morning returning their lanterns for charging, and came back around six p.m. to collect them, now fully charged. There were a total of 120 lanterns when the centre opened in 2012, but the number of lanterns has increased since.

5.4.1 Phone charging

Initially, the centre had a capacity to charge 60 phones per day, 30 at a time. The capacity has, however, increased since the opening of the centre, due to a technical innovation: One of the staff at IEC saw that more phones could be charged on the same battery if they were using a charger with more ports. This was brought forward to Kenny, one of the team members, who made this charger himself upon request. The centre can now charge up to 120 phones per day.

Illustration 4: This phone charger with several ports enhanced the phone charging capacity at the centre. It was requested by the staff, and made by Kenny, one of the team members. Photo: Author.

5.4.2 The lanterns

One of the most important services at the centre was the lantern rental and charging service. The solar lantern can be rented for two consecutive nights before it has to be returned for charging. The customer had to return the lantern before noon on the second day if it was to be fully charged for the next rental. It had been a challenge to make people return the lanterns on time, and the centre had therefore started to fine late customers 10 KES. It was possible to purchase lanterns as well, but as most people could not afford this, rental was the best alternative. A customer could rent the lantern when (s)he wanted/could afford it, and did not have to subscribe on a monthly basis. The lanterns provide light for 5-8 hours depending on the lighting mode, and it takes 5-6 hours to charge them fully on a sunny day. The lantern is equipped with a lead-acid battery with a life span of 1-2 years depending on usage (Muchunku et al., 2014, p. 19). Four different types of lanterns were offered at the centre during the time of field work. Their popularity amongst the customers and technical performance differed. I will, therefore, briefly introduce each type. The reason for having different types was to test new applications, but it turned out that customers had different preferences so both the staff and project team members found that it would be a good idea to offer different models on a general basis.

The Indian lanterns

Illustration 5: Indian lanterns. Photo: Author.

The Indian lantern was the most common type at the energy centre, and thus also the most popular. It was called the India-lantern because it is distributed from the Indian Energy and Resource institute (TERI). The lantern is, however, not available in Kenya outside the Solar Transitions project, so the presence of this lantern in Ikisaya is a reminder that the project in Kenya actually started in India. I was told that as these India-lanterns "retire", they will be replaced with other models, because it is expensive and impractical to continue to import them – as even the spare parts had to come from India. I was also informed it was the most expensive of the lanterns.

People loved it though. Informants among the users told me they liked how it was giving light in all directions, it was portable, and also a little heavy so it could stand steadily on the ground. The light was also very bright, but it could be adjusted into three modes. This flexibility was appreciated by the customers. The only drawback that I was informed of was that the battery capacity was poor, and had started to fade in many of the lanterns within the first year. After my return to Norway, I was informed that new, lithium-ion batteries had arrived from India, and all the old batteries in the lanterns were to be replaced. This battery type is also more powerful and has a longer life than the previous one.

The Sun King Pro

This lantern is produced in China for the American company Greenlight Planet. The Sun King Pro, which is the correct name for the model in use in Ikisaya and Turkana, is both a lantern and a phone charger. The users were, however, not equipped with the cable that enabled them to charge the lanterns. This was because the staff at the energy centre preferred that the customers charged their phones there. Also, since the users did not have their own solar panel, the battery could be drained if it was used for both charging and light at night time.

This lantern was also praised for its flexibility. The battery was more powerful than in the other lanterns and I was also told that people like the design, that it simply looked nice and elegant. It could stand on the table, hang from the roof or be carried as a torch. Still, it took an extra effort to alternate between the different functions, by decoupling it from the stand, or hanging it from the ceiling. An informant said that when using it outside, to go to look after the goats for instance, you would have to put it on your hand. If you then needed two hands and had to put it down, it would only give light upwards, and that is not so practical. The India-lantern was thus more adapted to all kinds of activities. It could be on the table, roof, or ground, and still serve its purpose equally well.

Illustration 6: The Sun King Pro. Photo: Author.

The Prakruthi lanterns

Illustration 7: Prakruthi lantern.
Photo: Author.

This lantern is also produced in India, but it is locally available in Kenya. I was told that it was cheaper than the others. It gives light in three modes which are all very bright. The lantern is very light and easy to carry around and it was therefore often a favourite among the older mamas, I was told at the energy centre. The light weight can be a drawback though, as it falls over easily – but it is harder to break than the India-lantern. The lantern gives light in only one direction, which was not so practical according to one informant. The model was relatively new at the centre, and not so many of the customers had tried it yet at the time of field work. The staff tried to make more people try it as this model is favourable for the centre from an economic point of view.

5.4.3 Batteries – the weak link of solar PV technology

Both the ST-members and the staff told me that the batteries were a weak spot of solar PV technology and the lanterns as well. The different lantern models were equipped with different battery types. The battery in the India-lantern was a lead-acid battery, which is a common type for solar PV, and relatively cheap but with a short life span, less than a year if the battery is deeply discharged and then charged only partially on a regular basis[18]. The Sun

18 http://www.solar-store.com/cat%2012%20BATTERIES.pdf. Read on May 22nd 2014.

King Pro lantern was equipped with lithium ion batteries, which have a life span of 2-3 years, but can handle medium discharge better than the lead acid battery, although severe discharge should be avoided (Tektronix). The limited capacity of the lead-acid batteries was known before the project started, but the project would have been delayed if lithium-ion batteries were to be used from the start (ST- team leader, interview). At the time of field work the lead-acid batteries were reaching a critical stage, but they were to be replaced just after my departure. I have been informed from the project leader that the lead-acid batteries have been replaced with lithium-ion batteries in all the India-lanterns.

The batteries were imported from India, which make the process of getting them more complicated than if they were locally available. Although the lithium-ion batteries are less sensitive to deep discharging, the practice of returning lanterns after 2 days will still be kept, I was told by the staff at IEC. There was uncertainty about how the battery would handle different treatments, and the users were already accustomed to returning lanterns after two days.

The importance of avoiding deep discharging of the batteries was a source of frustration for the customers, especially in the beginning. Some had suggested paying more to keep it longer, but technical experts warned that this would not be healthy for the batteries and would require frequent replacement (ST-team, 2011b).

5.4.4 Computer services

There was a separate room for the computer services in the energy centre, equipped with a portable computer, a scanner and a printer. The services offered here were typing, printing, photocopying, scanning and laptop charging. The IT-clerk explained that the services had not been that popular when the centre first opened but as people became aware of the services, they came to Ikisaya instead of travelling long distances to the nearest towns offering these services (these were Kitui and Mwingi, the biggest towns and administrative centres in Kitui county). The toner for the printer must be replaced regularly, and is sent by bus from a nearby town and paid via M-Pesa[19] (Muchunku et al., 2014, p. 22)

The typing work was the most time consuming task at the centre. The IT-clerk receives hand written pages from the customer, for instance a school paper, and then she types it on the computer. I assisted her with this for an hour or so where I read the text and she typed it.

19 M-Pesa is a mobile phone based money transfer and micro-financing service.

There had been requests from the community that the villagers and especially the school children could get computer training at the centre but they had so far not had the capacity to arrange this.

5.4.5 TV/multi-purpose room

The TV-room was equipped with wooden benches, a TV, and a video player. The room itself was also available for rent, either with or without the TV/video equipment. The villagers had to pay a small fee to watch news, movies and football or listen to gospel music. During my stay in Ikisaya the Al-Shabaab terrorist attack on the West Gate mall in Nairobi happened, lasting from September 21-24 2013. The TV room was filled with people watching news to have the latest update on the attacks and I got to see for myself the importance of having access to a TV to get information under such circumstances. As mentioned, the challenge with the TV room was that people tended to come and go without paying. Sometimes someone came by to greet someone watching TV, chat for a bit and then leave. The demand for room rental for other purposes, such as wedding receptions, church meetings and educational shows had not been as high as the team had hoped for.

The storage room

The centre also had a separate storage room where the batteries and control units of the system were located. It was also used for spare parts, spoiled parts and newly arrived equipment not yet taken into use. The walls were covered with flip over pages from the initial training of the staff, providing information about the technical equipment and routines. The storage room was, therefore, more important than it may sound like, as it was also a storage room for knowledge, learning and experience. The presence of spoiled parts and spare parts was also a reminder that the technology needed to be taken care of.

Overview of services offered and the costs	
Rental of portable lanterns	Deposit 200 KES per lanterns Charging fee 20 KES for two days
Mobile phone charging	20 KES
Printing	20 KES per page
Photocopying	10 KES per page
Scanning	15 KES per page
Laptop charging	350 KES
TV/video watching	News 5 KES Movies 10 KES Football 20 KES
Hire of multipurpose room (with light and TV/video)	100 KES (500 KES)
Haircutting	Adults: 30 KES Children: 15-20 KES
Retail outlet: sale of lantern	3,500-15,000 KES

Table 2: Overview of services offered and the costs. Source: Ikisaya Energy Centre

5.5 The social infrastructure

5.5.1 Ikisaya Energy Group

The Ikisaya Energy Centre is run by the community based organisation (CBO) “Ikisaya Energy Group” (IEG). The CBO was set up in May 2011, and had 199 members in October 2012. The IEG has an annual general meeting where a 12-member board is elected by the members. Six of these form an executive committee that oversees the management of IEC. To avoid clan disputes, there are representatives from each of the settlements in Ikisaya on the board. The ST-team still owns the technical equipment and the energy centre, but the operator (the IEC and the board) must submit quarterly financial reports and an annual audit to the ST-team (Muchunku et al., 2014, p. 26).

I discussed with one of the team members and the team leader how the idea of making a CBO to run the centre came about, as opposed to another way of organising the energy supply. I was told that it was the community that first brought up the idea of having a CBO. In fact, the team had been uncertain how to organise and manage the energy supply, when a suggestion to

have a CBO came up at one of the initial barazas[20] with the community. I was told by one team member that they had to build an infrastructure that could be there when the research projects ends. There were no alternatives:

> You cannot have employees that no one is responsible for, we needed a CBO to have an infrastructure to put the centre forward. We could not say to the community after three years: "thanks for renting the lanterns now go back to kerosene". We needed something to help it continue. Anyone can be above the energy centre, a business, the government, NGO etc. But we were a research project, so we went for the CBO. (aurice, ST-team member, interview)

This is interesting because it shows that a whole community is involved in making solar PV work in Ikisaya village. This community involvement has been a two-edged sword that has both created and solved challenges along the way, as I will get back to.

5.5.2 Economic aspects

It has been a goal all the time for the ST-project that the centre should be financially viable. It is about service provision that is not aid-based, but not about generating a large profit either. It can still be argued that it is aid based because it is the project that has contributed with the initial investments. The team leader says she sees it as a practical research project where they are searching for new solutions that are viable and that she, therefore, doesn't identify herself with aid actors. The outcome of the research can also be relevant to businesses, organisations and government authorities.

For the services to be available to as many people as possible, the prices must be kept to an absolute minimum. The project leader told me she feared that the prices were still too high, and wished that more people could benefit. The risk is that if the prices are lower, they are not able to save money in the battery replacement fund. The goal for the ST-project was to find energy solutions that could be viable in the long run. For this to be possible, the centre has to generate enough income to be able to save 21,300 KES (€178) each month to replace the batteries in about two years' time and other future maintenance related costs. The presence of such a fund shows that the project is taking the issue of maintenance seriously, but that finding the balance between the long term economic sustainability of the centre and affordability among the villagers has been challenging.

20 Public community meeting.

5.5.3 The staff at IEC

The staff at IEC were locals from Ikisaya who were hired after advertising and formal interviews conducted by the ST-team. They started off with the following posts as described in the report (Muchunku et al., 2014, pp. 26-27), but these have later been revised:

- A charging attendant, responsible for lantern rental and phone charging.
- An IT-clerk, responsible for offering the printing, photocopying and typing services as well as being responsible for the TV room.
- A part time book-keeper responsible for preparing the weekly and monthly financial statements, pay roll, receipts, and financial and audit reports. The part time book-keeper is also responsible for sending off reports to external audit.
- An evening attendant who collects fees from the TV room (if it is used in the evening after the other staff has gone home), security and cleaning.
- A manager responsible for reporting to the CBO, consolidating reports, collecting revenue and responsible for budget preparations.

When the centre opened in 2012, there were five staff employed, three full time and two part time. I was told by the staff and project team members that they had cut down on staff because they gradually realised that the centre could be run by fewer people. The cutting down process had happened "naturally" as the manager of the centre was fired by the board after a management issue. The ST-team also supported that decision. He was replaced by a new manager, who also disappeared six months later, because he got a job as a technician in Nairobi.

I asked his former colleagues if they thought he got the job because of his experience at the energy centre. I was told that all the staff got a certificate after they had received training, and that this certificate may have helped him to get a new job. To avoid brain drain, which comes from resourceful people leaving the community, other similar projects did *not* give their participants a certificate (Standal, 2008). I asked the project team leader what she thought of this. She said that it was wrong not to give people a certificate to hinder someone in getting a job elsewhere. That was up to the person. And that person could train others, so that the knowledge would spread locally, even though (s)he was leaving at one point. In Ikisaya, the rest of the staff did just fine even though the manager left. At the time of fieldwork there were three employees at the centre: a manager, a technician/charging attendant and an evening

attendant. That staff have to leave for different reasons is also natural, the project leader told me. Jane, first hired as IT-clerk and now manager of the centre, had contributed substantially to running the business. She is now getting married and has to leave the village to live with her husband. As an important resource at the centre, the project leader explained that replacing her won't be easy. “The centre needs a woman who is strict and responsible” she told me. This indicates that the characteristics of the staff are also important to how the centre works, and not only their technical know-how and access to spare parts.

The staff had received an initial ten days of training where they all got the same information, although they were to take on different responsibilities. Even the night attendant learned something about book keeping or maintenance. Maurice from the ST-team trained them in book keeping, that is recording how many lanterns are being rented, writing receipts to the customers, how the technical equipment worked, how to charge and repair the lanterns and junction boxes and routines that were necessary to the running of the business. He said the following about the purpose of the training:

> The main thing is understanding why are we having these systems, why we doing things this way, because if we understand it, so will, let’s say, as long as they understand why they are recording and what they are recording, they may find an easier way to do the exact same thing. so I am just teaching them pre-code this way, why are we recording this, we want to know this and that. And you will do it a couple of times and see OK, we will start out doing it this way but you can do it more efficiently this way. and that's how we learn, that's the learning process for everything (…) but as you go along you realize you find easier ways, different ways of doing it, and you feel free to change it. For me it is important that people have the ability themselves to make decisions, to have new ideas, and understand systems and change them, because that flexibility is the only way people grow. (Maurice, ST-team member, interview)

This reflection shows that there are no clear cut boundaries between the so called formal training and the more vague learning by doing. They are interlinked. The initial training and understanding may provide you with tools that can help you improve or innovate at a later stage. One of the staff explained his view on the training, and he too finds that their learning had continued after the initial weeks of training:

> We have been upgrading since then, because each and every time we're getting challenges here and there, you try to send your own views, or other enquiries, so the training has been continuous, we learn from the different people coming around who are very much familiar with solar energy. Kenny and Maurice from the project team have been around, and every time they come they give us additional training concerning the different gadgets so. So we are still advancing from the training which we had initially yes. (Vincent, IEC staff, interview).

Knowledge and understanding of the technology can lead to improvement of the current practices but also technical innovation, like the phone charger I mentioned earlier.

During my weeks of field work, I visited the energy centre many times. I found Vincent, one of the staff, busy repairing lanterns at least twice. He told me that when he was not busy with clients he liked to sit down and take a look at the lanterns the customers had complained about. The problem could be different things, either that the circuit board was not working and had to be replaced, the battery could be drained and had to be replaced, water damage, that the lantern had been dropped or heat damage. He explains that the customers had to be trained in how to use them correctly to reduce damage. For instance, during the rainy season the lanterns must be covered when you walk home with it.

“This one, an old woman brought it this morning. She had forgot it next to the fire, you see it is melted here. I have to replace the circuit board and then it will work again” he told me. Since they opened, only three lanterns have been “traumatised” to the extent that they could not be repaired. He had replaced around 29 circuit boards and 20 batteries, so this is an integral part of the job (Vincent, IEC staff, interview). I was also invited to assist with the repair, and I opened the lanterns, took out the battery etc. As a social scientist this is not something I do every day and I realised I would have needed some extra training to be able to be in charge of a centre like that myself. Maintenance was thus an important part of the work at the centre, and took place weekly.

Motivation

The attitude of key people must also be taken into account when studying how the Ikisaya model fared. The staff at the centre were dedicated to their jobs, and set to doing more than just offering lantern rental. Socialising and taking care of the customers are important as well. Jane, the current manager, explains her relationship with the customers:

> People come for different services, printing, typing, photocopying..so in that way, I do socialise with them, because when they come I have to talk to them, to be friendly with them, so I can know people with different characteristics. (…) If a customer come and I don't welcome him or her in a good way, maybe he or her will feel that they are not welcome, or think that she is not needed at that place, I plant in my heart that I will do my best to make the centre continue. (Grødtvedt, 2013, 11 min. 4 sec.)

When she was hired for the job, the board members emphasised her personal commitment, “she is really interested in what she is doing, it because of that, the strongest point when she got the job, we believe that she is going to do her best cause strongly she has the project in her

heart" (Grødtvedt, 2013, 2 min. 8 sec.). Her motivation in doing a good job, therefore, seemed to be more important than other possible reasons such as technical know-how or family/clan affiliation when hiring her.

5.5.4 The users

To understand how the Ikisaya model works in practice, the experiences and attitudes of the users and non-users must also be taken into account. In Ikisaya I conducted 31 interviews with villagers about the services. The vast majority of these were users. Some of the informants had been interviewed before the IEC opened in expectation about the services offered at the centre, and my interview, thus, made it possible to compare if they had used the services in another way than they had expected. One thing that struck me was that while most of the interviewees had answered in the previous survey that they would use the lantern to open a business, none of my respondents had done so.

People generally expressed positive feelings about the lantern rental and the other services. They said the lantern rental was cheaper and better than kerosene, and it had helped them in their daily lives: "it is multipurpose, portable and flexible, it gives light in all directions which is good" and "light is everything", "I like them because they have no heat or smell". The majority said they used the light for children to study or to have light while cooking in the evening. When I asked why they liked the lantern, many would mention the effect it had on their lives: "now we can see if there is a snake in the house", "it is easier to milk the goats after dark", "we don't have to worry about scorpions", "they are not flammable", and "it is safer to have in the house with children". Some of those who used the light for business said they had extended their opening hours in the evenings. One man said it was easier to have an overview of the shop in the evenings so that there was less snatching than before.

I asked the villagers what made them start renting the lanterns or use the other services at the centre. One informant said: "When I first heard about them, I was sceptical. Then I saw the first users, and I liked the light". The users around IEC had got information at the first public meetings when the project entered the village. Those who did not use the services were often excluded in the sense that they could not afford it, some said they never got interested in them. One informant had rented the lanterns for a while, but stopped because the battery became too weak. It was too far for her to walk when she had to go every day to charge instead of every second day. "Sometimes the lantern brings problem because it goes off before it should" she told me.

Although most people described the possibilities they got with the light, one informant said she preferred *not* to use the light in the evenings. She worked as a teacher during the week, and she then had to leave her village to live closer to the school. She was living alone and she said she felt safer when it was dark in the house, it was not necessary for everyone to know whether she was there or not. I also experienced something similar with the family I lived with in Ikisaya. Sometimes in the evening when a car drove by, or you heard talking or noises, people switched off the light, both for safety or privacy reasons. Too much light could be perceived as flashy or invading privacy. A man told me that his mum used to say that it is enough with one small light. If a person walks by, it is enough that s/he can see that there is someone outside, not how many they are. When I was drinking tea with the family outside the house in the evenings, we would have a lantern with us, but the light was set to the lowest light mode.

5.5.5 Putting the model into practice – initial challenges

When the centre opened in April 2010, it became apparent that what makes energy supply work in theory is something different in practice. The demand for the services was very low in the first two months. The interest from the community during the barazas and the surveys prior to the opening had indicated that demand would be high. One possible explanation was the users were unhappy they had to return the lanterns already after two days, and therefore didn't want to follow the rules in the beginning. Additional barazas and explanations were necessary to discipline the customers to use the product correctly, and to put forward that if no one used the services at the centre, or misused the lanterns, the centre could not continue (Ulsrud, 2012). The project leader says the IT-clerk (now centre manager), in particular, performed this task well as she is pedagogically gifted and an educated teacher. The demand for the services increased after the first two months, and soon all the lanterns were being rented daily.

Another issue had to do with management of the centre. When two master students arrived in the village to do fieldwork in autumn 2012, some people in the community felt that the families accommodating them and who worked as translators/drivers got too many benefits from the project, since the manager at the centre at that time was also from the same clan. This conflict was said to impact people's willingness to use the services. Local politics thus became a factor influencing the performance of the energy centre. That the users showed their dissatisfaction by not using the services, can also be seen as a healthy reaction to

mismanagement, or politics by other means. The problems were solved, however, when the board and the ST-leader reorganised the staff, and the use of the services soon got back to normal (ST-team leader, personal communication).

At the time of my field work, almost all the lanterns were being rented every day, and the centre met the economic targets to save money for the battery replacement fund. None of my informants among the users or the energy centre brought up this previous conflict or management as an issue.

Having heard about the initial challenges before entering the village, I was surprised that almost all the people I talked to expressed positive feelings about the centre and the services provided, and the ST project team too. This might also have to do with me being associated with the project, but the students visiting the year before got different and more critical responses. The information I got from the users indicated that the staff were respected and that the services were popular. Most of the complaints were concerned with the battery quality of lanterns, or the cost of the service, and not directed at the staff at IEC or project team members.

5.5.6 Relationship between the ST-team and the IEC

The staff at the energy centre told me that the contact with the project team members was very important.

> The contact with them is very important because if we have a certain challenge we do consult them, first we have a staff meeting, discuss that certain issue, then we contact someone from the team and explain to them so they can just give their view. They advise us on what we can do from there. They have been assisting us a lot. (Vincent, IEC staff, interview)

One of the staff told me that she used to contact the project leader the most. I asked her why she preferred to consult her and not some of the team members that were closer, geographically: “Because she has become my friend. We talk a lot about issues concerning this centre, she has been assisting me, giving me so many views. She is always very updated on what is going on here”. The team leader has regular phone calls with the staff, approximately twice a month. These phone calls last around an hour, and they discuss various things, both issues regarding the running of the centre but also how they are doing, their health and so on. The team leader's care for the staff goes beyond a mere project leader concern. She knows them well after these years. This contact has also been possible because

the team leader has devoted a lot of time and resources to the project. As the initiator of the project she has taken responsibility and contributed in coordinating the whole team and follow up activities of the project. She was also well known to the villagers in Ikisaya. When I conducted interviews with the users, several people asked me if I knew her, how she was doing and told me on their own initiative that they thought she was a really hard working woman. She has done more than what one can expect, and although the team were impressed with her efforts, she had also got a little criticism for this from project colleagues.

A former master student who conducted her field work in the village a year before I came suggested that it could be more viable to base the model on economic incentives than values like personal engagement (Berg, 2013, p. 88). She described this as a situation of dependency that could threaten the sustainability of the centre in the long run. Close ties between the ST-team and the IEC may cause dependency that makes it difficult to make the centre eventually stand on its own feet. At the time she conducted her field work, the centre had been operative for seven months. The situation I met one year later was different.

I found the staff at IEC to be self-going, motivated, hard-working and respected by the community, and it seemed like the follow up and the intervention by the team in problem solving in the start-up phase had actually strengthened the staff so that they had become more independent and aware of their role in making the centre continue than they were the year before. Informants from both the centre and from the team emphasise the close contact and the opportunity to follow up as an important factor for the project to go well, and also as something that was rare in other contexts:

> … the beauty of the solar transitions project was, you know am in consultancy, I know everything about consultancy, I know it hard core, you got a window, you deliver, and within the project finances, and [in] most of them, you don't have any time of follow up. But Solar Transitions is different because I tend to have the process of OK, we have done this, we've implemented it, it is up and running etc. but now we have this thing where we can keep coming back. You know, we sit down, and talk, how are things going, what do we need to change where. And that has helped them [the staff] evolve up to a point where it is no longer required to go visit them. (Maurice, ST-team member, interview)

The practice of seeking the team for advice was still present but technical innovations, identification of and training of other people and the daily running of the business and communication with the customers was done by the staff at the centre.

5.6 Competing infrastructures – the grid is coming

When the project selected a village for the pilot, one of the criteria had been that it should not be likely that the electricity grid would come within the next ten years. Therefore it came as a surprise to the project team that the government suddenly decided that the national electricity grid was to be extended to Ikisaya. When I did my field work the construction work for setting up the grid in the village was almost complete. I thought to myself one moment "will the whole energy centre become irrelevant?" It quickly became apparent that it would not. I asked all of my informants in the village if they were planning to apply to have their house connected to the grid. No one said they would, because it was too expensive. Some informants also asked if the energy centre would close, now that "electricity" had come to Ikisaya. I explained that it would not, and they reacted with relief. They were worried the solar powered services would disappear, because they could not afford to connect. The connection fee in 2013 was 35,000 KES (293 Euros). If the customer lives further away than 600 meters from the power lines, (s)he is responsible for paying for the additional cost of extending the line to the house (Ulsrud, forthcoming).

So even though an infrastructure with the potential of providing better energy services was about to be put into place, almost all the households were excluded in practice. This is an argument for solar energy. The solar services are simpler than what the grid can provide you, but they are available to more people. It also shows that areas reached by the national electricity grid are not necessarily irrelevant to electrification with solar.

5.7 Discussion: Which factors made the Ikisaya model work?

Now that the different elements of the model and the relationship have been explored, what factors were important for the model to work in Ikisaya? How can the concepts from the theory chapter be useful in explaining this? This section aims to give an answer to that.

5.7.1 What is the Ikisaya model?

To understand what made the model work, it is first necessary to somehow sum up what the Ikisaya model is. The description above shows that the Ikisaya model is composed of both technical and social elements. The Ikisaya model is thus composed of the physical energy centre, and the surrounding infrastructure, including lanterns, solar panels, cables, phone

chargers, batteries etc. It is also made up of the social infrastructure; the staff, the users, the project team following up, and the learning practices taking place in the process through every day tinkering with the technologies. The model would not have been what it is without these relations. When taking these relations into account it becomes clear that the model is composed of networks, that are upheld through the interaction between technical and social elements, for instance through the repair of lanterns, the knowledge of the staff to do this, the users liking the light and the services. It is, in other words, no clear cut definition of the centre, it is composed of both physical and social elements but also practices, and these change from day to day. This blurs out the distinction of what the model is and what makes it work. I will elaborate further on this in the following paragraphs where I will discuss the empirical findings above in relation to the concepts of script and domestication and care and maintenance.

5.7.2 Script and domestication

In the theory chapter we saw that both technology designers and users matter in shaping technology and making it work in new places: “Design and domestication are two sides of the innovation coin” (Oudshoorn & Pinch, 2003, p. 16).

The lanterns were designed for use in off grid rural areas. The flexibility of the lanterns was brought up as a feature that pleased the users. Just like De Laet and Mol (2000) praise the flexibility of the bush pump as a key to its success, the lanterns were designed so that they could fit different situations where light is required. Different models were available, but the differences were not fundamental, it was more of a question of preference: the old mamas preferred the lighter lanterns such as the Prakruthi, while some preferred the India lantern because it gave light in all directions, and some the smart design of the Sun King. The designers had done a good job in meeting the needs of the customers in this respect, but there was a fundamental weakness of the lantern that restricts the usage: the battery in the lantern has a short life span, and deep discharging shortens the life significantly. Here the script of the lantern did not match the context in which it was to be used. Ideally, the lantern should stop working the moment it *should* be charged, to protect the battery. It did not make sense to return the lanterns when they seemed to be working fine, and the customers felt they had not got what they paid for. “But there is still light” a user said when she returned her lantern to charge.

Weak batteries – a technological or social problem?

Akrich (1992, p. 220) describes a circular argumentation when a technology is not working like it should. Users blame the technology for not working, and the producer blames the user for misuse. A similar argumentation could be seen in Ikisaya. Both the project team members and the staff at IEC said that the customers had to be disciplined and taught about correct use. It is understandable that the customers wanted to keep the lanterns longer, but if they were taught why, that it was a technical reason (and therefore non-negotiable) that was behind the importance of punctuality, then they would come on time with the lanterns.

The users' attitude to this differed a lot. Most of the users said they wished they could keep the lanterns longer, but they explained why they couldn't and said they understood. "It is technical so there is nothing you can do about it", one user said. Others could blame the staff: "the lanterns are not fully charged, they are not well maintained", or they would blame the technology: "the lanterns are not working properly, they have become weak". The low battery had made some of the users stop taking the lanterns, because it was not worth it when you had to walk every day in order to charge. The discussion of this issue, between the users and the project members and staff, is useful to illuminate how interlinked the technical and social is, and how it is now it is not obvious who is responsible when a device doesn't work.

Rental *versus* ownership – a hindrance to domestication?

Very few households were owners of the lanterns, since the model is based on renting and not purchase. Can the artefact then be domesticated? I would say yes. It became a habit and a routine to come for the lanterns at IEC. One user said she could not imagine going back to kerosene again. The times I was at the energy centre in the mornings, people came by, dropped the lantern to charge, chatted for a bit and then went back to work. In the evening they returned to collect the now fully charged lantern on their way home. People adapted the lantern use to their needs, and it was not a given that the light should be on all the time, like when relaxing outside the house in the evenings. In this sense the lanterns had become domesticated, although the lantern usage may change over time.

So far I have only discussed the use of lanterns, but the energy centre as such can be said to have become domesticated as well. It was not alien to the people. Located centrally at the Ikisaya market square, it was hard to miss. The staff were good with the customers, friendly, and perceived as dedicated to their job by both the project team and users. The energy centre became a meeting place where people watched TV and listened to music, or just chatted with

others. The centre was domesticated in the sense that the community owned it, knew it and liked it. This does not mean that all of the services offered there can said to have become domesticated, but more that the energy centre as a point of reference had become an integral part of the Ikisaya community.

5.7.3 Care

Care was also an important element in the functioning of the centre. The staff at the centre took care of the lanterns, repaired them, wiped dust of the solar panels, talked to the customers. The staff were also passionate about their job and really wanted the centre to continue, and this was expressed through how they treated their customers as well as the technical equipment. The care concept introduced in the theory-chapter thus becomes relevant, as it encompasses this double meaning of care being a process of maintenance and doing what is required, but also something that goes beyond that- care for the customers and for the centre as an institution of importance for the community as a whole.

The relationship between the energy centre and the project team can also be understood as care. The project team members did care for the well-being of the project, but also for the people in it. The team leader found the close contact and follow up to be of great importance to the project going so well It was in this way that different challenges were solved, not by the staff or the board at the energy centre, not merely by the team, but through consultation with each other. The mutual care between the project team and the energy centre seems to be a two-edged sword. It enhances the performance of the energy centre locally in Ikisaya, and strengthens that exact project, but it makes it more difficult to replicate or up-scale elsewhere.

When discussing the social elements of the model, it becomes clear that the contact between the staff at the centre and core project team members were important in the operation of the centre. Regular phone calls and visits by the project team members were used to give advice, ask for advice, exchange ideas and discuss solutions helped in making the model work smoothly. The ST-team is international and none of the members are permanently based in Ikisaya, but this did not prevent care from being integral to the model. The social proximity to the Norwegian project team leader was more important than the geographical proximity of the Kenyan partners to the manager at the centre. They had become friends. Although a critique that came up was that this could lead to dependency, the personal engagement might have been exactly what motivated the staff to keep doing a good job, or this contributed to a low threshold to share ideas because team members had time to listen and were interested. And

also the other way around, the project members were also interested in how things were going.

Contact between the staff and the team had also resulted in a technical innovation, as the development of the phone charger with many ports is an example of. The continuous follow up from the project team may thus be understood as care for the project and for the staff. Also, the staff's work with following routines, repairing the lanterns, and asking for advice when in trouble also made them learn along the way, and contributed to upholding and further development of the model, both in terms of the technical aspects and the relationship with the customers.

I did not touch upon training and learning explicitly in the theory chapter, but my findings suggest that the training of the staff, combined with learning through experience was a key part of how the Ikisaya model worked. The staff had received ten days of training, and they did themselves elaborate on how their learning had enhanced since by working with the technology. I also witnessed the staff use this knowledge in practice by doing repairs.

5.8 Conclusion

In this chapter I have sought to answer my second research question: *What factors were important for the model to work in Ikisaya?*

By describing both technical and physical elements as well as the social infrastructure around it and the relationship between these, I have shown that what the Ikisaya model is and what makes it work cannot easily be separated. This is because the centre is being created and upheld through every day practices between these elements. By applying the concepts of script and domestication, I showed that the script of the lanterns is relevant for the customers. This way both the lanterns, but also the centre as such, become domesticated in the community. But the relationship between designer and user is not enough to explain what makes the centre work. I have argued that practices of care and maintenance and everyday tinkering were all important in having a functional model. This involves regular phone calls between the team and the staff at the centre, customer care, the staff taking care of the lanterns and doing repairs on a regular basis, the staff getting more knowledge through these activities and so on.

6 Third translation: From centre to agents

The Ikisaya model started out as an energy centre, but an important translation happened after implementation. The energy centre developed into a decentralised model with surrounding "agents". The purpose of this chapter is to describe this further development by answering the third operational question: *what translations happened after implementation?* Data sources in this chapter are based on my own data collections as well as secondary documents. Important theoretical resources to explain the developments are care, translation and flexibility.

6.1 From centralised to decentralised model

After IEC had opened, adjustments and changes were made to the initial plan. As mentioned in the previous chapter, people live very scattered in Ikisaya, and this had consequences for their access to the services at the centre. Many people walked to Ikisaya market every day in order to fetch water from the water point, and that was also part of the reason the energy centre was built at Ikisaya market in the first place. People from even further away started to come for the lanterns, and for them it was a long way to return them after two days (Ulsrud, 2012, p. 1). A previous manager at the centre was living in the neighbouring village Endau, and he started to rent out lanterns to people there by bringing lanterns on his motor bike as he went to work and back. The interest in renting lanterns grew in the community. That's how the idea of making smaller energy centres in the neighbouring villages, or agents as they are being called by the team, came about. One of the staff at the energy centre explains:

> So when we realised that people from the neighbouring sub-locations were so positive and people came even from Malalani to here and back again, use it for two days and come back again, we realised it was becoming quite expensive to them, the distance is long and they're spending a lot of time. So we decided that we can now open up sub-charging stations in Endau and Malalani, so that we can have services near them. (Interview, Vincent, IEC staff)

I asked if the idea of setting up agents in neighbouring villages came from the villagers, the energy centre or from the ST-team. The staff at the energy centre told me that when they saw how positive people were in the sub-locations, they informed the team about it. The team

leader said that Maurice from the team had mentioned the idea to her, but when they came to the village the staff had already thought of it themselves.

> It was a collective way forward, to open those substations, so that the services could be near the people. So we realised we can now start to expand this system with opening agent charging stations in different places where people are positive and need assistance in light. (Vincent, IEC staff, interview)

The agent is typically located in an already existing building, often a small retail shop. It is not necessary to build it from scratch as was done with the energy centre. A solar panel is installed on the roof, and a limited number of lanterns and cables to charge phones are installed inside the shop. The shop owner does the lantern and phone rental in addition to his other business. There were five agents around Ikisaya energy centre at the time of fieldwork; Endau, Malalani, Yiuku, Kathua and Ndovoini (see map). I visited all the agents during field work, and will elaborate on what I saw in the next paragraphs.

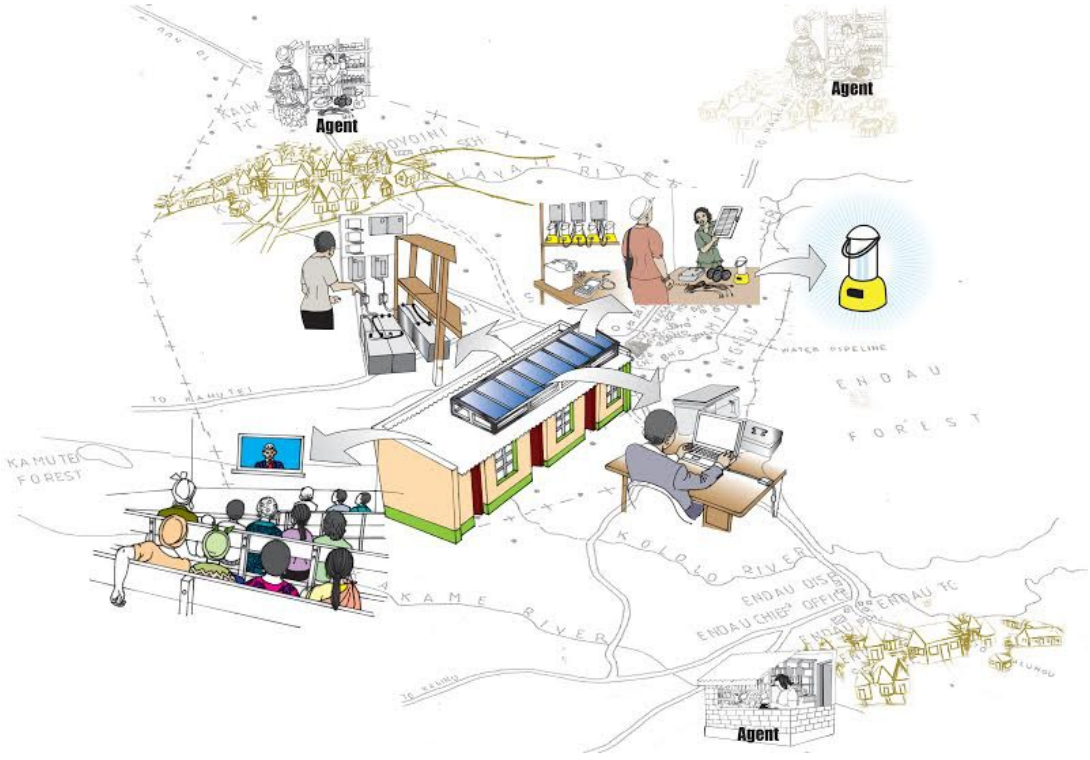


Illustration 8: The Ikisaya model develops: Energy centre with agents. Malalani (up right) and Endau (down right) and Kalwa (up left, but this agent is now closed down),. Since this illustration was made 3 new agents have opened in Kathua, Yiuku and Ndovoini. These can be seen on the map of Ikisaya village. Illustration made by M. Mabwa. and C. Muchunku., upon request from the ST-project.

Endau

Endau village is bigger than Ikisaya, and located ten km. from the IEC. The area has one primary school and one secondary school, and a weekly market with many visitors. This was the first agent that opened and the current employee, a 20 year old woman, has been in charge since May 2013. It was her first job, before this she was a student. The services offered were lantern rental and phone charging. The agent is located centrally in Endau, near the big market place. Because of this, many of her customers are local businesses who use the light to stay open longer after dark. One challenge she reported was that the batteries had started to fade in many of the lanterns and she found it difficult to enforce the fine when customers returned the lanterns too late. The centre has the capacity to charge 71 lanterns and a number of cell phones. The demand is high and most of the lanterns are being rented daily. Thursday is market day and that's when she has the most customers. She tells me the staff from the IEC comes regularly, often by the end of every month, to collect revenue.

Malalani

Malalani is located around ten-fifteen kilometres from the energy centre, and also houses the local administration for the Malalani location in which Ikisaya is a part. There is a secondary school in the village, and a number of smaller shops, although not as many as in Endau.

The first agent in Malalani opened in 2012 but the current agent, also a young woman, had been working for just a couple of days when I came to visit. The staff at the IEC had installed the equipment. The previous agent had been closed down due to mismanagement and when she heard that the staff at the IEC were looking for a new agent, she went to Ikisaya to tell them she was interested in the job. The services offered were phone charging and lantern rental, and there were 30 lanterns in total. She said the number of lanterns had exceeded the capacity of the junction box, so to charge all the lanterns she should ideally have another junction box.

She did not have much experience to share at the time of field work but she was optimistic and found the demand to be high. People were already used to the lanterns in the community so she did not have to start from scratch in terms of marketing the services and disciplining customers.

Kathua

Kathua village is located approximately ten kilometres south of Ikisaya. There are around 180

households in the village, and around ten businesses. The agent was located in a small shop selling groceries and run by the 39 year old shop owner. It was also quite new and had opened in July 2013. It differed from the other agents because it was also testing out a different charging system from the company “Mobisol”. This technology has mechanisms for remote monitoring of the charging so that the number of lanterns and phones charged is registered on the internet and the amount the agent owes becomes traceable. If the agent doesn't pay the amount (s)he owes, the system can be switched off from remote. The system did, however, not work as intended. It was possible to charge both phones and lanterns but the records were inaccurate: if a customer came to charge a phone, and then came back to make a quick phone call, this one phone counted as two phones as it was put back to the charger again. It was not uncommon that people came to unplug their phones during charging and the records were thus unreliable. The technical equipment was installed by the technology provider Mobisol but one of the staff from the IEC accompanied them.

Most of the customers are housewives, the agent told me. He found it tiresome to explain to all the customers why they have to return the lanterns after two days. They often brought the lanterns too late for charging, so they didn't become fully charged before the evening: “they are supposed to bring them at ten but they come at four in the afternoon. Then I fine them 10 KES but it is difficult” I'm told, and he continues: “the only help I need is how to tame these customers”. He explained that they overstay with the lantern because when they have paid, and maybe only used it for one hour outside the house, there is still a lot of light left, and they find it unfair to return it.

Yiuku

Yiuku is in Endau location, and has 467 households and 37 businesses in total. This agent opened the same day as the agent in Kathua, since this agent is also using the Mobisol technology. The middle aged man in charge of the business offers phone charging and lantern rental, and he has ten lanterns for rent, all of them Sun Kings. In addition to being an agent, he has a green grams cash crop on the side. The technical equipment was installed by the Mobisol company, but staff from Ikisaya accompanied them and trained the agent in how to do the book keeping. He finds the demand for lanterns to be high, but dealing with the customers can be difficult: “people want to use the light as a phone..until the battery goes out. We have to explain to them every time, and they get used to it, pole pole[21]” He also tells me

21 Pole pole means slowly, or little by little in Kiswahili.

that people are requesting more power, if they can have a TV for instance. Customers had also been requesting the India lantern, because they think this model has better light and they want to compare.

Ndovoini

This agent opened in August 2013, after it had been moved from a neighbouring area where the agent did not perform well. This transfer and the installation were done by the staff at IEC. It is run by a middle-aged couple, who also have a small café establishment on the side. One day they received training on book keeping and how to charge the lanterns. Lantern rental is the only service offered, and they have 10 lanterns available. All of them are being rented on a daily basis, and people are scrambling for them. The customers here also wanted to keep the lanterns longer than they are supposed to – and some also complain about the price. “It is now very dry, and then the income becomes a problem. Some cannot afford it”. If a lantern is returned too late they do not always enforce the fine: “I don't tell them to bring the fine, but I explain the reason why they have to be punctual. You have to fix things to have customers, you know”. They had been informed why they had to return the lanterns early at a local public baraza, the agents told me. Two of the customers are teachers at the local school, two are business people and the rest mothers. In the case of a problem, she or the husband goes to Ikisaya, but they also have regular visits to Ikisaya themselves for other errands, and then the staff at the IEC ask how they are doing. This agent had been open for two months at the time of field work, and the agent did not report any technical problems so far.

To summarise, the agents seemed to be much simpler than the IEC At first sight it was just a shop with some lanterns and cables in a corner. The people in charge had received little training compared to the IEC staff. The people in charge were all fairly new and did not have so much experience to share yet. But the agents themselves, the staff at the IEC and the project team said they were all enthusiastic and said that things were going well and that the business from the agents was very good. So how were these agents linked to the Ikisaya model? I will in the next section discuss the relationship between the IEC and the agents to shed light on the translations that took place after implementation.

6.2 Relationship between the agents and Ikisaya Energy Centre

The technical equipment was installed in independent shops, but the agents were, in turn, managed by the energy centre in Ikisaya. The shop owner got to keep 30 % of the amount (s)he made, and the rest had to be paid to the energy centre. Each agent, therefore, had a book to record their transactions, and the staff at the energy centre would look at the books when they dropped by. There was no fixed time they would drop by, this happened regularly, typically combined with collecting revenue from the agent or other errands either at the agent or in the village s/he was located.

The two agents first opened in Endau and Malalani. The actual installation of the equipment in these villages was organised by the ST-team. The first agents in Endau and Malalani was installed by technicians coming from Nairobi, but the staff at the IEC also came along. After the installation of the first two agents, they had become acquainted with the procedure and were able to install or remove the systems themselves. The agent in Ndovoini was installed by the staff from the centre themselves. The agents in Yiuku and Kathua use a different technology supplier, and employees from the company came to install the equipment. I asked the staff at the IEC how they went about in opening a new agent:

> First we have meeting with the staff here, we saw it important to place the agent, and we do consider the population and the income of that area. Then we, like in Yiuku and Kathua, to get an agent, we planned to visit those areas and just visit different shops and talk to them and see how they behave, how they do approach their clients, also we looked their building, so from there we just ask the person. Like in Kathua we went, I visited different shops, talked to them. later I went to where you saw our equipment, I talked to that man, I saw him being good and to costumers, social, polite, approaching the customers well, and also the kind of building was neat, strong, later I asked him whether he can manage if we install our equipment there. So he told me that it is good, and he can manage, and run the business, also my colleague went to Yiuku and did the same. (Jane, IEC staff, interview)

The current manager at the centre explained to me that she had attended the installation of this agent. She said the technician coming from the company had been a woman, and that this inspired her.

> I was very interested by one girl who came to install our system in Kathua and Yiuku, she was a girl like me [laughs], and she climbed on the roof and fixed everything, solar panel, batteries, everything. I was eager to know, I was asking how, what do you do, can I do this, can I do that, [laughs]. (Jane, IEC staff, interview)

So, even though it was a technician coming to do it and not a formal training session, the manager was interested in learning and increasing her understanding of the technical aspects of the system. This shows that the staff at the IEC was important both in deciding where the agent should be and who should be in charge. A careful selection took place. If the agent did not perform well, this also had consequences. There had been challenges with dishonesty and stealing in the start-up phase with some of the agents, but the staff from the energy centre had closed down two agents that didn't follow the rules: “It has been revealed to us that some of the agents started to steal, they were hiding money” (Vincent, IEC staff, interview).

This had so far happened twice, and in both cases the staff from IEC went to the agent in question, took down the solar panel and collected the lanterns. A neighbouring shop or a neighbouring village got the chance to try instead. This had happened in Malalani and in Ndovoini. I wondered if the removal of the agent caused conflict in the community, but it had happened without drama I was told. When the staff selected new agents they also made clear that there was no acceptance of cheating, and also argued that their honesty mattered for the surviving of the whole solar energy centre system in the area, and that they mattered for the community. The project team leader found that the relationship between the agents and the IEC was based on trust, and that it worked without additional measures like technology to discipline them.

This section has shown that the IEC was very important for the agents. They suggested which area was suitable, and who should be an agent after certain criteria, and they also closed down agents that broke the rules. The staff trained the agents, and in some cases also carried out the technical installation.

6.3 Relationship between the agents and the users

Several of my informants amongst the customers complained about low battery quality, and that they, therefore, had to charge the lantern every day instead of every second day. In Ikisaya you don't have to pay extra because of this, but some of the agents told their customers to pay each time they came to charge. It is not known if they did this because of a misunderstanding or because they wanted to earn extra money. Some of the customers had stopped taking the lanterns because it became too expensive when they had to pay 20 KES every day. One informant in Malalani explains:

> I started to take the lantern, and I did it for 6-7 months, then I stopped because it became too expensive. […] The first agent here she did not manage well, she was rude. Also I think the lanterns in Ikisaya are better, these are not well-maintained. But the new agent, if she will be charging the lanterns fully, I may come back later. (User in Malalani, interview)

It may be that the lanterns' battery quality faded earlier for other reasons, but it was perceived as the agents' responsibility when the technology started to fail. Also, when it became clear that a former agent was hiding money, this made customers unhappy. The presence of a new agent, thus, evoked optimism for better service and better quality of light. When the agent is not doing her/his job properly, this will be reflected in the technical equipment too: "The last agent did not manage things well, the lanterns had to be charged every day". In Malalani, one user said that she considered taking the lanterns again now that the former agent had been replaced, because she knew the new agent was a good girl. Who the agent is, if it is a trustworthy person thus matters both for the technical aspects, how the lanterns are being taken care of, but also how they are perceived by the community.

The customers of the agents in Endau and Malalani complained, generally, more about the light and quality, and having to return them earlier than the customers around IEC. There may be different explanations. One reason for this problem being bigger in Endau could be that this is where the lanterns were first being transported via motor bike between the IEC and Endau before the agent opened, and they were often not returned to charge in time. The previous agent in Malalani had been closed down because of mismanagement.

The agent is also one link further away from the ST team, and does not have the same direct and close contact and follow up as the energy centre. The agents had also received less training (about one day) on how to use the equipment and on how to do the book-keeping. The review of the agents shows that they were inconsistent in collecting fines, and that it was not necessarily the best way to go if you wanted to have a good relationship with your customers, especially when you are new in the business.

6.4 Training of the agents

The first day I visited the energy centre in Ikisaya, I found one of the staff busy showing a young woman how to record the lantern rental in a book. This woman was going to be a new agent in the neighbouring village Malalani. She, therefore, received training on how to run that shop, how to charge the lanterns, and how to do the book keeping. The training lasted for

half a day, and she was to open the shop the following day. All the other four agents in the area had received similar training. It was less comprehensive than the training the staff had received. They were not supposed to know how to fix and repair technical equipment, it was seen as sufficient to know how to run the business and how to charge the lanterns, phones and check their battery status. The energy centre in Ikisaya was still supposed to be in charge of the technicalities, so the agent could call the staff in case of a problem.

Vincent told me that he dreamed about having up to 20 agents that the IEC could be in charge of, but admitted that it would be too much work to do maintenance for all of them. He said he was willing to train the agents more on repair, and provide them with spare parts so that they didn't depend on him for small issues. The project team members did, however, not find it necessary or important that the agents got more knowledge and responsibility for repair. The project team member working with the up scaling in Turkana, Kenny, told me that there was a limit to how much you could teach the agents, because it was better to have a centralised repair station. He had seen for himself how those with experience – who were handling solar technology every day- quickly got a grip on things and could solve problems, while those who had attended a formal training once, but rarely got into repair situations would be less handy with them. He, therefore, argued that the employees at the IEC were clever with the lanterns because they were in charge of all the technicalities, and handled repairs on a weekly basis. It was less likely that the agents would be equally busy. Also, with less training and less practical experience, there was a risk they could break something. This had happened at a solar power station in a different region. He had received a call from that agent saying that the system had broken down. When he went to check on it, it turned out that the agent had tried to use the battery for something it was not meant for – to power a fridge, and that's why it had stopped working. These kinds of situations could happen when the agent doesn't know the limits of the technology (Kenny, ST-team member, interview).

The agents had not been operative for a long time, but I wanted to check how the maintenance situation was since this could shed light on how the model worked. Most of the agents told me that there were some parts that did not work properly, for example a lantern, or a cable. The agent in Endau said that sometimes lanterns had to wait for charging, because all the cables required to charge were full. The IEC had yet to replace it. She did some repairs herself, like replacing batteries. Sometimes when a lantern battery was discharged, the user would still press the "on" button until it got stuck inside the lantern. It was then necessary to open the lantern with a screwdriver to put the button back. It was still not a very advanced problem,

and the agent said that she used common sense in most of the problem solving she was faced with. There were no signs of a severe lack of maintenance in any of the agents visited and it seemed like the over-all systems could operate just fine, even though some lanterns or cables were not functioning. These were minor issues. The staff at the energy enter came on regular visits, and would then bring the spare parts required, or bring new lanterns if necessary, as well as checking on their books.

All the batteries in the India-lanterns were replaced after my return to Norway. The team leader told me that the agents took part in this work. This way, the technical know-how can be said to have enhanced even though they received less formal training.

6.5 Discussion – what translations happened after implementation?

While we in the last chapter got to know the Ikisaya model, this chapter has shown that the model continued to develop after implementation. I will in this section analyse these developments by using the concepts of translation, care and mutable technology.

6.5.1 Translation

This “natural” development of the Ikisaya model fits with Elam and Sundquists (2011, p. 248) understanding of technology having to be communicable and translatable in order to survive. The gradual development from centre to agents was based on practice, by first taking the lanterns to Endau and back by motor bike. The interest grows as many people like the light. Soon an agent is established in Endau. The same thing happens in other villages. The agent is selected by the IEC-staff based on certain criteria, not anyone can get the responsibility.

While the photo-electric lighting kit described by Akrich (1992) fails when meeting the users, the lanterns continue to spread because the designer has projected the users right. But this doesn't happen all by itself. The staff at the IEC are important mediators in spreading them. Through their knowledge of the local context it is easy to find the right people to be in charge and to know where there is demand for the lanterns or not. A successful relation between the IEC and the surrounding villages has, thus, been established. And the relations are not stable: if an agent doesn't perform well, the staff come and closes the agent, and a new one gets the chance. It is tempting to start to describe the Ikisaya model as a flexible model here, because

of these changes and the constant developments taking place. But there is as much happening because of the efforts of the staff, taking us to the next concept of care and maintenance.

6.5.2 Care and maintenance

The IEC was crucial for the well-being of the agents as they had the necessary tools, spare parts and technical know-how for more advanced repairs. Their role in overseeing agents ensured that breaking the rules had consequences, thus holding the agents accountable. The users and the neighbouring shops saw unreliable agents being closed down and this worked as an incentive for the agents to follow the rules and increased the trust that the users held towards the centre.

All though I had expected the agents to perform poorer than the IEC, because I assumed they had received less training and follow up, the links between the current number of agents and the IEC seemed to be fairly strong and sufficient to keep it going. Phone calls with the staff at the IEC, regular visits from them and careful selection of the agents, as well as procedures for rapid closure of those who were dishonest, were mechanisms that made the “agent model” work in practice. Improvisation – “I use common sense” and “they will bring it when they drop by” – proves that repair, maintenance and learning are constantly taking place. The commitment of the agent also matters. An agent who is not doing his/her job properly will not only become unpopular, but will also make the technology fade.

6.5.3 Is the Ikisaya-model flexible and mutable?

De Laet and Mol attribute the success of the bush pump to its flexibility, both in mechanical design, but also because it is a public domain and nobody owns it (de Laet & Mol, 2000). But while the bush pump de Laet and Mol describe could work because of its simplicity, “Years of experience have gone into paring it down to a minimum” (Law, 2007, p. 14), it is also mechanically malleable, and some of its components can be replaced by other materials It can even work even though some of its parts are missing. None of the technical devices I have described can be said to be equally flexible. If a charging cable is broken, it needs to be replaced by another one as it is not possible to use leather or other materials. But the system, as such, can work even though one cable is missing, or if some lanterns are broken, as long as they will be replaced or repaired at some point. The technology wears out over time, and the way the technology is being used, is taken care of, the presence of funds to finance repairs and the dedication of staff and project team influence the flexibility of the model.

The Zimbabwe bush pump was also a success because it was a public domain, and the community took part in deciding where the bore hole should be, and they also took part in installing it. This is also the case with the Ikisaya model, as it is owned by the CBO. The local knowledge of the staff became relevant in developing the model, they knew best where agents could be installed, and who could be in charge. The way that both the staff and the agents gained more knowledge through everyday tinkering with the artefacts showed that this may be a way of overcoming the restrictions of the fluidity of technical components of the model.

6.6 Conclusion

This chapter has sought to answer the third sub-question: *What translations happened after implementation?* I have shown that the Ikisaya model continued to develop after implementation. Agents offering lantern rental and/ or phone charging have opened in five surrounding villages. I have argued that that these translations took place because of the flexibility of the Ikisaya model, and that this flexibility or fluidity was partly a result of the model being owned by the community: the staff at IEC came from the community and their knowledge was important in the further development of the model, such as selecting where the agents could be, or closing down malfunctioning agents. This enabled the smooth translation from energy centre to a decentralised model with agents, and I have argued that this could not have been done by actors who did not know the local context equally well. Care also mattered in this process, as the well-being of the agents also was depending on the support from the IEC in terms of training, maintenance and follow-up.

Now that up-scaling is attempted and desired, both by the team and other actors, can these elements be transferred? Or is it a paradox that the next step – the up-scaling, cannot realise or bring along the elements that were important for the smooth functioning of the Ikisaya model. What happens when the Ikisaya model travels to Turkana and is attempted up-scaled? That will be discussed in the next chapter.

7 Fourth translation: From pilot to up-scaling

In the previous chapters we have followed the development of the Ikisaya model, but the goal of the ST project was to find a model that could be relevant for other places too. This chapter will investigate the process of translating the "Ikisaya model" to Turkana. This is a process of technology transfer, but it is also just as much about translating a pilot project to the up-scaling phase. By studying what happens in this phase closely, the aim of this chapter is to answer the fourth operational question:

What negotiations does the Ikisaya model go through as it is attempted up-scaled in Turkana?

The empirical data in this chapter is primarily based on my own data collection. Important theoretical resources will be translation, care and maintenance. The ST-project has now formally ended, but the activities it started continue into different directions. The team has got the project Solar xChange, also funded by the Norwegian Research Council, that allows for research activities in Kenya and India to continue. New places and projects in India and Senegal are included in this follow-up project. The research of the ST-team has also lead to practical action and attempts to replicate and up-scale solar power distribution based on the experiences from Ikisaya. One of these efforts was initiated by Kenny, a team member, who also works for the Kenyan national energy company. He is currently working hands-on with making the Ikisaya experiences relevant in Turkana, with support from the project team.

7.1 From pilot project to up-scaling – reflections from the ST-team

I discussed the challenges associated with going from a pilot phase to an up-scaling process with all my informants from the team. The pilot phase was perceived as a safe haven where all the learning happens, before you enter the ruthless world "out there" – just like a laboratory. One of my informants from the project team emphasises how the pilot project allows for more learning than you rarely find under other circumstances, you are allowed to

come back and test, follow up:

> We can keep coming back, you know, we sit down, and talk, how are things going, what do we need to change, where, and that was has helped them evolve up to a point where it is no longer required to go visit them [the energy centre]. (Maurice, ST-team member, interview)

Here the pilot is described as situation that provide unique possibilities you normally don't have. It allows for that care and follow-up that I argued was a crucial reason for why the Ikisaya model worked. Another team member who also worked for a company selling solar PV appliances, looks at pilots as a mere learning phase before further action is taken:

> The pilots have their own role, to know things, it is helpful to pilot and get to know how to do it, get to know the community and the rules of engagement, the capital costs involved, the operation costs. So the pilot it is very, very important. Having said that, moving from pilot to scale is usually the biggest challenge, and as a business person it is also what I'm struggling with. Because I don't wanna sell 200 lanterns, 300, I wanna sell a thousand. Ten thousand. So how can I do that? That is an important question from a business point of view and a researcher point of view. Because even as a researcher, until we figure that question out, the question of scale, our contribution to the off-grid systems will be limited. (Gregor, ST-team member, interview).

This quote reflects a common challenge in an up-scaling process both from a research and a business perspective. So all though the research pilot works, it came into being under protected conditions, and the experiences won't be relevant if no one can use the knowledge that it creates.

One of the team members found that the pilot had also taught them how *not* do things. He found that creating both the physical and social infrastructure from scratch in Ikisaya was unnecessary:

> We have learned many lessons. And one of them is that this physical infrastructure of doing a solar centre as a physical infrastructure is not sustainable. If I was to do this again I would not do that, I would not construct a building. The capital costs are very high, ehm, and the building is unnecessary. And the other lesson is that in terms of management, the CBO model is also complicated, because dealing with communities is..you know they have their own issues, who is responsible, who has ownership, these communities are always changing, community has issues, about leadership, you know leaders keep on changing, ehm, sometimes you know you messed up with this leader and another time he is not there and the other thing, the challenge of revenue sharing, how do you share the revenue in a community, how do you share the losses, every time there is a money issue. Even before you introduce money, organising and managing communities is difficult, just inherently. (Gregor, ST-team member, interview)

Based on the Ikisaya experience, Gregor here finds the model to be too costly but also too

complicated. As mentioned in the introduction chapter, rural electrification with solar PV in Kenya is predominantly market driven. This also influences what room for manoeuvre the team has when thinking in terms of up-scaling. As already stated, the interviewed team members found that setting up the whole infrastructure from scratch in Ikisaya had been both time and resource consuming, and led to unforeseen challenges with regards to entering a community. They saw obstacles to replication, at least if the replication was to be economically viable. The question of *who* should do it becomes relevant. If a business was to replicate, the profitability had to be higher than if it was about public service provision. In Kenya, with no current government subsidy for solar PV, it was more likely to reach people in need of electricity if the model could be interesting for business.

> Ok see, when we look at revenues, you start with the energy centre as a concept, and you say how do you roll this up, and the question is: who is going to pay for it? so the interesting for business is how much am I investing and what's my return, and how soon will I get my return, but it depends of course on who is investing. This Kenyan energy company is looking at replicating and up-scale, what is the simplest, most effective way to replicate? and what makes good business sense? and the agent model where you are just doing the lights and phone charging, is the simplest, you don't need to build the centre, you don't need to train anyone, you can work with existing shops, it takes half a day to set up, and it is up and running, and all you need is an agreement saying that whatever money you make I want this no..it is very quick to develop and roll out. (Maurice, ST-team, interview)

In order words, translating the Ikisaya model to a model that can be interesting from a business perspective demands a model that is as low-cost and efficient as possible. The Ikisaya model on the other hand, never was about making something as cheap as possible, but about testing and experimenting within the protecting frames of the pilot project, with funding secured for that purpose. The up-scaling thus becomes a whole different project:

> It is a simple numbers game. You got a fixed budget, let’s say five million KES, and of this money you have to allocate both capital costs and operations. And choosing between the solar centre model and the agent right, you just do numbers and you see that..well of course, you have your target, how many people do you want to reach? Yeah? Maybe with this money, my aim is to reach 10,000 households, simple numbers game. (Gregor, ST-team, interview)

This indicates that while the primary focus of the pilot project in Ikisaya had been to experiment, test and learn, the up-scaling process is about replicating the findings in the most cost-efficient way. If that cannot be achieved, the model would be irrelevant from a business perspective, and it would travel no further. The project team leader agrees that there are

challenges in up-scaling the Ikisaya model as it is today, because of the level of follow up required:

> Close follow up is important, and I feel that we maybe have failed a little in making an up-scalable model because of this. I'm happy things are going well in Ikisaya, it is an example for others. But you get a lot of punches in the face along the way, when you see that what you thought would work doesn't work. So you have to solve a problem. Think. And adjust, so things fall into place. (ST-team leader, personal communication, my translation)

This reflection shows that making the model work is as well a learning process for the team members. In the aftermath they see that what made the model work in Ikisaya may not be easily up-scalable. The project team leader does not dismiss its relevance for other actors, it can still be relevant if it is implemented within an existing organisational infrastructure:

> I think the energy centre model can still be useful or relevant outside Ikisaya, it depends on who are gonna roll out. The success depends on many different things, but some kind of organisational apparatus is important: someone who checks on them, a mentor, an advisor, someone who can follow up closely, and gradually strengthen the local centre so they can take their own decisions and look after the economy at the centre. That's an important reason for why things are going so well as they do in Ikisaya. An NGO, for instance the Red Cross, could have a suitable infrastructure for doing something like that. They already have several local offices in Kenya. (ST-team leader, interview my translation).

As the above mentioned comments show, the team members expressed different things they found to be of importance in the up-scaling phase. From a simple numbers game to the need for an organisational apparatus. I will in the following introduce the context in which the model was to be up-scaled, and then provide a closer description of the places and the agents that I visited.

7.2 Turkana County

Turkana is the largest and north western most county in Kenya. It is well known for Lake Turkana which is the world’s largest desert lake. The climate is semi-arid and harsh, which makes agricultural activities challenging and unstable, yet it is one of the most important income sources in the region. The people of Turkana depend on nomadic pastoralism, fishing from the lake, livestock keeping (goats and camels), causal labour, honey production and small scale businesses (Watson & van Binsbergen, 2008). Despite being one of the poorer regions in Kenya, Turkana is also home to vast resources, there is gold mining, and recent

discoveries of water and oil have made the population optimistic about the fortunes this might bring in the future. The region has traces of Stone Age cultures and human fossils such as the "Turkana boy". Because of this archaeological significance, Turkana is also known as the "cradle of human kind" (Betti, 2010, p. 3).

Knowing that temperatures around 40°C were perfectly normal, I was prepared that data collection could be challenging in Turkana. I had to take a small propeller from Nairobi to get there. I landed in Lodwar, which with its 45,000 inhabitants is the biggest town and capital of Turkana County. I was going to stay in Lodwar the last days of my field work, but first I was heading straight to the village of Kalokol, located 56 km from Lodwar town. On the road to the village I looked at the remote and arid landscape unfolding outside the window. Every now and then we would pass herds of sheep or goats, being looked after by Turkana pastoralists. The sun was fierce, no doubt that the region had a vast amount of solar resources that could be exploited!

During the week I stayed in Turkana, I visited a total of three villages where solar power systems had been installed as a first step of the up-scaling process. I also followed the activities of a Japanese businessman who happened to be in Turkana at the same time. He installed pilot agents to test a solar lantern solution for his company. It was useful for me to get an insight into how private actors engage with rural electrification in the region, and his solution was also of special interest to Kenny, who was the driving force of the up-scaling attempts of the Ikisaya mode in Turkana.

7.3 The agent model in Turkana

That the experiences with off-grid solar power from Ikisaya were to be made relevant in Turkana was much due to the work of Kenny. I will in this section describe his efforts in this process, and then introduce what the agent model to be used in Turkana looked like.

7.3.1 A dedicated entrepreneur

Kenny is the man in charge of the up-scaling attempts in Turkana. He did not have a formal role in the Ikisaya project, but was perceived by the team as an important person to have on board, both because he was clever, and because he represented the Kenyan government through the national energy company where he is employed (personal communication, project

team leader). He thus functioned as a link between the research project and the government. The company he works for does not do solar power projects at this point, so the activities Kenny is doing are therefore not associated with this company. He tries however to demonstrate to them that small scale solar solutions can be interesting and relevant also for a company, where service provision is also about making money. The motivation to do this is that he is passionate about solar power:

> When we are using solar we are not degrading our environment health, I am very very enthusiastic and passionate about making sure that people stop using kerosene, to me that is more important than having computers for instance. If they stop using kerosene and use solar instead. [...] One thing I believe is that when we are using solar energy, we are appreciating God, because it is something he has given us free of charge, we are letting it go to waste and then we are spending money on importing other commodities or sources. (Kenny, ST-team, interview)

With his background from technical engineering, he is particularly interested in the technical appliances such as lanterns and charging systems, and in testing these to see how they work in practice. He explains that often when a product, for instance a lantern, is put into practice, it works differently from what they thought. What works well in one community can turn out to fail in another.

A challenge associated with up-scaling is lack of resources and funding to do the initial investments. Kenny had on his own initiative applied and got funding from the Nordic Development Fund (NDF) to make up to 500 charging stations, or agents; similar to the agents that evolved around IEC. From the Ikisaya model, he perceived the agents to be more up-scalable than the energy centre:

> The energy centre is offering many services. Now for me, now I want to up-scale, I want to do many of them. I mainly looked at the management of this centre and what it brought. And I said if I have to do 20 of these it would take all my attention. So I looked at the services, how they are doing it, the agents. And I felt using the agent model would be easier, because me I want to offer basic services to as many people as possible. I also wanted the management part to be easier to me, so I don't have to go there every day checking. (Kenny, ST-team, interview)

It is thus only the agent element from the Ikisaya model he wants to take to Turkana. How can this be done, and will it work, without an energy centre there to support them?

7.3.2 Piloting for up-scaling: The agents in Kalokol, Gold and Nasiger

The agent model in Turkana is very similar to the agents in Ikisaya, except from the fact that

there is no energy centre there to select them and oversee them. Instead, the local conventional power station in Lodwar could be contacted in case of repair. They had no previous experience with solar power, but Kenny wanted to change this. The agents offered phone charging and lantern rental, and the solar PV systems were installed in already existing shops. The shop owners had been shown how to switch the systems on and off, how to charge the lanterns and phones, and on how to do book keeping. Finally, solutions such as remote monitoring of the charging systems were tested on some of the agents to avoid theft. The agents got to keep between 20-30 % of the money made in commission, while there rest went to the energy company. At the time of field work, seven out of the planned total of 500 agents had opened, as demonstration pilots for how the models could be organised in the up-scaling.

I visited all the agents that had been installed at the time of field work: three agents in Kalokol village, three agents in Gold village and one in Nasiger village. They were all located in already existing grocery shops. The agents had been identified on previous field visits by Kenny, and had been operative since April/May when I visited them during my field work in October. I will introduce each place in more detail below.

Nasiger

Nasiger is located 30 km from Lodwar, and was the smallest village of the areas visited. Pastoralism and small businesses are the most important livelihoods, and there is one primary school in the village. I visited a butchery and a charcoal retailer in addition to the agent.

The solar agent in Nasiger, called the Nasiger solar kiosk, had first been installed in 2011. Kenny had initiated this first agent in 2011, and had received funding to install the agent as a Corporate Social Responsibility (CSR) activity of the company he works for. Nasiger had been selected because it was located close to Lodwar, but had no hopes of receiving off-grid power supply within the next ten years (personal communication, Kenny, ST-team member). 30 lanterns had thus been given to a school in the village, and the children brought the lanterns home in the evening to study. The problem was that not sufficient money was saved to replace the batteries, so when the batteries faded, the project died. Since Kenny had been involved in this project, he wanted to restart it in the up-scaling phase. The lanterns were this time given to a shop owner, identified through a public baraza. The technical equipment was installed June 2013, so the lantern rental had been operative for 4 months when I came to visit. The shop owner had a total of thirteen lanterns, but only five were being rented on a

regular basis. The lanterns could be rented on a daily basis just like in Ikisaya, and the cost was 10 KES per day. This was however the only village I visited where the demand was lower than the number of lanterns. The agent had also stopped doing book keeping. I talked to two of the five customers, who both were business owners, and used the light in their shops. The explanation I got from the non-users was that they did not rent the lanterns because of poverty. Kenny meant that it also had to do with the first round of the project being perceived as a donation rather than a service that had to be paid for, which made people unwilling to pay.

Kalokol

The village is located 56 km from Lodwar, and is a separate administrative division with a population of 28,735. Situated close to Lake Turkana, fishing and fish processing is the major economic activity in the village, besides pastoralism. The Norwegian Agency for Development Cooperation (NORAD) established a fishing cooperative in the region, and fish was sold in the cooperative up to 1989, when it collapsed. The fish is now being exported, making fish a rare commodity, although the village is close to the lake (Watson & van Binsbergen, 2008, p. 12).

The three agents in Kalokol were located close to each other, but that did not seem to interrupt their customer base. One of the agents, “John”, was already running a shop and had a phone charging business with his own solar panel from before. He had a certificate in electrical engineering. He became an agent after having met Kenny, who was visiting the village to find suitable agents for the up-scaling. John's work with solar power is not only restricted to the system installed in his shop. He seemed to be very interested in solar technology and its potential to help people in the area. He is assisting the two other agents in Kalokol, both with technicalities and with marketing the services: “I'm helping the other agents in Kalokol on how to put the credit because they easily forget. Even sometimes, the power goes off, I go and reset again the machine, to take the power back. they were taught how, but they forgot on how to do it”. The other agents in Kalokol also confirmed that John had been of help to them.

A Japanese business man was also in Kalokol at the time of field work, setting up a pilot project for a solar lantern system he had developed. John was an important resource for him. The business man was to install several off-grid charging systems in the region to test his technology, and John was present in this process. I joined them for the instalment of three

agents. John and the business man cooperated during the installation, if something was not working they discussed and found the solution together. John was also the one instructing the agents on how to use the technology, sine he spoke the local Turkana language. In other words, John was good at his job, and he mattered for the functioning of the solar systems locally, both those provided through the project, and those that were owned by private households.

The customers were primarily businesses. They used the lantern in their shop, but some also brought it home after work. I asked one of the other agents in Kalokol if it was a challenge to collect payment, and if the lanterns were being charged regularly. One of the agents told me that payment was not an issue, but the charging was:

> The instructions we are given, we don't use until light goes off completely, so by the time the light starts to be dim, you stop using it, and you bring it back to the charger. All though they are supposed to be charged every second day, some people forget, they use it until it goes off. So that brings another problem, it doesn't take long with the power inside it. So that problem we keep putting forward to them. The problem with these people is that they forget..you know they are doing a fish business, they are smoking fish, frying fish, packing fish, somebody who works there overwork and forget about the lantern until it goes off, it's not like it is difficult. (Kalokol agent 1, interview)

The disciplining of customers was an issue for the agents, and they had experienced some technical problems, as some of the lanterns they had been issued could not be charged by their current charging system. The "agent 1" in Kalokol had not been in his shop when the actual system was installed, but his assistant had been there and received some training on how to charge, register the transactions in a book and inform the customers to return the lanterns after two days. "Maybe he was given the information too fast, because after a short while Kenny came back with this thing [points at the Mobisol charging system], he talked with us and then I understood what it was all about." The agent is here referring to how the Mobisol system allows for remote monitoring of the agents, and that this was a way of making the agents stricter with the customers. I will elaborate on the use of remote monitoring later in this chapter.

Gold

Gold is located in the Turkana West district, 70 km from Lodwar, and has a population of 8,000 divided on 1,600 households. There is a primary school and a secondary school in the village. Livestock keeping of goats and camels are important income sources for the villagers,

but a little mining of gold is also taking place, thereof the name (Kenny, ST-team member, personal communication). The value of the gold was not being reflected in the community though, which can be characterised as very poor.

There were a total of three agents in the village. I got to visit two, as the third one was closed because of a funeral. The agents had opened on June 1st 2013, so they had been operative for 4 months at the time of visit. Both agents said that all their lanterns were currently being rented, but that the demand was low, fewer people asked for the service. They also complained about the customer will or ability to pay. One agent said:

> When there is gold, they pay, when there is no gold they don't. The customers are appreciating the light they tell us, but we experience a lot of delay in payment. I have paid the bill to the company, but the customers have yet to pay me. (Kalokol agent, interview)

I asked the agent about the training they had received. “They trained us for a small minute”, I was told, and the agent explained that his training had been on how to charge the lantern, phone charging, and to tell the customers to return the lanterns after two days. They had a total of twenty lanterns that worked, and another ten that did not work because the battery had to be replaced. I was told that these lanterns had been in Nasiger before. The agents found the equipment was working fine and was easy to operate, but there was a cable for charging that did not work. They had requested a new one, and were waiting for it to be replaced by Kenny. I was also informed that the Mobisol system with remote monitoring didn't work optimally:

> Sometimes, this thing is going off (points at the Mobisol charging system), preventing them [the company] to see how many lanterns we have charged. The network doesn't see how many we have charged. They used to tell us how much we should pay based on that. It is inside there, it is closed, we cannot move it [referring to the GSM modem that allows charging data to be transferred to the company online]. But they do see us, they normally see us. (Gold agent, interview)

They explained to me that they didn't like the Mobisol solution, because it was rigid. “If we don’t pay on this or that date, they switch us off, but we have yet to collect money from our customers”, the agent explained. This is an indication that the model is less flexible than in Ikisaya, which I will get back to in the discussion.

7.4 The users and non-users in Turkana

7.4.1 Non-users

I interviewed a total of ten non-users. Most of the non-users explained that they did not use the services from the agent because they could not afford it. I was surprised to hear this, because the cost of renting a lantern was cheaper than buying kerosene or candles. Then it turned out that many of the non-users did not use kerosene on a regular basis. The Turkana pastoralists were not even considered to be potential customers by two agents I met in Gold.

“The nomads don't have money”, was the response I got when I asked why so few of them were using the service. In Turkana, it was the responsibility of the agent to market their services. They went from door to door to tell nearby shops, family and friends about the services. I asked the agents in Gold if they had approached any of the nomad homes, because the majority of the population there were pastoralists. I was told that this had not been done, because it would be of no use, they were simply not interested: “They only use firewood or sit in darkness”, an agent in Gold said. The fact that they were perceived as non-users even before they had got information about the service, surprised me. It also shows that although the lantern rental is cheaper than kerosene, it doesn't mean it is affordable to everyone.

Affordability is one issue, and I did not get the time to map whether this was the only reason to why nomads were not as interested or assumed not to be interested in the services. It may also be a question of need: a pastoralist informant told me she did not *need* the lanterns. This is not necessarily representative for the other non-users, but it is relevant for the discussion of script as well. In the chapters about Ikisaya I argued that the script of the lantern fit the users, in the sense that the product was well adapted to their needs for lighting, and the users said the lanterns were multi-purpose and flexible. This Turkana informant who chose to be a non-user shows that the lanterns were not perceived an important artefact for everyone.

7.4.2 Ownership and willingness to pay

Although poverty did produce quite a few non-users, there was also reason to suspect that some of the informants did complain about the price because they hoped they would be given the lantern for free: one user said he preferred kerosene to the lantern, because that was cheaper. I asked him how much he normally spent on kerosene. The response was 30 KES for

3 days. I then explained that it was the same cost as for renting a lantern for 3 days. He still argued that kerosene was cheaper. Kenny meant that there was a culture of non-payment in the region, which originated from a long history of receiving foreign aid. One message that was put forward to me by the users in Turkana that was never mentioned in Ikisaya, was the question of ownership. Some of the users I talked to asked “when will the lanterns become ours? “and “I pay 10 KES every day, when will I get to own it?” An agent in Gold said that people paid when they had money, but when they didn't have money, they complained that the lantern was somebody's property.

Making the customers pay for the services was something the agents in Turkana struggled with. “We wanna know how we can deal with the customers so that they pay us on time”, one agent in Gold told me. His customers rented the lanterns on a monthly basis, and were encouraged to pay the total of 300 KES upfront at the end of the month. The agents had been instructed to tell their customers to come back to charge often, after two days, but this did not work in practice. Since the lanterns were rented on a monthly basis and not daily, the incentive to come back to charge them after two days was gone. A high number of lanterns were being deeply discharged on a regular basis because of this, but it was too early to see the consequences in terms of reduced battery capacity, as the agents had only been operative for a few months.

The renting on a monthly basis as opposed to daily, as in Ikisaya, could be harmful both for the technical aspects (avoiding deep discharging of lantern battery) and the flexibility of renting when you can afford it. The only agent that practiced “rent when you can afford” was Nasiger. The uptake of lanterns was however very low in this village, only five out of thirteen lanterns were being rented regularly. The agent had stopped recording in the book, so it was not possible to trace the recent developments. I asked some of the users in Nasiger when they took the lantern, and they all said “I take it whenever I can afford it”, which implies that they could not afford it every day. It is therefore reasonable to think that the current model of renting on a monthly basis might produce non-users as well as future technical problems that will also become economic problems.

These problems can however be fixed by organising things slightly differently. I discussed the possibility of using “rent when you can afford” for all the agents with Kenny. He said it was problematic, because if the model was to be of interest to businesses, it had to be possible to predict how much money they were going to earn each month. Paying on a monthly basis

makes it easier to have a clear overview of the money collection for the agents. “we don't want money lying around in our shop, we already do Mpesa[22] in addition to selling our own goods” one agent told me. So making payment flexible for the users would make the agent model less attractive for businesses.

7.4.3 Technological solutions to social problems.

Training and learning was regarded as important in the pilot project, but in the up-scaling process this aspect was reduced. The agents did not need much knowledge to run the systems. It was sufficient to know how to charge the lanterns, and how to do the book keeping. In the event of a technical problem, the agent could contact the local power station in Lodwar, instead of fixing it herself. Technical know-how was not necessarily a good thing, in fact; too much knowledge could even be negative. If the agents were to engage in repair, it could in turn cause new problems. For instance, their interference could cause damage, or they could learn how to overcome the remote monitoring systems (interview, Kenny ST-team). As discussed in the chapters about Ikisaya, theft had occurred both at the centre and among the agents. Still, there were some elements checks and balances where agents were accountable to the centre, and the centre in turn to the board and the project team. Follow-up and closer ties increased the trust in Ikisaya, but how could this be achieved in a process of scaling up? Like one team member said:

> “See, now there is no way I can tell if you are lying or being straight with me, maybe you are renting out and putting this money in your pocket. So the Mobisol technology, it is to get that feel, is it twenty lanterns or is it ten?” (Maurice, ST-team member, interview)

22 M-Pesa is a mobile-phone based money transfer and microfinancing service

Illustration 9: The Mobisol charging system seen in use in Turkana. The system comes with a GSM modem that register the number of phones/lanterns charged. The modem is inside the "solar controller" (the yellow box). Photo: Author.

Kenny was looking into ways in which these challenges could be met by "seeing" the agents from a distance, through technology. The system mostly used for this was the Mobisol charging system, which was also tested by two agents in Ikisaya (Kathua and Yiuku). Mobisol is a German company mostly delivering solar home systems, but Kenny noticed it could be relevant to use for the agent model as well. The essential aspect of the Mobisol system that makes it interesting for Kenny in the up-scaling phase, is the use of a GSM modem that can track technical data from the panel and battery and store it in a web-based database. This way he can check the records of the number of phones and lanterns being charged online. He can also disconnect the agent remotely if he doesn't receive the agreed upon payment on the due date.

The experiences with the Mobisol solution in the up-scaling pilots so far have been mixed. In order to register the number of phones and lanterns charged, the equipment had to be installed

in an area with GPRS[23] signal. Kalokol did not have this signal. Gold has the signal, and a Mobisol charging system was therefore installed there. Kenny explained that charger had caused the charging system to "trip", to stop working. Neither Kenny nor the company could explain why this happened. Another challenge that had also been reported from Ikisaya, was inaccuracy in recording the number of phone charging, because the system would count the same phone twice if it was unplugged from the charger and then put back again.

> "In Kalokol, you have internet, SMS, Mpesa, voice, but not GPRS. That is a third network that is required. So when there is no GPRS network, you cannot see the agents. So some of the agents here you can never see. For some of the agents we can see them sometimes, but the data we get through the system in inaccurate. When I compare the data from the system with their recordings in their books, they have charged more than the system has registered. So that is a problem, yes." (Kenny, ST-team member, interview)

I asked Kenny if there was any use in the Mobisol system, when it did not record as it should. He explained that he was still able to switch the agents on and off. So if an agent did not pay on time, he could switch them off. He had used this method a couple of times. The agent had called and said that the system was not working. "I told them you pay and it will work again. Then they paid quickly!" Despite these challenges, the team members were still positive and thought that the technical challenges could be overcome. In fact, I was told that the technical challenge was the smallest of their problems. Things could be improved as they went, and they were still learning what could work and what could not:

> These agents took us a day to set up… so that looks like a simpler option, it seems to be working, you can manage a large number of agents… OK, so these are within a certain radius, so these you can go to and fro, but if there is a thousand, I can't, so then we start to look at what are the technical options to address this? Remote monitoring, remote connection, let's experiment with this Mobisol, this type of systems. It is a curve, it is not like we are going from "this is the solution, and boom we find it." There is a path, we are learning along this path. The pilot allows us to see, "ah, that worked, this didn't work, that work is still going… and that is how we get from here to there. (Maurice, ST- team member, interview)

The challenges with remote monitoring are thus seen as a temporary phase, which can and will be overcome with additional learning and adjustments. It was in other words a technical problem that had to be fixed in order to make the up-scaled version of the Ikisaya model work

23 GPRS is a standard for transferring data through mobile network that are faster than the normal GSM standard.

optimally. This will be discussed further in the following section of this chapter, where I will analyse which negotiations that took place in the up-scaling process.

7.5 Discussion: From pilot to up-scaling, what negotiations took place?

The Ikisaya model has changed quite a lot to become up-scalable. To be relevant for actors that can roll out, Kenny is the initiator of making the Ikisaya model more business friendly. This changed both what the model looked like and how it worked. I will now discuss which negotiations the Ikisaya model went through when it is attempted up-scaled, by using concepts from the theoretical framework.

7.5.1 Up-scaling and translation

In the process of going from a pilot which has more of an exploratory approach that allows for testing and learning, the current up-scaling process is more targeted into finding a model that works for businesses. An important negotiation in this process was to cut down the Ikisaya model. Kenny and the team members had seen that the agents in Ikisaya were doing well economically, and that the centre itself was an unnecessary investment in both physical and social infrastructure. The focus had to be on the most basic services, lighting and phone charging, so that TV-watching and IT services, which did not generate as much income, fell out of the up-scalable agent model. So did the research activities concerning the local community, on topics such as vulnerability and addressing the needs of the most marginalised groups. After cutting down all unnecessary elements it is in fact only the agent element left, and that is what is being translated from Ikisaya to Turkana.

Another important negotiation in translating the model, was the necessity of remote monitoring of the agents through the Mobisol charging system. In the absence of an energy centre, remote monitoring was important to manage the agents, to ensure payment and to avoid stealing. This became even more important in the up-scaling phase, as there was no CBO or energy centre to manage the agents, but a company. The remote monitoring did not function optimally at the time of field work, one reason was that some of the villages lacked a GPRS network upon which the Mobisol system depend to send data, but also that the number of phones and lanterns recorded tended to be inaccurate. Kenny and Maurice still meant that

such technical issues could be overcome. It was a matter of testing and improving it, so that this problem would be solved in the future. The Mobisol charging systems were also being used by agents of Kathua and Yiuku in the Ikisaya region, but this was more about technology testing than necessity, the agent model there was not depending on it to the same extent as the agents in Turkana. Like Kenny and Maurice said, it is impossible for us to visit each of the 500 agents to follow up on them. This translation into an agent model that is remotely controlled, had consequences for how the model worked as well, which I will touch upon in the next paragraphs.

7.5.2 Up-scaling and care

In the previous chapters I have described the staff at IEC as very dedicated to their job, and how they expressed a strong will that the centre should continue. In Turkana, I was not expecting to see the same thing, because the renting of lanterns was just an additional business for the shop owners. When I spent some days in the village of Kalokol in Turkana, I was therefore surprised to find the same type of commitment with one of the agents there. John's work with solar power was not restricted to his system only; he also helped other agents and households, as well as assisting the Japanese business man. I argued that he mattered for the functioning of the solar power systems locally, because he had the knowledge, but also the commitment that it takes to cultivate a technology in a context where it has not been before.

When the team leader is emphasising the need for follow-up and assistance as an important aspect for the project or model to be viable in Ikisaya, John did have such a function in Kalokol. He could look after the local agents, and he was frequently in touch with Kenny. When he talked about his work, he reminded me of the staff at Ikisaya Energy Centre – proud and committed, and with ambitions to expand. Regardless of what the underlying motivation may be, I will argue that this commitment, together with knowledge of the technology, are factors that influence the performance of the agents, and thus also the viability of the model. Care therefore still matters in the up-scaling phase.

7.5.3 Up-scaling, script and trust

In Ikisaya, the staff at the energy centre had an understanding of the technology. Through practical experience they have been able to improve the model by re-organising the energy

supply though the agent model, and also by new innovations – small, but innovations nevertheless, like the development of the new phone charger with several ports.

In Turkana, the agents are dealing with a closed technology: just like the users and technicians of the photoelectric lighting kit Akrich (1992) describes, the agents in Turkana are not trusted. They are not supposed to interfere with the technology. Knowledge could even be harmful to the viability of the model, as the customers can overcome remote monitoring or break something when trying to repair or test stuff with the technical equipment themselves. The Mobisol system had already “tripped”, in Kenny's words, because an agent had used it for another purpose than it was intended for.

This is not an attempt to criticise the efforts done in scaling up the project, but to show that in this process some elements make it less likely for this kind of improvement and learning to happen. When the user cannot interfere with the technology, or is not even given the chance to understand how it works, the conditions that made innovations and improvements occur in Ikisaya are gone. It can be argued that the agent may still be able to acquire skills over time, by hands-on experience and watching the people from the local power station do their job. Much of this work was expected to be merely “replacement” of broken parts, and not advanced repairs. If it was possible to provide the agents with spare parts, they could be able to this themselves after a while.

One may ask if technical competence of the staff is a goal one should strive for, when the actual goal for the project is to increase people's access to basic electricity services. If this can be done without training, why bother? An argument for this is that this knowledge can be a resource locally, not only restricted to maintenance of the system. Also, chances are that the agent will be able to see possibilities to improve both technical and organisational aspects, and give feedback and suggestions to the technology company. They can take a more active part in shaping and improving the technology in unexpected ways. In Ikisaya the energy centre developed into a decentralised model, and more people were trained at the centre thanks to the experience of the staff. This is in turn linked to the next concept of flexibility, which I in the previous chapter argued was important for the Ikisaya model to work. How *flexible* was the agent model in Turkana?

7.5.4 Up-scaling and flexibility

As already stated, the off-grid electrification in Kenya is market driven(Jacobson, 2007),

which was also reflected in the factors that became important in the up-scaling process. Finding a suitable model for up-scaling became synonymous with finding the perfect business model, where service provision to the poorest segments of society also should be profitable for a business. And with up-scaling and profitability comes the need for predictability, introduced through charging systems with remote monitoring and stricter payment arrangements. The up-scaled agent model thus became less flexible.

Some of these practices, for instance the payment arrangements, can be adjusted. The deadline for the customers to pay the agent can be set to a week before the agent's deadline to the company, which allows for more time to collect the money. But the monthly subscription scheme, as opposed to "rent when you can afford it", does not fit with poor people's unstable income. For some, kerosene thus became a better option, because it was flexible in the sense that you only buy it when you can afford it.

The remote monitoring, however, may be necessary for the model to work, given that there eventually will be up to 500 agents and not resources available to follow them up like was done in Ikisaya. I have still argued that a local resource person with technical know-how and interest was important, like the role of the agent John in Kalokol shows. This aspect is very important when comparing the agents in Ikisaya to the agents in Turkana. In Ikisaya, the model continued to develop into a decentralised model. This system worked because the staff at IEC could use their knowledge, both the knowledge acquired from working with the technology in terms of doing the actual installations and repairs, but also from the local context – which villages can get the system, who can be responsible, how to train the personnel, when to replace this or that, and so on.

This dynamic way of developing the model is unlikely to work in Turkana, as the agents become isolated units, and the communication with the company overseeing the agent happens through the technology – pay the monthly fee, or you will be disconnected. This is an efficient tool to ensure payment, but at the time of fieldwork I found that agents using this technology did find it difficult the collect revenue from customers on time, and the lanterns were not charged as often as they should. It takes additional disciplining of customers, and with no public barazas or pedagogical instructor such as Jane around, disciplining was difficult for the agents in Gold and Nasiger. It seemed to be working better in Kalokol where John had done the marketing locally with the other two agents. It is of course important to keep in mind that the agents had been open for only a couple of months, and the same

problems with disciplining customers were also present in Ikisaya in the start-up phase. The situation may improve over time, but it does not happen by itself.

7.5.5 Up-scaling and infrastructure

When discussing the views of the team members on the up-scaling process, we saw that building on existing infrastructure in the villages in Turkana mattered when developing a model suitable for up-scaling. By building the new model on existing shops, and outsourcing repair to the local power station, precious time and resources were saved on not having to build social and technical infrastructure from scratch. The instalment of a solar panel and a charging system in a shop could be done in less than an hour, and then teaching the shop owner how to charge the lanterns and phones and record the transactions could be done in half an hour. Very efficient compared to the ten days of training the staff in Ikisaya. Also, if other actors, for instance the government or an NGO were to do the up-scaling, the team leader meant that an NGO with an existing infrastructure of staff and local offices could roll out the energy centre model. In other words, existing infrastructure turned out to be very important when going from pilot to up-scaling.

So while building on what is already there may save time and resources, this alone is not enough to succeed with up-scaling. In the theory chapter, I mentioned Thomas Hughes "reverse salients", which are economic, social or political factors that could hinder the development and use of a technology. Such reverse salients become more relevant in the up-scaling phase, as you go from the protecting frames of a pilot project to the up-scaling process. There were "reverse salients" present in developing the necessary infrastructure of the solar powered services. I have already mentioned that the GPRS system was a prerequisite for the Mobisol system to work properly, but there were also other hindrances on the political and economic level: Kenny had secured funding for this up-scaling project, but it remains a project – it is a not given that it will be institutionalised after the implementation of the 500 agents. – who will continue, and how, to keep the newly established networks going. They are still vulnerable.

This shows that off-grid solar power, which can give the impression of being disconnected, is depending on a network, or an infrastructure. The efforts of this project and other actors doing similar research are important in the sense that they are trying to find solutions that can work. These efforts may develop into new and stable networks that last. But as this thesis has

shown, building stable networks takes time and work – and many elements normally not associated with technology. Care, for instance, matters in establishing new networks. As said in the theory chapter, Latour (2005, p. 132) prefers to refer to networks as work-nets, to emphasise the work that is actually needed to keep networks going. This project and the up-scaling phase is an example of that.

7.6 The way forward

After I left the field, new agents have opened, not only in Turkana, but also in other regions defined in the Rural Electrification Master-plan of the Kenyan government (Kenny, personal communication). I was informed by Kenny that nine agents had opened in Kirinyaga County (in the former central province). As already mentioned in the introduction to this chapter, the Solar Transition project is followed up by Solar xChange: A comparative study of socio-technical innovations and sustainability factors for up-scaling in village scale power supply model. In this project the experiences from ST will be assessed, and they will work further with the efforts from the ST-project and further work to up-scale these. “The project team will actively transfer, translate and build on insights between the investigated cases, actors and countries and apply the knowledge in pilot projects implemented by the team.” They call for further research on project design and models for solar supply, with regards to ownership, energy service design, business model, staffing and training, and maintenance.

7.7 Conclusion

This chapter has sought to answer the fourth operational question: W*hich negotiations does the Ikisaya model go through as it is attempted up-scaled in Turkana?* This question is closely linked to the main research question on what happens when the model is attempted up-scaled. This chapter has shown that the Ikisaya model was too complicated and costly to be relevant for up-scaling. An important negotiation is thus that the Ikisaya model is being cut down to be more cost-efficient. Cutting down is thus a prerequisite to be up-scalable from a business perspective. It is therefore only the agent element that is being transferred from Ikisaya to Turkana. Without the IEC to oversee them, this has consequences for how the model works, as the flexibility, the practices of care, maintenance, training, follow up are no to be replicated.

Measures such as remote monitoring are tested instead, but this solution was not working optimally at the time of field work. Other challenges seen were that the agents had problems collecting money from the customers and the more rigid payment model did not fit with the needs for a flexible approach of the poor community. Making the model more flexible would in turn influence how attractive the model is for businesses. In the village of Kalokol, I found *care* to be of importance, as one of the agents took more initiative and had more technical know how than the other agents, and this made the systems work better in this village than in the others. This indicates that care is still important for technology to work in an up-scaling context. I finally brought in infrastructure, as it was pointed out by the team members that going from pilot to scale was also about going from protected frames to a ruthless world. I argued that the current process of setting up some agents doesn't mean that they will survive, making this up-scaling work is also about building an infrastructure, and having mediators such as the government, businesses or NGOs to put it forward.

8 Summary and conclusion

This thesis has studied a case of technology transfer, by following the activities of the interdisciplinary research project “Solar Transitions”. The ST-project has implemented an energy centre in the Kenyan village of Ikisaya, offering basic electricity services such as phone charging, rental of solar lanterns, TV watching and IT services. The energy centre subsequently developed into a decentralised model with agents in the surrounding villages, offering only phone charging and lantern rental. Elements from the pilot project in Ikisaya – often referred to as the Ikisaya *model* – are currently attempted up-scaled in Turkana county, northern Kenya.

In this concluding chapter I will go through the main findings in this thesis to answer the research question, and discuss the implications of the findings and suggestions for future research. The main research question was: *What makes the Ikisaya model work, and what happens when it is attempted up-scaled in Turkana?* This question was explored by conducting six weeks of field work in Kenya, autumn 2013, and by employing a theoretical framework inspired by the STS field, consisting of the concepts of *translation*, *care*, *flexibility* and *script/domestication*.

I had four operational questions to answer the main research question, each question has been addressed in its own chapter. These were: *1. Where did the Ikisaya model come from? 2. Which factors were important for the model to work in Ikisaya? 3. Which translations happened after implementation? 4. Which negotiations does the Ikisaya model go through as it is attempted up-scaled in Turkana?* Through the four analysis chapters, in which I have tried to answer the four questions in turn, we have seen how the Ikisaya model came into being, and what made it work and develop further. From being an idea about a solar mini-grid that was to be transferred from India to Kenya (Chapter 4), it became an energy centre (Chapter 5), then an energy centre with agents (Chapter 6), and then agents without an energy centre in Turkana (Chapter 7). I have analysed these changes as a set of *translations*. It helped visualise that a technology transfer is not about making a blueprint, it is rather about building or cultivating something new. This is in line with John Laws argument that there is no such thing as technology transfer (Law, 1997, p. 2).

So what is the Ikisaya model? As has been shown throughout the analysis chapters, the model is in constant change, and I argue that this is one of its main characteristics. This makes it unclear whether or not it is appropriate to call it a model. In chapters 4, 5 and 6, I have argued that the translations were the results of the model being flexible, and that it was this flexibility that made the model work. In the theory chapter, the following was said about another technology, a water pump called the Zimbabwe Bush Pump:

> We have argued that the Zimbabwe Bush Pump is a fluid actor. It brings a lot about, but its boundaries and constitution vary and its success and failure, instead of being clear-cut, are a matter of degree. Although one knows a Zimbabwe Bush Pump 'B' type when one sees it, we claim that the technology has no core. (de Laet & Mol, 2000, p. 248)

This is also a suitable description of the Ikisaya model. It was difficult throughout the whole research process to pin point what exactly the Ikisaya model was, until I realised that it is flexible and mutable, and therefore changes when it has to, in order to work.

This did however not happen automatically, but as a result of work done actively by the involved actors: In chapter 4 we saw that the Solar Transitions team had planned to transfer a solar mini-grid from India to Kenya. This never happened. Instead they developed what gradually became the energy centre model, in cooperation with the local community in Ikisaya, because a mini-grid would not fit the scattered population settlements. In chapter 5 I showed that the staff at the energy centre had been trained on how the technical equipment worked, and how they had enhanced their knowledge through tinkering, repair and hands-on experience with the technology. Their monthly phone calls with, and regular visits by, the project team members allowed for sharing of ideas and problem solving. These activities can be understood as *care*. In the theory chapter I explained that care is not only care in a motherly way, technology also must be taken care of through repair and is improved through tinkering and adjustments (Mol et al., 2010, p. 16). I argued that care allows for understanding maintenance as a social activity as well, such as follow up through a phone call or visit, where there is no technical component directly involved.

The role of care was crucial for the model to work in Ikisaya. Like was said by one of the ST-team members in chapter 5:

> The beauty of the solar transitions project is that we (…) can keep coming back, we sit down, talk, how are things going, what do we need to change here. And that has helped

> them evolve up to the point where it is no longer required to go visit them. (Maurice, ST-team member, interview)

Care was also present as the model developed into a decentralised model with agents. The staff at the energy centre was essential for the well-being of the agents: It was the staff at IEC that carefully selected the agents, trained them, and, if necessary, closed the agent if stealing or misconduct was detected. This could not have been done by external actors in Nairobi or elsewhere. The Ikisaya model is thus flexible in the sense that it can continue to develop and adapt – it is not rigid.

The empirical findings suggest that the practices of care and maintenance were linked to technical knowledge, and these were drivers in making the model work and spread. In chapter 5 and 6 I showed that the staff at the centre were able to do the practical instalments of new agents themselves after a while. The development of a phone charger with more ports was a direct result of their technical understanding, but without the close contact with the project team, it would not have been possible to actually create it. Repair of broken lanterns took place regularly at the IEC, and when the customers complained about having to return the lanterns after only two days, pedagogical skills mattered in putting forward why this was necessary. Being good to the customers was also important: Customers both at the Energy centre and around the agents had stopped using the services when they found the management to be poor. These examples suggest that good care is based on skills, both technical and social.

Kenny from the ST-team was interested in testing different types of lanterns and technical appliances. This curiosity contributed to finding lanterns that fit the needs of the users. In the theory chapter, the concepts of *scrip*t and *domestication* were included because the relationship between designer and user influence how a technology works. Generally, the users both in Ikisaya and Turkana, found that the light helped them in their daily lives, and that the lanterns were “flexible” and “multi-purpose”. It was cheaper than kerosene and the light was better. A challenge, however, was the mismatch between the customers' wish to keep the lanterns longer than two days, and the shortening of the battery's lifespan when being deeply discharged. This challenge seemed to be bigger in Turkana, where the customers rented the lanterns on a monthly basis, and the incentive to come back to charge every second day was gone. These lanterns were thus more prone to deep discharging and a premature

death, threatening the economic viability of the model.

When the Ikisaya model was to be moved to Turkana, it was also going from the pilot phase to up-scaling. As the title of this thesis suggests, the agent model in Turkana had to be made simpler than the Ikisaya model. In Chapter 7 we saw that elements that made the model work in Ikisaya – such as training of the agents, follow-up and care – was cut down to make the model more cost-efficient and easy to manage. Going from pilot to scale was also a translation from learning and experimentation to finding the perfect business model. These negotiations in translating the model from Ikisaya to Turkana also had consequences for how the model worked. Instead of having an energy centre to oversee the agents, charging systems with remote monitoring were used, but the results were mixed, as the technology did not work as intended. An even bigger challenge was the absence of the elements that made the model work in Ikisaya, referred to as care in this study. Still, care could be found even in the up-scaling phase, although this was not an intended move: In the village of Kalokol, Turkana, the agent John was important for making the other agents in the village work, as he assisted them if they had a problem. He was himself interested in solar power and took on a coordinating role for solar power locally. This was possible because he had a background in technical engineering. Technical knowledge was thus important both in Ikisaya and in Turkana, but not every agent needs to have a technical background. It is probably sufficient with a local resource person in the area with a basic understanding and interest.

To conclude, what makes the Ikisaya model work and what happens when it is attempted up-scaled in Turkana? This study has shown that the Ikisaya model is flexible and therefore able to travel between places – it is translatable. The model is however depending on more than its flexibility to work in the different contexts. In Ikisaya, I showed that care and maintenance were the most important factors to make the model work, and being able to do good care was also linked to technical know-how and customer care. Good care is thus skilled care. This had implications for the up-scaling attempts in Turkana, where these elements were cut down in order to make the model more cost-efficient and business friendly. Instead, technological solutions such as remote monitoring were introduced to overcome challenges related to trust, theft and follow-up visits. The results with these systems were however mixed. Although such remote monitoring solutions may improve, it is unlikely that care can be replaced by technology, as technology needs care to work.

8.1 Implications of the findings

In the introduction to this thesis, I showed that both the UN, governments and aid agencies emphasise the importance of technology transfer of environmentally sound technologies, both to mitigate climate change and enhance development.

This study shows that successful technology transfers are possible, but that it takes more than a smart device, such as the most innovative solar lantern or a perfect business model, to achieve it. I have shown that as technology moves, it changes, which implies that it is hard to predict how a technology transfer is going to work. When a technology travels it doesn't stay the same, and often much has to be made anew in the recipient context. Acknowledging this, when making policies and recommendations for technology transfer projects, it must be taken into account that work is necessary in establishing such new networks, for instance through follow-up and training. In Ikisaya, having local resource persons with basic technical know-how and an interest of the technology helped cultivating the technology in a new context. Also in the up-scaling phase, this turned out to be important, and something that should not be down-prioritised by actors involved in similar projects. Lastly, the importance of script to make a technology work is not only restricted to the technological artefact, such as the lanterns. This study shows that the script of the model as such mattered as well. As seen in Turkana, the monthly subscription model did not fit the users as their incomes were unstable and unpredictable. “Rent when you can afford” was a more appropriate model that gave the customers more flexibility.

Although it is too early to say how the agents in Turkana will continue to develop, there is, based on the findings from Ikisaya, reason to suspect that they may get problems unless local resource persons like John becomes a more integral part of the model. This can probably be organised in different ways, but having more careful recruitment processes looking for such individuals may be one way of doing it.

8.2 Theoretical implications and recommendations for further research

The translation concept was helpful to visualise how the model changed throughout the process, and divide this technology transfer process in four different translations. The

concepts of care, maintenance, script/domestication and flexibility became useful in analysing what made the model work in each context. From the theoretical framework, the care concept proved to be particularly fruitful to conceptualise the relationship between technical components and the people in the model, and thus what made the model work. But there were also findings where my chosen framework came up short. The role of learning could be touched upon using the care concept, but it would have been useful to have other theoretical tools to conceptualise this aspect, because learning, both through practice and formal training, was of relevance for how the staff at the energy centre and the agents could do their job. Other elements, such as trust and motivation, also came up in the analysis process, and they were not explicitly dealt with in the theory chapter either. So although the chosen theoretical framework enabled this study, it could not shed light on all aspects and nuances of what made the model work.

I entered the up-scaling process at a very early stage. It would be interesting to study the project when it has been up and going for a longer time, to get a fuller understanding of the up-scaling phase. The impacts of the up-scaling both in terms of social, technical and political change over time were not a focus of this study, but these are nevertheless interesting aspects. Can such projects change current ways of doing rural electrification? Charging systems with remote monitoring were perceived by the ST-team members as promising solutions in dealing with many agents, but at the time of field work, there were challenges in making this type of technology work as intended. It could therefore be interesting to study this aspect closer.

STS scholars such as Latour and Woolgar (1986) and Collins (1975) have been studying scientists and science in the making, through laboratory studies. The Solar Transitions project is a social science project, but it is possible to draw parallels to the works by the above-mentioned scholars, as the pilot is perceived as an experiment – just like a laboratory – before it is taken out into the real world. This aspect is briefly mentioned in this thesis, but it could be interesting to dig deeper into this in a similar project, as there most likely will be numerous similar attempts of scaling up pilot projects in the years to come.

9 Appendix

9.1 Interview guides

9.1.1 Interview guide for users

Background questions: name, age, occupation, number of children

Do you use the services at IEC/the agent? If, yes, which services? How often?

How did you first hear about it?

When did you first start to use the services?

Do the lanterns help you? In what way?

What activities do you use them for?

Have things changed after the Energy Centre came?

Did you participate in the public barazas?

Has the centre and the services offered lived up to your expectations?

What do you miss?

Have you experienced any problems with a lantern, service or other issue related to the centre?

Which lantern model do you normally use?

Has the services helped you to make business?

What do you think of the management of the centre?

9.1.2 Interview guide for the agents

Background: name, age, location, number of kids, occupation

How did you become an agent?

When was the system first installed in your shop?

Who installed the system?

What information did you get?

Who gave you the information?

Was the information you got sufficient?

Is the system easy to use?

Have there been any problems?

Can you show me how the system works?

Can you tell me about your customers?

What happens when there is a problem?

How has the lantern rental affected your business?

How do you cooperate with the energy centre (for agents in Ikisaya)?

What do they do? (for agents in Ikisaya)

What is a typical day here like?

9.1.3 Staff Ikisaya Energy Centre

Background: name, home place, education, children

What did you do before you started to work here?

How did you get this job?

Can you tell me about the training you got before starting to work here?

What did you do?

How has the training been useful?

Are there some things you were missing from the training?

What is your responsibility at the centre? Has it changed?

Can you describe your tasks in more detail?

Have there been any changes in the technical or organizational set up after you opened?

Can you tell me about your customers?/ who are your customers?

Which service is the most popular? Why?

Which lantern model is the most popular?

Can you describe a typical day at the centre?

Are all days here the same?

Do unforseen things happen?

What do your customers ask you about?

Do you have a lot of contact with the customers?

Do you find the technical equipment easy to use?

Can you show me how it works?

What type of problems/ challenges have you experienced after the centre opened?

How are problems solved?

How do decide who should be an agent?

How do you go about setting up a new agent?

Who installs the equipment?

How is the contact with the ST-team?

How often do they visit?

How often are you in touch on the phone?

How important is this contact for operating the business?

How is the contact with the board?

9.1.4 Interview guide Solar Transition team members in Norway and Kenya

This guide was adapted to the individual members depending on their background and role in the project.

Can you tell me about your background and how you got interested in solar?

Why are you interested in this topic?

What is your role in the project?

What is your contribution?

Why did you choose technology supplier x for village y?

Can you tell me about the training the staff got in Ikisaya?

How do you perceive the performance of the technology?

What have been the main achievements of the project?

What are the lessons learned from the pilot?

What has been the main challenges in implementing the technology?

Have there been any problems in how the users interact with the technology?

What do you think is important to have a viable model?

What innovations/ new knowledge has been developed?

Why did you decide to establish a Community Based Organization in Ikisaya?

What do you see as the biggest obstacles to up-scaling and replication?

9.2 Overview of interviews

Informant group	Informant ID	Interview date
Staff IEC	"Jane"	September 29th 2013
	"Vincent"	September 24th and 27th 2013
Solar Transition project team members	"ST-team leader"	Several meetings and discussions from the outset of the master thesis project to the end. Dates not listed as

		they were not necessarily formal interviews
	"Kenny"	September 29th 2013
	"Maurice"	October 5th 2013
	"Gregor"	October 25th 2013
Agents around Ikisaya	Agent Ndovoini	September 25th 2013
	Agent Endau	September 23th 2013
	Agent Malalani	September 26th 2013
	Agent Kathua	September 28th 2013
	Agent Yiuku	September 30th 2013
Agents Turkana	"John" agent in Kalokol	October 8th 2013
	Agent 2 Kalokol	October 8th 2013
	Agent Nasiger	October 10th 2013
	Agent 1 Gold	October 9th 2013
	Agent 2 Gold	October 9th 2013
Users/non users in Ikisaya	User 1-39	September 22nd-October 1st 2013
Users/non-users in Turkana	User 1-12	October 6th–12th 2013
Consultant, Strathmore Energy Research Centre (SERC)	Consultant, SERC	October 25th 2013

9.3 List of documents analysed

Document	Year	Source
Community solar power plants for development: Transfer of technological and social innovations from India to Kenya	2009	ST-team
Taking advantage of relevant experiences, learning from solar power supply in the Sundarban Islands. Article published in The Solar Quarterly July 2010	2010	ST-team
Solar Transitions' study tour to the Sundarbans. Documentary film. http://www.sv.uio.no/iss/english/research/projects/solar-transitions/announcements/	2010	ST-team

Report from the Solar Transitions meetings and field work March 17-23, 2011 in Ikisaya, Kenya	2011	ST-team
Minutes from visiting Ikisaya November 16-21, 2011	2011	ST-team
Report from Ikisaya visit August 15-19, 2012	2012	ST-team
The start-up and first weeks of operation at Ikisaya Energy Centre1	2012	ST-team
Solar Xchange funding proposal	2013	ST-team
Brief on Turkana solar charging systems	2013	Kenny, ST team member/Kenya Power
Ikisaya Energy Centre documentary film: http://vimeo.com/57061330	2013	Marius Mass Grøtvedt, for the Solar Transitions project and Spire.
The Energy Centre model – An Approach to Village Scale Energy Supply	2014	ST-team

9.4 List of observed activities

Activity	Description	Date
MILEN mini-conference: "Development and implementation of technology, a focus on solar energy"	Participant at a conference with ST-team members and a diverse group of practitioners researchers from the field of off-grid solar solutions in developing countries	April 11th and 12th 2013
Hanging out at IEC	Staying at IEC and Ikisaya market, observing and talking to people	Throughout the field work in Ikisaya between September 22nd-October 1st 2013
Technology testing	Observing and learning how the Mobisol remote monitoring system works with ST-team member “Kenny”	October 27th 2013
Setting up agents in Turkana	Joined a Japanese business man and the agent “John” in Kalokol when setting up agents for pilot projects for a solar lantern company	October 7th and 8th 2013

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