

# A STRATEGIC ENDEAVOR: EXPLORING ALTERNATIVE ENERGY GENERATION OPPORTUNITIES IN TANZANIA

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Delft, the Netherlands  
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DATE  
April 8 2016





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## ACKNOWLEDGEMENT

Executing this project was a challenge, which I could not have realized without the agreement, support and trust of my supervisory team, **Maria Sääksjärvi** (chair) and **David Keyson** (mentor). Maria's knowledge about innovation adoption, marketing and research were a critical success factor and valued person in the team. You helped me stay focus and motivated me at times when I was not sure if I made the right choices. David's experience in sustainability systems, your overload of suggestions and critical view kept me sharp. For that I would like to thank you.

### Financial

This project has further been supported by the University Fund, Delft Energy Initiative in the form of the Energy Start Up Voucher and Students for Sustainability. Without your financial support I couldn't have experimented with prototyping and made the final product, S4S. Delft Energy Initiative made it possible for me to perform my graduation research and validate assumptions. Your decision to provide aid financially appreciated dearly.

### Former Coaches

A special thanks to Boukje Vastbinder and Esther Blom, through which I came in touch with the possibility to design for the BoP and who I have kept in touch with after the minor that I followed and which changed everything for me. I dearly appreciate your dedication and the fact that you are always open to sit down with me and provide me with so many tips and suggestions.

### Experts

I would also like to thank all experts from related fields that have taken the time out of their often busy schedule to set down with, advice me and refer me to others: Jacques van Rooijen (Support2Develop), Andre Leliveld (African Study Center Leiden), Ellen van Andel and Anke Dahlman (Delft Global Initiative), Abhigyan Singh (PhD'er), dr. ir. J.C. Diehl (Design for the BoP) and Bernard Hulshof (SolarWorks), Marcel van Heist (Rural Sparks) and Martin Havranek (Sustainable Studio Lab). Richard Bekking (Sustainable Studio Lab), you I have to thank especially for your kind attitude, openness to let me experiment even though you sometimes advice me differently and because you had the patience to explain me the basics and more about electronics which made it even more fun to exper-

iment. I also appreciate that you were the one who made me realize that sometimes you have to "kill you darlings" and you opened perspective.

### Tanzanian Relations

Nelly Yindi (Tanzanian Diaspora), Ahmed Ndyeshobola (Tanzanian Diaspora), Manon van Oldenbarneveld (African Touch), Christian Mollel, Kevin Mureithi (Kenyan UNESCO alumni), who are all connected to Tanzania (and Kenya), have made time to answer my questions, refer me to others and gave me advice about Tanzania in general. Here, I would like to thank Freddy Mageni (Tanzanian UNESCO student), who checked in on me once in a while and referred me to his friends and professional network without me asking.

Matthew Hansen (Mobisol), Barnabas Mtelevu (GEVP), Keira DiSpirito (Plaster House), Athina Kyriakopoulou (Rafiki Power) Moses Ngereza and Jacob Winiecki (Off Grid Electric), I have to thank you all for your quick reply, for welcoming me at the company facilities and your openness during interviews. As a consequence, I was able to validate assumptions and develop my own thoughts for LITA.

The families that I have interviewed, lived with or developed a connection with, you are the people that motivate to keep going, you have invited me in your house and you have given me an in depth understanding of a different and but fulfilled life. Chief, January, Mama Henriette, Mama Frida, Oswald, Godwin, Mama Lawrence including all children and other community members that would have liked but couldn't be part of the research. Ahsante sana kwa safari. (Thank you very much for the journey).

All members of AISE Twende, have been so valuable for this project. I have enjoyed using your workshop; working and building with you guys. Your openheartedness has been so refreshing: from giving me rides home, to sharing music, eating together and most importantly asking critical questions about what I was doing. Jim, Frank 1, Frank 2, Marko, Chris, Bernard, I laughed nilicheka sana (I laughed a lot) with you. Keep the good work going and become the most successful incubator in Arusha. I have to thank Deborah Tien in particular as you have been a great ambassador and made it possible for me to get connected and involved with what you are doing.

### Friends and Family

My dear friends, who checked in on me and my graduation buddy. It was nice to have you there. Mom, brother and dad, you have always always been there to here my sob stores, you have been asked for advice and you heard when I succeeded. **Dad**, you had to suffer from me asking advice, asking assistance when building prototypes, stealing all your equipment to build my prototype. **Mom**, our dining room area has been such a mess during the weeks that I've been prototyping, sorry for that. **Clayton**, sorry that I did not have much time to spend with you the last while. Will make up for it. **Benjuda Bob Manda**, thank you for being a supportive, patient boyfriend, who took the time out to find households to interview, assist me in carrying out the interviews and has been a wonderful interpreter. You have made working with you easy and you fulfilled a double role of also supporting me emotionally when I thought I couldn't make it.

### Last but not least

H.R.H Princes Abze Djigma, her husband Anton Martens and dean ir. **M.A. Ena Voute**. Thank you for your willingness to guide this project even though you all have a tight schedule, you being open for me to contact you and ask any questions I have and your critical questions.

- Deborah

Universiteitsfonds  
Delft



Delft Energy Initiative  
TU Delft

Strategy is about  
stretching limited  
resources to fit  
ambitious  
aspirations.

C.K. Prahalad.

## PREFACE

Over the years I have become more and more interested in designing for, with and in the Bottom of Pyramid (BoP) as this ensures complex assignments. This passion for social and sustainable design was sparked through one of my first adventures in Tanzania at the end of 2012. As part of a multidisciplinary team of other Bachelor students I worked on writing a business plan for an organization that provided football classes for (less) prosperous youth in Arusha. The organization wanted to expand and ensure a sustainable income. Since then I've been there yearly and it was at the end of yet another project executed in collaboration with the University of Dar Es Salaam in 2013 that I realized how lack of electricity influences the daily lives of people living at the BoP. That motivated me to set a challenge a challenge and look for alternative ways of electricity generation, which have a great possibility to work.

As I was involved in the development of a human powered energy solution, this was my starting point and the first step would be to investigate its feasibility. I was aware of the fact that my attachment of to this project could make it hard to let go when the outcomes of the feasibility research wouldn't be positive. I decided to stay focus on the situation of the people that I am designing for, who live in an intriguing socio-cultural environment, and develop the best solution possible for them. Next to that I realized that, with such a complex project I will not be

able to do all I've set out to do, even though I'm quite ambitious and love to take on everything I can. Even so I was interested in researching this further, see what I can come up with and most of all offer a solution that is routed in the research so I can give valid arguments for my choices. I was able to intensify my Strategic Product Design knowledge by using [Rogers \(2003\)](#) innovation adoption theory. Simultaneously this would theoretically enlarge the chance for success as it provided me with a framework that I could adjust to the context.

Since I like to combine theory with practice this formed the perfect challenge for me as this can be used later on as a case study in which the literature is used. Challenging was the fact that due to me working on my own project and thus being an entrepreneur I lacked the sparring with others and had to make all choices myself, which at points resulted in me doubted whether I made the wrong decision. However, this was definitely worth as this has aided in strengthening of me as a human being, designer, and researcher. Something which I would not have imagined at the time that I started my academic career at the Delft University of Technology. I am happy that I choose to go on this journey, and I hope that my thesis will benefit the people that I started the project for in first place.

## EXECUTIVE SUMMARY

The lack of access to electricity worldwide contributes to the Bottom of the Pyramid (BoP) – living on less than \$2.50 per day – being trapped in poverty. Household holds spend a considerable amount of their income on what they think are cheap, but polluting resources due to lack of education and the desperate situation they're in. Not only are consequences of the use of biomass resources polluting for the environment, it also results in a great decay of the health as these resources are used inside to cook and to provide lightning. Women in particular have the the responsibility of carrying out these time-consuming chores of searching and using biomass. Instead they could have been used to educate themselves or do paid work. With the knowledge that only 7 % of Tanzania is electrified, and the fact that cleaner alternatives are mostly out of reach due to high prices and lack of financing possibilities, the problem is set.

Deborah Sumter, had been looking for alternative ways to generate energy during the course of her study, motivated by her visits to Tanzania. Therefore, this was the exquisite chance to initiate a strategic journey on which this could be investigated. As a start an earlier developed human powered energy concept was investigated in terms of feasibility. When this was discarded due to lack of this aspect a new start was made with leads on new opportunities that were rooted in both desk as well as field research. The main goal was to search for and strategically place a feasible electricity generating product-service for low income households in Tanzania. Focus was to reduce the use of polluting sources with the help of education and habit change.

Developing solutions and a strategy with a solid base made it essential to investigate three aspects of design; technology (feasibility), people (desirability) and market (viability). While technology assumptions could be validated by prototyping and test set ups, people and market were researched in the form of a two month during extensive field research, which was part of the project that took seven months.

Through iterative prototyping cycles different forms of technology were evaluated based on technology and later on customer interest was gauged. Market research entailed estimating how big the market is, looking what offerings were already on

the market, which parties are behind this offering and how to position the product as opposed to those competitors. Knowledge about people was gained through qualitative interviews and observations with local customers that fit the target group. Through these interviews assumptions could be validated and opportunities could be identified regarding daily activities that they perform and products they needed electricity for: light, phones and radios.

From various endeavors there could be concluded that generating electricity while cooking would be a great opportunity as this fits the goal that was set. LITA was born. Cooking is currently still a main source of concern as the WHO estimated that 4.3 million people are dying from indoor pollution. As the researcher was aware that change does not happen in a split second the choice was made to strategically use LITA as a way to educate people about their current cooking habits and collaborate with stakeholders to adjust the current or develop a new cooking stove in the future. This would ensure a cooking stove fit to the context will be designed. LITA itself due to the possibility to charge phones and have access to lightning contributed to less use of kerosene.

LITA is part of a new complementary product category; accessories for current cook stoves. Although, this makes it unique it also poses a threat as this is something people do not know, meaning resistance of innovation. As a consequence, a push strategy would be best to use. In a price sensitive market, it therefore is essential to focus on the affordability of the product and the possibility of save money. The advisory sales price is therefore maximum \$25. However, emphasis on this aspect is an absolute no go as this will affect the status of the buyer. Rather in positioning the product is the focus on relatable discomfort, which the product now takes away.

Point of sales are advised to be existing retail channels such as community grocery shops, cook stove vendors and fuel sellers as these are respectively daily touch points and places where cook stoves are bought already. Using existing channels saves on costs and aids in keeping focus on product design and development. Regarding the supply chain more thorough research would need to be done when setting up a pilot to see what amount of money will have to be reserved to supply the



chain and to maintain an acceptable cost price. Promotion of LITA will be done through the use and instruction of opinion leaders in the community. As [Rogers \(2003\)](#) explains these are the community members more open to innovation and change and they have a leading role in society. In the interviews it came forward that community members trust these individuals and purchase decisions are often started through others close members (friends and family) having the product. Next to that the retailers will have to be instructed on how to demonstrate and sell LITA.

With the awareness of limitations in the market introduction plan a strategic roadmap is set up. The roadmap entails four phases, with each phase having its own objective starting with a pilot, going forward to building a business case with the trial data acquired in phase 2, moving forward to a null-series for which seed money needs to be collected and ending with scaling up with LITA to other parts of Tanzania. The two-year road map is build up like this to offer enough time to gain feedback, iterate on that and move forward as this is deemed to be the essential in designing valuable solutions.

In conclusion, the operational roadmap in which the strategy is enclosed is routed in desk and field research, keeping all aspects of desirability, feasibility, viability triangle in balance. Following this plan can result in the first step of long journey that fulfills the promise to low income households to offer an alternative, affordable daily usable electricity generating product-service.

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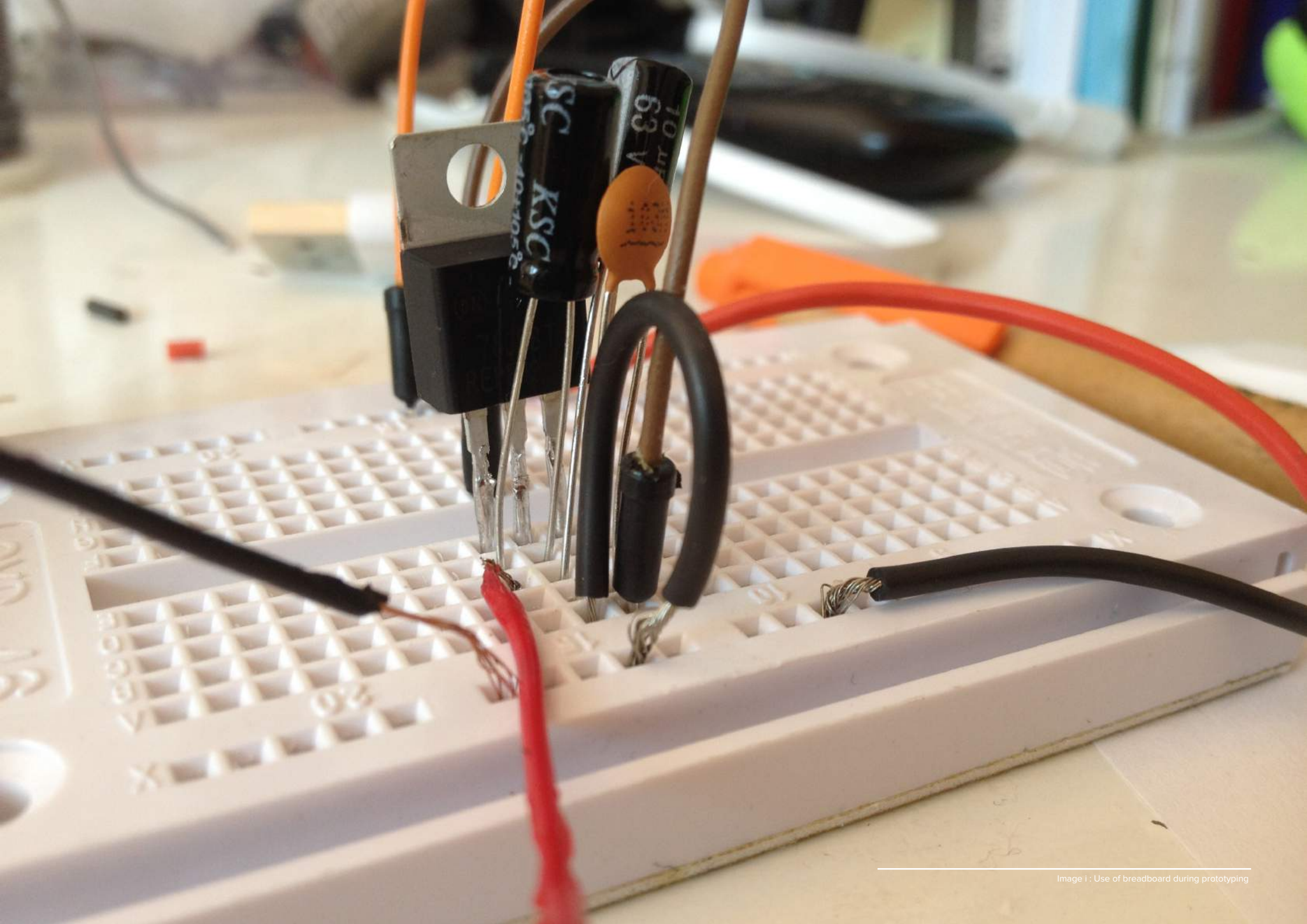


Image 1 : Use of breadboard during prototyping

## GLOSSARY

### BMC

Business Model Canvas; strategic management and entrepreneurial tool. It allows you to describe, design, challenge, invent, and pivot your business model (Osterwalder & Pigneur, 2010).

### BoP

Bottom or Base of the Pyramid; the 4 billion people living on less than \$2 per day. (C.K. Prahalad, 2005).

### GDP

Gross Domestic Product

### HCD

Human Centered Design

### Human-powered products

“Electric products powered by muscular work from the user”. Conversion of muscular work into electricity. (Jansen, 2011)

### MFA

Micro-finance Agency

### NGO

Non Governmental Organization

### OL

Opinion Leader; individual who leads in influencing other's opinion (Rogers 2003, p.300)

### Startup

Entrepreneurial business or organization, which is seeking and developing for disrupting innovations and corresponding new ways of evaluating current business; pursuing and exploring new technologies and scalable business models.

### Biomass

Biomass is biological material derived from living, or recently living organisms (Biomass Energy Center, 2011)

### Fossil fuels

Flammable biological material, that absorbed CO<sub>2</sub> from the atmosphere million of years ago. Examples are oil, coal or natural gas.

### Firewood

Wood chopped, collected and used to burn as a fuel. Kerosene | Lamp Oil | Petroleum  
Fiery hydrocarbon liquid used as fuel.

### Charcoal

The porous, carbon-like material with a black color, which is a result of burning organic material with little to no air supply. The material is widely used for different purposes used for it adsorption and filtering qualities as well as for fuel.

### User

The person using the product or service.

### Customer

The person paying for the product or service. This term is used interchangeably with user. The definition shows that the user is not always the one paying.

### Conversion Rate

1 Euro = 2500 TSH

1 Dollar = 2200 TSH

# 1.THE PROJECT

This chapter forms an introduction to the graduation project that is executed as part of the Strategic Product Design master program of the faculty of Industrial Design Engineering (IDE) from the Delft University of Technology (DUT). The project is initiated and fully executed by the designer/researcher and is focused on exploring opportunities for alternative energy generation. To make the assignment more manageable the assignment is sectioned in parts, with each part focused on answering a specific sub-research question.

polluting

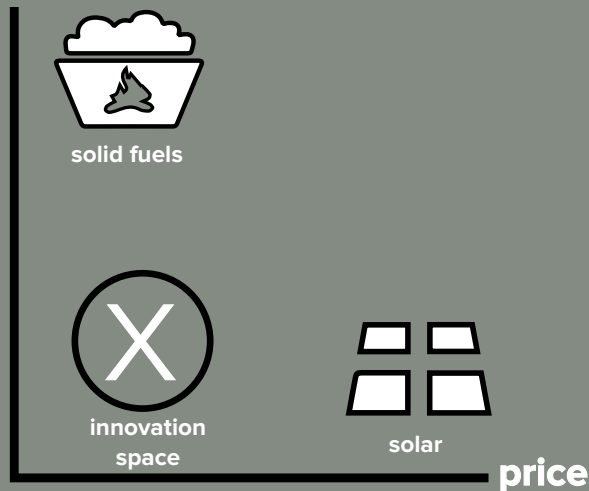


Figure 1.1: Innovation space for alternative energy solutions

## 1.1 INTRODUCTION

“Over 1.2 billion people - 20% of the world’s population - still live without access to electricity worldwide. Almost all of whom live in developing countries. This includes about 550 million living in the continent of Africa” (World Bank, 2015). In Tanzania 70% of the population corresponding to 35.14 million people in 2013 live in rural areas. However, 7% of these rural areas are electrified resulting in only 2.5 million people having access to electricity. The *Tanzanian Market Intelligence (2013)* states there is a correlation between the rate of literacy and access to electricity: 59% of the population in Dar es Salaam has access to electricity and the literacy rate is 91%. In the Linda Region on the other hand these numbers are respectively 5% and 60%. The presence of electricity is necessary to fulfill human basic needs and encourage local entrepreneurship in rural areas, which will help the population to improve their living condition and overcome poverty. Currently the day is mostly cut short after it turns dark, which is between 6.30 and 7 PM, while a lot more can be done if basic appliances can be powered and if there is light. Combining this with the fact that the common clean alternatives such as solar are still out of reach for most households in Tanzania, of which the GDP per capita per year is estimated at \$488 (National Bureau of Statistics, 2013)<sup>\*</sup>. This makes it clear that there is an untouched market that can be served by means of a not yet offered energy alternative with corresponding service (figure 1.1: Innovation space for alternative energy solutions).

## 1.2 PROBLEM STATEMENT

Initial exploration of the world of energy alternatives started in 2013. The researcher participated in a project executed in collaboration with the University of Dar Es Salaam in which human powered energy concept was proposed as a solution for the problem. The concept had some limitations such as: low commercial viability (cost price was already as high as €200), functionality was limited as the only way to generate energy was in stand alone position (not during cycling). The design researcher saw some potential in this concept and therefore it was used as the starting point to perform a feasibility research with.

<sup>\*</sup> GDP per capita in 2012 of Arusha was 1,258,334 TSH (\$599) making it one of the five wealthiest regions of Tanzania. Kigoma, the region with lowest GDP per capita has a measure of \$290 (608,652 TSH). Dar es Salaam is the wealthiest region with a GDP per capita per year of \$826 (1,734,842). The average GDP per capita per year of the Tanzanian Mainland year was measured at \$488 (1,025,038 TSH). Source: National Bureau of Statistics (2013)

## 1.3 ASSIGNMENT

The main aim with this thesis is to explore the opportunities of alternative energy generation in Tanzania. The human powered energy concept formed the initial anchoring point, of which the emphasis was to make it more affordable while still having it fit in the context of low income Tanzania. While it seems easy to just make a more affordable version of the current solution, social and cultural aspects come into play, which can lead to rejection of innovation. There was freedom for the design researcher to discard the concept once the set goals could not be met. First choice would be to search in the domain of mechanically sourced energy, but there were no limitations to this as the aim was to come up with an optimum solution. The end-concept has to fulfill the following tasks; offer an affordable, clean energy alternative for low income Tanzania, ensure (daily) access, generate energy for the most important appliances and be complementary to and with other (clean) sources of energy). The design researcher through iterative prototyping (on site) aimed to discover the f the technology. The main aim in this graduation project can be described as:

**“Design of a feasible product-service system and an accompanied market strategy for clean energy generation in rural Tanzania”.**

First objective is to design a concept that embodies the vision the designer has for the product-service system. Part of this concept is embodiment of the concept through a prototype. The prototype can act as a catalyst for further conversations by functioning as a boundary object (Carlile, 2002) during conversations. The second objective is to develop a corresponding strategic operational plan. Fulfilling the set objectives could lead to the development of a post-graduation startup that can use this master thesis as the theoretical foundation for subsequent implementation. Do note that the proposed concepts are initial proposed visions, which can be altered in case the project will be continued.

## 1.4 RESEARCH QUESTIONS

The main research question of this graduation project is two-fold and can be described as: "Which alternative energy generation opportunity for the clean energy market would entail the most feasible product-service system and what market introduction strategy should accompany it". This question mirrors the tension space between technology (feasibility), people (desirability) and business (viability). Finding a balance between these three elements is essential as it provides the ability to answer the question thoroughly. Hence, the sub-research questions are divided accordingly; will people want it (people), can you make money from it (business), can it be delivered (technology) as subtracted from the feasibility, viability, desirability figure from IDEO (n.d.), see figure 1.2: Innovation Balance.

### 1.4.1 SUB-RESEARCH QUESTIONS

This project incorporates core aspects of the theory thought at the faculty of IDE as it entails all aspects of (integrated) product-service development; (contextual) research, (re)designing a concept, prototyping and writing a business plan. Based on the main aim, three sub-research questions that deal with the technology-people-market triangle were set up. The researcher will shed some light on how each of the sub-research questions are helping to achieve the main aim and which questions were part of each of the sub-research questions. Note that there is a tension between the three sub-research questions in terms that they cannot be seen as total loose aspects, but that they are interdependent.

#### 1.4.1.1 TECHNOLOGY (FEASIBILITY)

Since this graduation project is part of a quest for a new clean energy alternative for a low income context the boundaries of the term alternative energy are widely explored to see in what format the technology could have the most impact. Within this subdomain (re)designing (the initial) concept and applying (integrated) product development will be touched upon by constantly iterating the cycle of defining, testing and validating.

*Questions as part of this sub domain: To what extent is the technology and corresponding prototype innovative? To what extent can the designer prototype the theoretical technology? What will actual production cost be (estimation)? Most importantly, can it be delivered?*

#### 1.4.1.2 PEOPLE (DESIRABILITY)

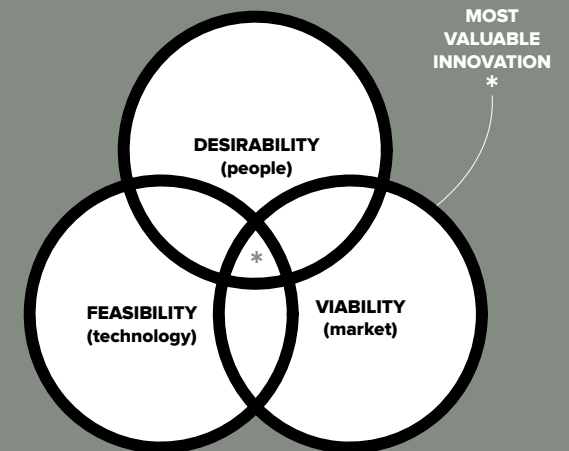
The domain of people is focused on understanding the users of the product. What moves them to buy (or not to buy) a product. Fit with the context is definitely essential in this case. When the product is too far from what the user is comfortable with rejection can take place. Rogers (2003) offers a framework about the diffusion of innovation and explains which steps to take to ensure adoption of innovation. Part of this will be to explore what the customer is already exposed to and to understand why, so that these elements can also be used in the proposed concept. In the form of interviews – in which the context, household and decision making, aspirations, wants and needs are discussed - and observations qualitative data on the people aspect collected. The rest of the questions in people domain concern:

*Does the customer understand how the technology works? If not, how can we make the technology more understandable? Which elements are crucial to make the customer see the relative advantage of the proposed concept pertaining to other current offerings? In which use scenario case could this concept mean the most to the customer? How should the concept be altered to fit customer needs best?*

#### 1.4.1.3 MARKET VIABILITY

To develop a market introduction strategy, which can be used to enter the market with the proposed alternative energy concept the product should be positioned well as this forms the base. Part of this is identifying current competitors. Therefore, it is relevant to explore the local business landscape. Since there is no company with its own vision, but instead a researcher with her vision the thesis will serve as an initial proposal on what the researcher expects is the best way to go about putting the proposed concept in the market.

Who are the competitors? How is the industry build up? Which channels to use to get the product to the customer? How to make sustainable money from selling this product?



## 1.5 PROCESS

To keep the process structured the Human Centered Innovation Approach (AmlaDesigner, 2014) is used. This approach divides the innovation trajectory in three subsequent phases - HEAR, CREATE, IMPLEMENT - in which there is room for diversion, iteration and conversion. This thesis starts with contextual exploration through desk, literature and field research. All part of the HEAR phase. As a starting point the human powered energy concept is taken and reviewed on feasibility. In the subsequent phase CREATE designing a (new) solution based on the main insights is the point of focus. Prototyping is used in this phase to validate the technological ideas and iterate accordingly. The corresponding positioning and actionable strategic roadmap are set up after synthesis of the data from the previous phases and are part of the concluding IMPLEMENTATION phase. As depicted in Figure 1.3: Project Outline the chapters fall into one of the phases of the approach.

businesses, observations and in-context immersion. Next to that some feedback is collected about the initial innovation direction. The chapter concludes with a more solid advice about for the redesign. Afterwards, in **chapter seven** the redesign is proposed after the defining the design goal and setting noting the criteria, which are based on previously stated insights. This entails on the elaboration of the product-service system and how it fits with the previous insights. Once the specific use case is identified and the main accompanying technology questions are answered the focus is shifted to positioning of the proposed concept as apposed to competitors, in **chapter eight**. This requires some background regarding the market that the product is positioned in and the competing parties. **Chapter nine** entails the strategic marketing plan accompanied by an actionable roadmap, which can both be described as objects that incorporate all that has been done during the project and thus offers an answer to the main research question. The thesis ends with an evaluative chapter in which recommendations are done about the work and for the future in **chapter ten**.

## 1.6 STRUCTURE

The thesis starts off with **chapter one** in which the origin of the assignment is explained and the corresponding research questions are highlighted. It then moves on to sketch the research outline of applied methodologies and approaches are particularized for each step of the process in **chapter two**. In **chapter three**, the context – Arusha City in Tanzania - is elaborated on to get a feeling of the situation in which the final proposed concept will be used. Topics dealt with in this chapter are related (socio) demographics, culture and infrastructure and the Tanzanian energy market with its current problems. This gives an indication of what would be relevant to look at during the (re)design of the proposed product-service system and corresponding strategic plan. **Chapter four** zooms in more on the customer themselves. Defining the target group, their needs and income (struggles). Subsequently, in **chapter five** the market is explored, starting with stating what the scope for the project is in terms of technology, what the current offerings are and what kind of topics are relevant, trending and inspiring. The chapter ends with a selection of an interesting innovation directions, supported by the collected data with some first thoughts about what the (re)design should look like. **Chapter six** continues with a field research in which the context is explored through face-to-face interviews with end-users and

Each chapter consists of a short introduction. At the end of each chapter, the **take away** of the information is presented in **highlighted boxes** to allow the reader to quickly browse through the thesis and grasp the essence of each chapter.

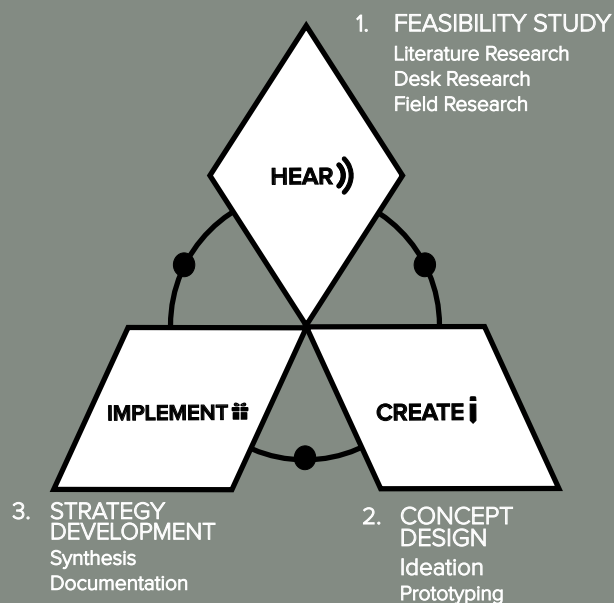


Figure 1.3: Project Outline



## 2. THEORY

In this chapter the main theoretic sources about innovation will be discussed. This forms a base for the research as to which aspects to keep in mind while not only designing the product itself, but thinking about the service that goes with it and the strategic market plan.

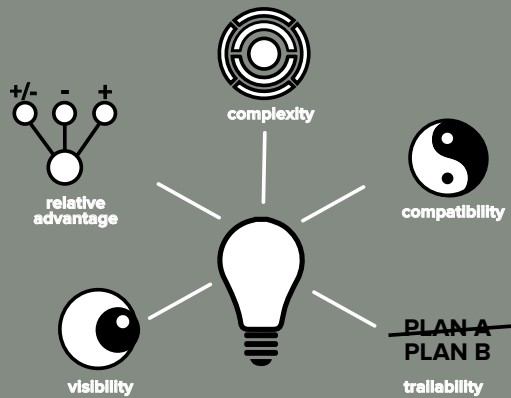


Figure 2.1: Attributes influencing innovation adoption.

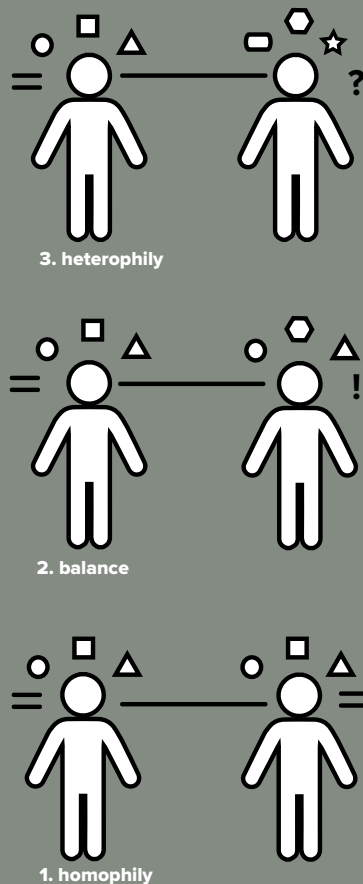


Figure 2.2: Heterophily vs. Homophily. Visual explanation from Rogers (2003).

## 2.1 DIFUSSION OF INNOVATION

At the start of the graduation project certain literature two main literature approaches about the the *Diffusion of innovation* (Rogers, 2003) and about marketing of technology products to customers (Moore, 2002). These two approaches to the subject of innovation were used to set up a framework regarding what innovation is, how it normally is diffused spread i.e. dif-fused and more practically, which aspects to take into account when marketing innovations. As this strategic design project had the goal to evaluate the opportunities for a new innovation regarding clean energy alternatives in Tanzania, the researcher also had to be aware beforehand of innovation diffusion theory so that common mistakes could be avoided.

“Diffusion is the process by which (1) *an innovation*, (2) which is communicated through certain *channels*, (3) over *time*, (4) among the members of a *social system* (Rogers, 2003, p.1)”. Diffusion specifically has to do with spreading things that are **perceived** as new. Innovation is basically an (in)tangible idea perceived as new by certain objects. New can be defined as knowledge that was not known before, which might aid in persuading or deciding customer to adopt an innovation Rogers (2003), suggest that the following five perceived attributes, influence the rate of adoption of an innovation:

1. **Relative advantage**, which is about perception of the innovation in relation to previous innovations. The more perceived relative advantage (higher satisfaction more convenience, better economic position) there is, the higher the adoption of the innovation.
2. **Compatibility**. This is the extend to which the innovation fits with the existing values, needs and past experiences. The better the fit, the higher the adoption rate.
3. **Complexity**, has to do with how difficult an object thinks the innovation is to understand. When perception of complexity if low, the more like it is that the objects will embrace the innovation
4. Object also care about the option to try and thus experience the product before deciding on the purchase. This is called **trialability**. When new ideas can be tried, they will be adopted faster.
5. The last attributed constitutes **visibility** of the results regarding the innovation to others; observability. The lower the barrier of receiving results, the quicker the adoption of innovation will be.

Note that there are more variables that affect the rate of adoption of an innovation (see figure 2.1: Attributes Influencing Innovation Adoption). As most research has been concentrated on perceived attributes the common knowledge from this topic is implemented in the proposed innovation.

Gathering information is a remedy against the uncertainty about the innovation and helps reduce the perceived risk. The channels used to transfer this information differ from mass media to interpersonal channels. While the first has a greater effect on knowledge creation, the latter actually has the option of forming and influencing adoption decisions. Peers have the possibility to influence each other when they differ in certain characteristics such as social status and education, called heterophily. The crux is that there should not be too much of this as hinders effective communication. Consequence is to find a balance between heterophily and homophily to achieve the optimum diffusion of communication (see figure 2.2: Heterophily vs. Homophily)

Just placing an innovation in a new context is therefore not enough. The five attributes have to be carefully incorporated as part of the new idea. Studying current energy practices and the possible resistance to new disrupting alternatives will therefore determine the future of the proposed concept. Current practices should be adjusted to the use of this new idea. Explorative research is necessary to understand local culture so that specific use practices and application situations for the concept could be determined and a corresponding market introduction plan could be set up. This gives input about the innovation decisions process of objects, which is the timeline from gathering knowledge, getting persuaded, making a decision to purchase or not, implementing the new idea in current practices and confirming if the new idea fits with the expectations. Getting to know who are involved in this process and which the norms of the social structure influence the decision making process. Rogers (2003) states that opinion leaders due to their stature in the community are able to influence and change attitude of objects frequently. “A network... can be used, rather than ignored, when creating [diffusion] programs” (Rogers, 2003, p.321; Valente and Davis, 1999, p.56). These persons are usually more prone to innovation and hence adopt new ideas earlier than other community members. They are not paid to do so, but due to their function as role model they have that authority. Change agents and aides on the other hand are not always part of the community but they do have an agenda. Aides fulfill a less professional role in this. Identifying members of the community who can fulfill these roles is therefore essential in cre-

ating the optimal condition for innovation adoption. Within this thesis ways the aspect to identify the roles in Tanzanian communities will be highlighted. Applying **Hidden Design** (Tomico, Winthagen and van Heist, 2012), which entails becoming part of the community is essential for acquiring direct raw data and prevents getting answers that the interviewees think you want.

## 2.2 MARKETING INNOVATIONS

Before bringing the innovation diffusion theory into practice, the **Technology Adoption Life Cycle** (figure 2.3: Technology Life Cycle) by Moore (2002) has to be understood. This cycle has the form of a bell curve and segments all the types of customers that are part of the innovation adoption cycle. Note that while the model seems to run smoothly overtime, there are also gaps between the different groups based on their innovativeness c.q. openness to innovation.

### 1. Innovators (techies)

This small first group can be characterized as people who actively search for new technology as this is part of their lives. They see the value in the technology, don't care about having to fix peripheral problems and are good references for the following group. Luring them in can be through for example demo's. Their vision is that technology is for everybody, hence they don't want to pay a lot of it. Most important value is the truth.

#### Gap (1)

The gap between innovators and early adopters emerges when the benefits of a new technology cannot be made understandable to the innovators.

### 2. Early adopters (visionaries)

Visionaries are concerned with finding a breakthrough technology. They have a wild send of imagination and understand the benefits and strategic leap forward that a new technology can entail and appreciate that. The fait that they have in their vision urges tem to invest in a certain technology and results in low price-sensitivity. However, this makes them the hardest to satisfy as their dream cannot be fully realized. They derive their information about new technology mainly from communicating horizontally with inter alia the techies, although they are not techies.

### Chasm

Chasm related to the gap that is the hardest to bridge as the objectives from early adopters and early majority differ tremendously. Early adopters on one hand want disruptive innovation and they can live with the product or service not being perfect. Early majority on the other hands wants a fully working product that improves the productivity of current practices: they want a proper working sustaining innovation. Major problems occur here because the early adopters cannot inform the late majority as they want different things out of an innovation. Early majority wants to hear from other people out of their group, preferably as many as possible; resulting in a chicken or the egg causality dilemma.

### 3. Early Majority (pragmatists)

Happy to see what other people think of their experience with the innovation, that characterizes the pragmatist. Focusing on references from well established proven market leader. Purchase innovation only when a supporting system is established and reliable service is offered. They are relatively price-sensitive. Moving from the visionaries to the pragmatist result in substantial growth It is important understand their values. Only by doing so their trust can be won. To get to know more about innovations they communicate vertically, meaning with similar people.

#### Gap (2)

The use of the new technology requires technological competency of the user. Between the early majority and the late majority this often differs and the product has to be made more understandable for the late majority so they can adopt this. When this is not done the risk of not reaching full saturation is enlarged and the market stagnates too early.

### 4. Late Majority (conservatives)

The late majority has a big resistance against disruptive innovations. They are often not comfortable with technology and wait to see a full blown support system in place as this gives them a more secure feeling. Adoption by this group result in high profitability for large companies as these are the only companies they trust and thus by from. The profit margin declines over time as the innovation matures and competition to obtain the biggest market share leads to low prices. The late majority is more more likely to discontinue innovations than early adopters and early majority.

### 5. Laggards (skeptics)

This group does not relate to technology at all, is small and not worth pursuing.

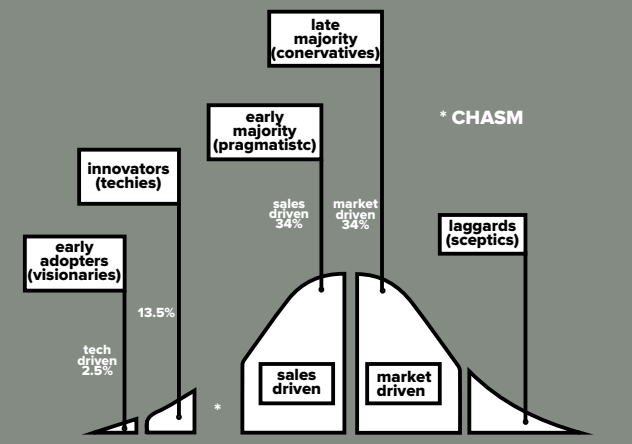


Figure 2.3: Technology Life Cycle Moore (2002)

The main outcome from analyzing the model is that to keep obtaining new customers during the life cycle of a new innovation new strategies have to be applied. This means focusing of on the characteristics of the segment and adjusting the marketing strategy accordingly

### 2.2.2 WHOLE PRODUCT CONCEPT

The Whole Product Concept (Moore, 2002,; Levitt, 1986; Davidow, 1986) resembles how there is often a gap between the marketing promise made to the customer and the product's ability to fulfill that promise. For that gap to be overcome, the product must be augmented by a variety of services and ancillary products to become the whole product (Moore, 2002, p.105).

- Generic product; Basic product. That what is in the box.
- Expected product; minimum product and services that the customer expected when he chose to buy the product.
- Augmented product; elaborated product, meant to persuade buying behavior.
- Potential product; the growth margin of the product.

It might be clear that when moving from left to right through the Technology Life Cycle the customer group expects more and more and more a whole product, which is an important aspect to keep into mind when marketing the innovation to people. This again stresses that there is not one strategy, but that the strategy instead should be evolving.

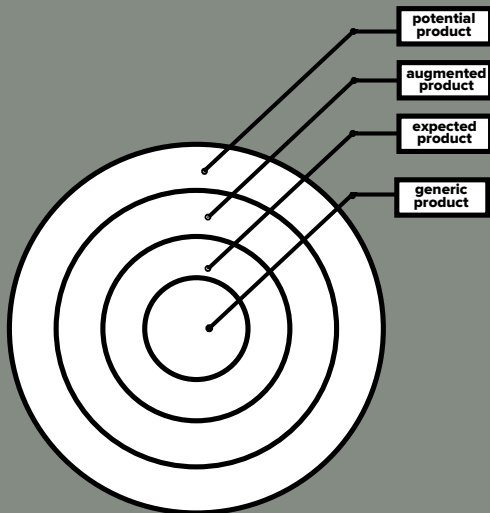


Figure 2.4: Whole Product Concept (Moore, 2002)

## 2.3 TAKE AWAY

- Five perceived attributes of innovation should be taken into account for the design of the alternative energy solution. Including these aspects in the new innovation affects the adoption rate.
- Getting acquainted with the customers is key to understanding them and gaining their trust. Various customers might be in a different stage resulting in them needing other stimuli to move forward in their innovation decision process.
- Marketing the diffusion is a dynamic process as the Technology Life Cycle evolves and attracts customers, who all have different conditions for innovation adoption. Marketing strategy therefore plays an imminent solution as part of the solution. The proposed solution therefore should exist out of a product with corresponding support and service system as this aids in lowering resistance.



**HEAR**

# 3. CONTEXT

Within this chapter topics that relate to the domain context are discussed. After presenting regular facts about Tanzania, and the general energy market Arusha is analyzed. Zooming in on demographics, culture, the economy and the local infrastructure and reflected issues creates an understanding of the contextual situations. This in turn lowers the threshold for new product design and introduction. Van Boeijen (2015) in her dissertation 'Crossing Cultural Chasms' mentions to not dwell on cultural differences. The advice is to rather accept differences, try to look for similarities between the cultural context and put it in perspective. This caution is also applied during the cultural analysis as to avoid bias and stimulate openness in later design practices.

## 3.1 TANZANIA GENERAL FACTS

The United Republic of Tanzania - also known as Tanzania - is one of the countries categorized as part of East Africa, together with Kenya and Uganda, with which it borders in the North, Congo, Rwanda and Burundi in the West and Mozambique, Malawi and Zambia in the South. The coastal country, independent since 1961, has a total surface of 945,203 km<sup>2</sup>. This is including the island Zanzibar that together with Pemba forms a semi-autonomous state, which is part of the Republic of Tanzania. Kiswahili and English are regarded as lingua franca. The average population density is 51.06 per square kilometer (Tanzania Market Intelligence, 2013). The population is approximately made up of 51.82 million people and has a growth rate of 3.2 (World Bank, 2014) and 29 administrative regions (Msyani, 2013). Urban centers usually have higher growth rates, but the rural areas have the largest households. Inhabitants of urban areas in general have more opportunities considering "the highest influx of sustainable technology and environmental infrastructure services are found in Tanzania's cities" (Tanzania Market Intelligence, 2013, p.34). While the official capital of the Tanzania is Dodoma, since 1996 the financial and governmental institutes mostly reside in Dar Es Salaam. This is due to the establishment of the port which gives the opportunity for trading. Supported by inter alia the International Monetary Fund (IMF) and the World Bank Group the country has been able to sustain its economic growth rates (respectively 7.3% and 7.0% in 2013 and 2014) over the last decade through structural reforms in the financial arena. "The main contributors to growth were the construction, trade, agriculture and transport sectors" (World Bank, 2014). Even though the economy has been stable, Tanzania's has a position as a net exporter of gold. Additionally, it depends highly on the import of oil, which makes it vulnerable to external shocks. World Bank (2014) estimates that 28.2% of the population lived below the poverty line in 2012, which is set at living of less than \$2.50 per day. The institutions states that roughly 12 million Tanzanians are living in poverty: as it seems this comes down to on average \$1,34 per day in 2012 (see section 1.1: Introduction; based on the GDP of \$488 per year). Tanzania's main developmental challenges are dealing with infrastructure bottlenecks, making the business environment more attractive, empowering the agricultural market, bettering the skilled workforce and managing the urbanization. Tanzania works on tackling these problems and has recently adopted the Big Results Now Program. This pro-

gram helps governments focus on so-called priority result such as: "increasing agriculture productivity (...), improving reliability and access to power supply, reducing transport costs, improving quality of basic needs" (World Bank, 2014). An example of progress that has been made is the literacy under women that has improved over the years by empowering women to participate in innovative micro enterprises. However, households are still male-dominated (3:1) and literacy between young women is low (Tanzania Market Intelligence, 2013).

## 3.2 ENERGY MARKET

The Tanzanian overall energy market can be described as a diverse market from which a lot of sources such as hydro, uranium, natural gas, coal, solar and wind are still untapped (Msyani, 2013). As a source of energy supply biomass (90%) is used primary.

### 3.2.1 SOURCES

As a second source petroleum products (8%) like oil and gas are used, which costs 25%-35% of the nation's foreign currency earnings (Msyani, 2013). In rural areas 80% of the energy is sourced through the use of biomass. This results into an impact on the environment as this leads to increased CO<sub>2</sub> levels, loss of biodiversity, erosion of top soils and increases vulnerability to floods (Alliance for Rural Electrification, n.d.). Different sources mention contrasting electrification rates Lyimo (2006) mentions an electrification rate of 14%, Msyani (2013) mentioned 18.4% and the Tanzania Market Intelligence (2013) indicates that the rate is 21%. Although the last source focuses on doing research for the Lighting Africa Program, the choice is made to work with the data provided by this source as this source presents the most extensive research. The Tanzania Market Intelligence (2013) for its research has identified six regions, including Arusha (more in section 3.3: Arusha). BoP communities living in rural and peri-urban areas of these regions were the focus of this research. This matches the focus of the designer.

In Tanzania there is a gap between rural and urban areas, with only 7% of the rural areas being electrified, even though 70% of the total population lives in these areas. This is regarded as not being financially feasible, reports Msyani (2013). Low electrification is not the only problem, as the network is also the grid is often also unreliable resulting in power cuts and people having intermittent energy supplies.

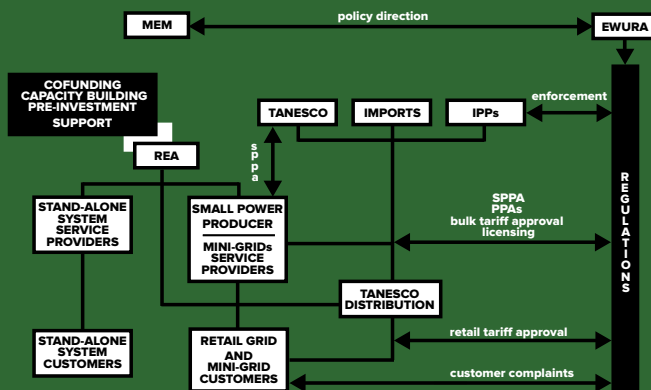


Figure 3.1: Electricity Stakeholders & Institutional Framework. Adapted from Tanzanian Market Intelligence (2013). Source *Scaling up Renewable Energy Program*. Ministry of Energy and Minerals (2013)



The fact that most rural areas lie far from the urban areas, makes it financially too costly to connect the grid up to there. Additionally, the rural population does not pose a threat to the government's inaction as they do not champion for change. The rural population instead results to the use of alternative resources, which mainly consist of fossil fuels as this is what they have access to and is within their budget. Entities offering clean alternatives such as solar have difficulties penetrating the market due to the fact that up-front costs are too high (most retailers sell on a cash basis only), excessive margins are used, lack of credit and continued cash flows and inconsistent quality is offered to customers including imitation solar products (Camco Clean Energy, n.d.).

### 3.2.2 GENERAL STRUCTURE

The *Tanzanian Market Intelligence (2013)* identified the institutes in figure 3.1: Electricity Stakeholders & Institutional Framework as important players in the energy market. In this figure there can be seen that only a few governmental bodies are responsible for the making, execution and regulation of the financing and research policy regarding the energy sector. The Ministry of Energy and Minerals (MEM) is regulated by the EWURA (Energy and Water Utilities Regulatory Authority) in their activities. The Rural Energy Agency (REA) in turn has the task to ensure that rural areas are foreseen with modern energy solutions. Their main goal is to facilitate public and private power producers: they provide technical and commercial guidance as well as funding for studies and business plans. This entity helps these power producers promote alternative energy solutions. The *Tanzanian Market Intelligence (2013 p.74)* has concluded that the REA is less good at its 'organizing equity and debt financing'. The body thank its existence to the national vision for 2025 of the Tanzanian Government. The sole utility company, which is called TANESCO (Tanzania Electric Supply Company) is established in 1975 after merging with DARESCO (Dar Es Salaam and District Electric Supply Company) and controls the electricity supply, but is being able to get support of (1) Independent Power Producers (IPPs) and (2) Small Power Producers (SPPs)\*

\* The *Tanzanian Market Intelligence (2013)* explains: 'Small Power Producer — the SPP program was created by EWURA in fall 2009. SPP regulations enable cogenerated electricity and the expansion of renewable energy through standardized power purchase agreements (PPAs), standardized feed-in tariff (FITs) payments, and streamlined interconnection and licensing requirements. (Nganga et al., 2013).

due to privatization. SPPs mostly consists of micro and mini-hydro connected the national grid installed by TANESCO. They are simultaneously connected with an isolated mini-grid. Note that TANESCO is still the one responsible for the supply, meaning that the energy from the IPPs and SPPs is sold to TANESCO.

### 3.2.3 OBSTACLES

according to the Ministry of Energy and Minerals (2013) the main challenges in the energy market of Tanzania are:

- The growing population is causing the electricity demand to grow as well. However, in 2013 the per capita electricity consumption was lower than 100 kWh per year. The vision of the Tanzanian government is to (1) reach a middle-income state in 2025 and have 75% of the country electrified in 2035. To be able to achieve this the climate for private investments has to be more favorable and there has to be room to diversify energy generation sources.
- Due to climate change, meaning uncertain rainfall patterns and droughts, hydropower is becoming more and more unpredictable. This in turn affects electricity generation and the corresponding prices. Utility entities have to switch to the use of emergency fossil fuel-based power plants. While hydropower used to count for two-thirds of energy generation around 2010 it only accounted for 35% in 2013.
- Due to climate change and the need to invest in high cost fossil-fuel based power plants in 2012, which now account for 13% of the total installed capacity, TANESCO has an unstable creditworthiness. While the government is intervening by inter alia investing in the gas infrastructure and restructuring TANESCO, the impacts will not be imminent directly.
- Population in hard to reach areas suffers from low access to reliable electricity, which puts a strain on their daily life. Next to the fact that access to electricity helps increase agricultural productivity and education, it also could help with food preparation and water collection. Grid extension to these areas is too expensive, since it's too far and the population density - 80% of the population in 2002 lived in areas where population densities were

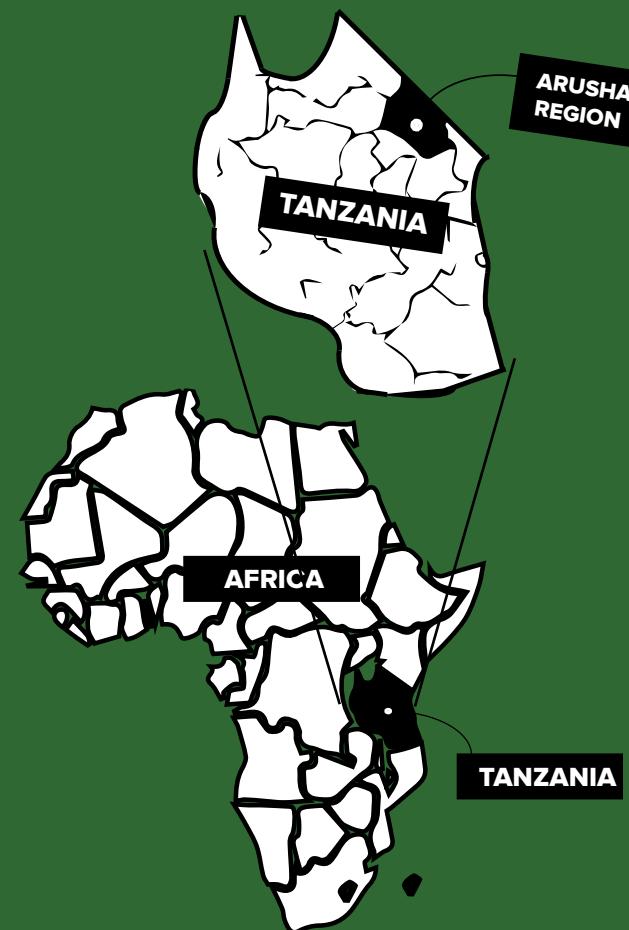


Figure 3.2: Tanzania in Africa

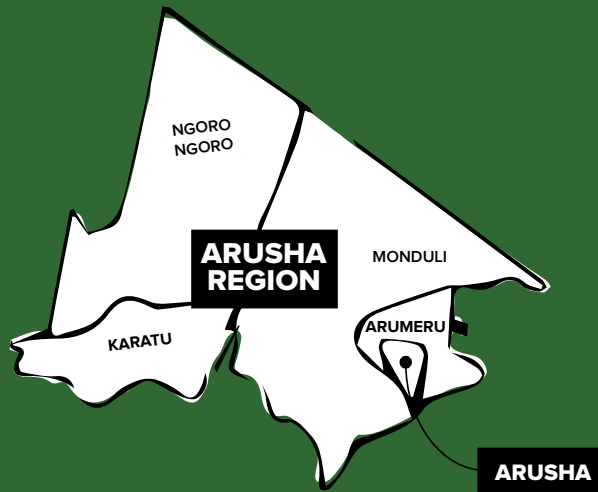


Figure 3.3: Arusha City in Arusha Region.

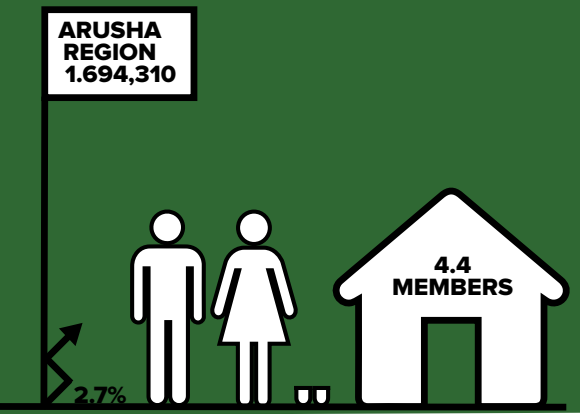


Figure 3.4: Demographic Statistics Arusha Tanzania. Adapted from National Bureau of Statistics (2012).

less than 70 people/km<sup>2</sup> - is low making it financially unattractive.

- As stated previously biomass is still used as main source of energy, which results in health risks and deterioration of the environment.

### 3.3 ARUSHA

#### 3.3.1 DEMOGRAPHY

Arusha City - 266.99 km<sup>2</sup> (City Population, n.d.) - officially declared a city by the Tanzanian government in 2006 is the capital of the Arusha region - 37,576 km<sup>2</sup> (City Population n.d.) -, which lies in the northern of Tanzania and borders with Kenya. The Arusha region had a population 1,694,310 in 2012, while the city itself is reported to have a population of 416,442 (City Population, n.d.). The district, which lies out of the border of the city has 323,198 people and consists out of mainly rural wards. With it's population of 416,442 Arusha is the third city in Tanzania. The urbanization in 2012 was 24.2% and the urban population growth between 2002 and 2012 was 3.3%. (International Growth Center, 2014). More demographic numbers, see figure 3.4: Demographic Statistics Arusha Tanzania.

*The fact that this city is large, dynamic and easy to reach the rural areas contributed to it being chosen as a place to conduct the initial exploratory research. Combining it with the fact that the researcher already had some previous experience on the ground and contacts from previous visits, made it the most practical choice as well.*

#### 3.3.2 CULTURE

Even though the researcher had experience working in Tanzania on other projects, a cultural analysis was done to aid in the (re)design and create insight in local behavior. This could in turn help when thinking about strategies for introduction, as a new product introduction requires behavior change. As a base cultural value measures Hofstede and Hofstede (2005) was used. The following insights were gained (see figure 3.5: Hofstede Comparison - The Netherlands vs. Tanzania)

Arusha, like any other large city reflect the various clans that are present in Tanzania. The country holds over 120 different tribes, with the Sukuma tribe being the largest one. In Arusha

specifically there are also minorities of Tanzanians from Arab and Indian descent in addition to a minority of white Europeans and Americans. Prevailing religions in this city and area mirror country wide measures as well: Christianity, Islam and Hinduism. Due to its convenient location close to several national parks such as the Serengeti National Park, Arusha National Park and Mount Kilimanjaro has become a tourist hub. Next to that a large number of diplomats are settled in the city due to the fact that it hosted the International Criminal Tribunal for Rwanda.

The fact that Arusha is exposed to a great deal of tourists, expats and volunteers working for NGO's has had an influence on the (socio) cultural context. The researcher observed that the population has a more open demeanor towards foreigners - the so-called mzungu's - who are in general not part of their establishment. Having said that, the culture in Arusha has more similarities with the overall Tanzanian culture as opposed to Western Cultures such as the Dutch culture. One of the first things clarifying this statement is the costume habits, which is focused on covering yourself i.e. covering the legs with a skirt or so-called kanga, certainly as a woman. This is influenced by the Islam and the Arabic culture, which are part of the history of the formation of the United Republic of Tanzania. However, the so-called mzungu's are not necessarily expected to adhere to the local rules. While in Arusha tourist are advised to try and cover their legs by wearing long pants, in Zanzibar the tourists are urged to dress according to the local norms. This shows how the cultural values are influenced by the religious beliefs, knowing that Zanzibar has a predominantly Muslim community.

##### 3.3.2.1 SIMILARITIES

Looking at the Hofstede cultural dimensions the following similarity can be noticed. The level of the dimension **uncertainty avoidance** lies close to each other with 53 in the Netherlands and 50 in Tanzania. However, the way both cultures deal with ambiguity and anxiety is indeed different. While religion and superstition prevails in Tanzania, logic and rationality is the way to go in the Netherlands. This results in bureaucracy in the Netherlands, due to the factual rules that are set up and which people have to be adhered to. In Tanzania on the other hand the rules are less clear due to the fact that they have their base in less certain - unless you are part of the religion - aspects of life. This makes it essential to be part of the community to understand all the unwritten rules.

### 3.3.2.2 DIFFERENCES

The Hofstede comparison of represent a different on all other measures. Hofstede asserts that the Tanzanian culture has a relatively high **power distance**, meaning that a large hierarchical structure is in place. The society is mainly build with low individualism, meaning there is a great sense of social control and support for each other (We). In conjunction with the large power distance there is also a preference to focus on achievement reflected in relative high **masculinity**. Beyond that, the culture is rated low for **long term orientation**, meaning that the culture is more normative and honors traditions from the past. Hence, societal change is looked at with distrust. In terms of **indulgence** the Tanzanian culture is ranked as low, making it a culture in which people can control their desires and indulgences more. This all is reflected in the contextual situation; Tanzania is a developing country in which people generally have to work a long time to earn a small amount of money. Thus they don't have a lot of time left for leisure.

From field observations in Arusha it became clear that the community experience can be pointed to as the most important factor in this culture. Having a shared sense of belonging is reflected in the way people experience religion and how they deal with family and friend ties. A sense of sharing and helping each other is part of this dimension and hence reflected in the daily behavior: being curious about what others have and learning from your peers. In relation with [Rogers \(2003\), section 2.1: Innovation Diffusion](#), this works out positively as peer to peer communication prevails as well. In contrast, in the Netherlands learning through new products happens a more rational way through mass media and includes relatively more facts. Another observation pertaining to the youngsters was that achievement has become increasingly important. Their craving for achievement is reflected in them yearning to own items e.g. cars, houses, proper clothing. These items are all seen as status items, which reflect success. Within this new-found hunger for achievement they do not lose their sense of community totally, but they try to work and in general to what they say 'find a better life' for their family. Whenever possible they try to send the brightest child to the best schools in the city. When reaching the new levels of wealth, they look for more indulgence as well. However, indulgence does not have a prominent role in their lives. In their new found self confidence, the youngsters respectfully challenge the power distance in place. This is partly influenced by the foreigners who they meet and who they

aspire to be. Barriers are broken with the normative Tanzanian culture. The Western culture starts to change the youngster, because their role models also behave and dress like the foreigners. This causes somewhat of a split between the young generation up to 30 years old and the older generation. However due to the fact that the youngsters still respect the hierarchy in their immediate surroundings, the split is not as black and white. Note that as a researcher the power distance is not perceived as the locals often put foreigners on a pedestal.

### 3.3.3 ECONOMY

Due to the fact that more recent data is the economic situation of 2007 can only be described. The Arusha Region contributes to the total GDP of the country with 4.77% according to the [\(United Nations Development Programme, 2014\)](#). Looking at a micro level the [United Nations Development Programme \(2014\)](#) mentions that the per capita income in the Arusha region was 1,258,334 TSH. In comparison, the estimate of the per capita income of the Tanzanian Mainland is 1,025,038 TSH. This is all can be asserted to the blossoming safari climate, tourism industry and the fact has a diplomatic population, due to the hosting of international legal institutes. Next to that a large amount of non governmental organizations are settled in the city, even though they mostly work outside the city. Moreover, Arusha primarily relies on the agriculture in the form of crops like coffee, beans and maize. This contributes to 45% of the Arusha region GDP and 75% of the general export earnings from this region [\(Lamudi, 2015\)](#). Next to agricultural activities, mining is also regarded as important measure that makes up 35,1% of the shared of the GDP for the Tanzanian Mainland in general. Arusha houses the gemstone, Tanzanite, which can only be found in Tanzania. Secondary activities such as manufacturing, electricity, gas and water account for 22.8%, while tertiary activities, which include services like wholesale trade, retail trade, information, communication and others make up for the shares of the GDP, namely 44.2%. Within these activities Arusha is prevalent: hosting a wide range of businesses, banks, retail centers and commercial enterprises, such as Coca-Cola, beer breweries and even pharmaceutical business.

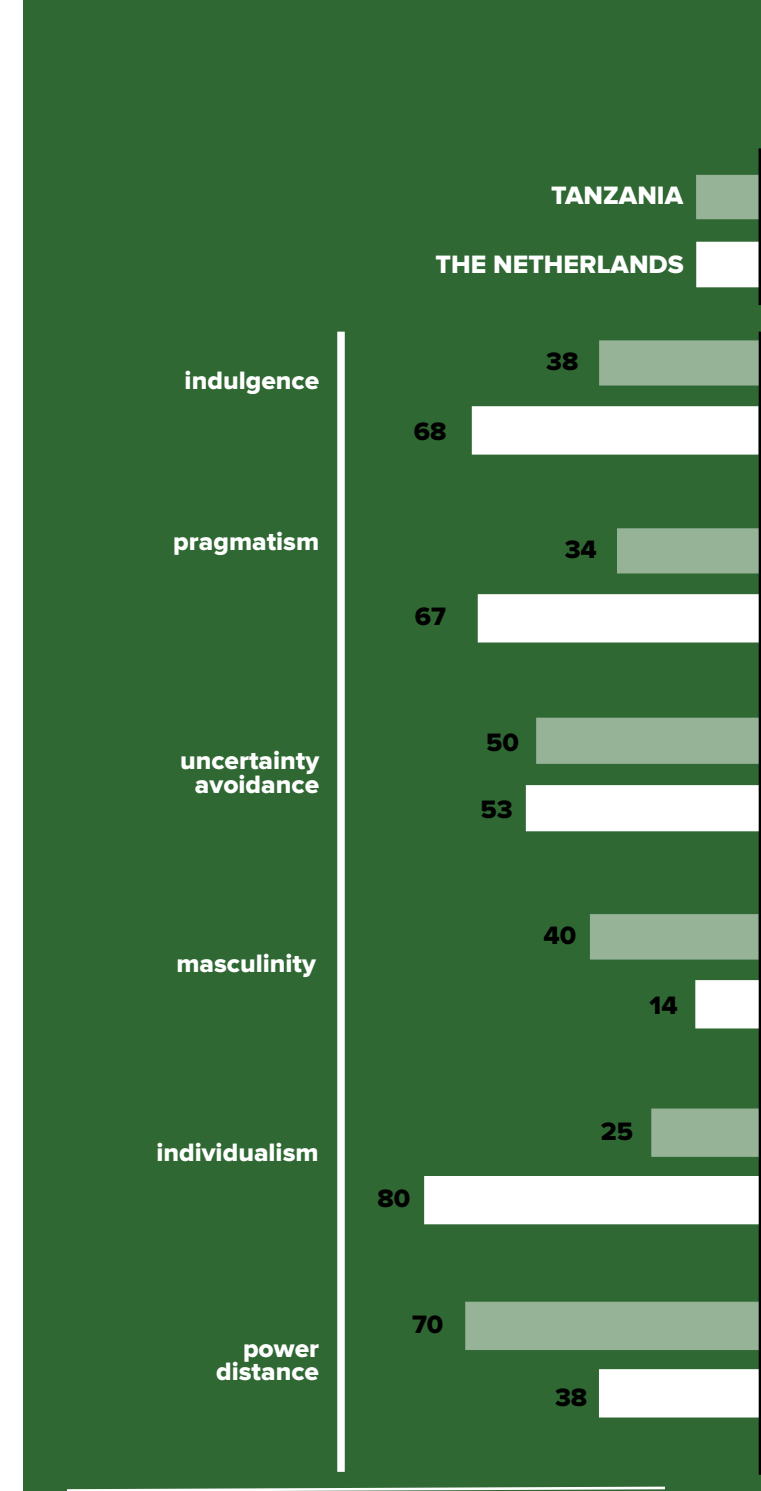


Figure 3.5: Hofstede Comparison - The Netherlands vs. Tanzania

Even though the economy of the whole region is reflected to run well and the Human Development Index<sup>\*\*</sup> reported by [United Nations Development Programme \(2014\)](#) ranks Arusha as number one city, the researcher kept in mind that still only 11% of the rural population has access to electricity. Besides, the high reliance on activity in the center of Arusha contributes to the higher GDP per capita. The poor that live outside the direct center, in the Rural Wards of the Arusha District are exactly the ones that do not benefit from the prosperity in town.

### 3.3.4 ELECTRICITY INFRASTRUCTURE

In Arusha there is a difference in access to electricity based on where you live. While 92% of the population living in urban ward says to have access to electricity 75% in some regions lack access to electricity ([Tamasha, 2010](#)). Overall [Energylopedia \(2015\)](#) explains that the poor next to that seem to spend 35% of their household income on energy, while the more prosperous part of the population spend 14% of their household income on this utility. The lack of access can be explained through the fact that TANESCO has build its main grid in places where it is economically feasible. The researcher, during interviews, obtained the knowledge that customers in turn need to invest in the poles that need to be placed from the main grid, which between 300.000 and 500.000 TSH (\$140-\$235) per pole<sup>\*\*\*</sup>. TANESCO works with a prepaid system, which means that customers pay their usage fee including service costs in place for the monthly use of electricity on forehand. Resulting in a lack of access to electricity. Cleaner alternatives often have the same limitations: the investment is higher and can often be paid in (higher) installments. However, the unstable cash flows of customer form a restriction in this case.

## 3.4 TAKE AWAY

- Arusha is a good starting point to perform research. Even though it is one of the bigger cities that are doing relatively well due to the fact that it forms a large base for tourism the city still provides a valid reflection of people suffering more from poverty and a lack of access to electricity. The fact that the researcher already has contacts here and previous experience from working in this area ensures for a larger learning potential as there will be more time to “go deeper”. This due to the fact that common local knowledge is already part of the system of the researcher.
- In the design of the market strategy plan there should be an emphasis on cultural values as this can determine whether the product will be accepted or not. It is important here not to focus on similarities in culture and how this fits with the culture characteristics fit with the innovation diffusion theory. Focus on differences can form a barrier for designing.
- Arusha is an adequate place to start due to more openness from consumers to talk about their situation. This willingness to share information stems from the exposure to foreigners often interested in their different living environment. They look up to members of the “outside group” but are missing guidance to come out of poverty themselves.
- Shedding some light on the local structures of the energy situation gives an extra dimension to the market strategy plan. It shows preparation regarding which governmental bodies to approach and work with based on the desk research.

<sup>\*\*</sup> The Human Development Index measures average achievements in living standards, health, and education.

<sup>\*\*\*</sup> This Measure coincides with Msyani (2013), who states that before January 2013, the charges for electricity connections were \$245 without pole and \$845 with pole. The government reduces the costs and stated new prices for rural areas to respectively \$113,6 (-60%) and \$211,25 (-75%). In urban areas this discount entailed prices of respectively \$201,64 (-29%) and \$113,6 (-60%).

# 4. CUSTOMERS

Chapter four focuses on gathering qualitative as well as quantitative data about the customer group through desk research. The data collected during the field research (chapter 6: Field Research), will form an addition to this. First the target group is defined and described and their needs are identified and their income and expenditure is discussed. Providing this information aids in forming the background story by adding whom there will be designed for.

## 4.1 TARGET GROUP DESCRIPTION

The customer group for whom there will be designed can be described as low income or BoP households that currently do not have access to the main electricity grid. These households mostly are present in the rural and peri-urban areas as Tanzania's sole utility provider, TANESCO, does not regard it economically feasible to expand its network up to these vast areas with a low population density. The target group has a yearly GDP of \$488 (section 1.1: Introduction), which makes it evident that it is hard for them to invest themselves in clean off-grid energy solutions. These often differ in up-front costs with a spread of \$41 (Tanzanian Market Intelligence, 2013) between the cheapest and the most expensive offering. Their unstable cash flow also makes it difficult to always keep up with periodic payments. Consequently, this results in the use of polluting energy resources instead such as charcoal, wood and kerosene. A sizable chunk of their already small budget is spent on kerosene, which is only 13% of the costs of electricity. In essence, their income is spent on food, rent and fuel (Global Alliance for Clean Cook stoves and IDEO (2012)). When they do get a great amount of money, which happens due to seasonality of work, the target group chooses to invest in fixed assets as this stands for stability, but also prevents family members to demand cash from them. Tanzanian Market Intelligence (2013) also reports that mostly there is no extra monthly available income left for rural lower income households. Peri-urban BoP households on the other hand could have savings of on average \$55 dollars. The institute suggests that this is due to them having higher primary and supplementary incomes and more opportunities to engage in micro-enterprise activities.

When it comes to lightning the sample that represents the target group said that they used the following lightning sources. Notice that solar light is used only by 4%. Hurricane Lamps are used the most even though kerosene is more expensive, especially on the long term. See an overview in figure 4.1: Sources used for lightning. This is caused by the recurring costs, which make the Life Cycle Costs (LCC) higher. Next, to that it poses a threat to both the health of the user as well as the pollution of the environment. Dry cell batteries in torches in contrast ensure better lightning, but due to the way they are disposed they still cause harm to the environment.

## 4.2 NEEDS

Terms in need of product functionality and feature can be summarized as follows. Lightning is one of the most essential needs as it becomes dark after 6.30 PM. However, the target group is searching for multidimensional products, which cannot only provide light, but also charge mobile phones and even bigger devices such as radios and TV's. Since households cannot buy many clean energy applications they value a product which is highly portable, see figure 4.2: Lightning Usage Purposes. What is currently lacking is also solid financial assistance, which makes them succeed in fulfilling payments.

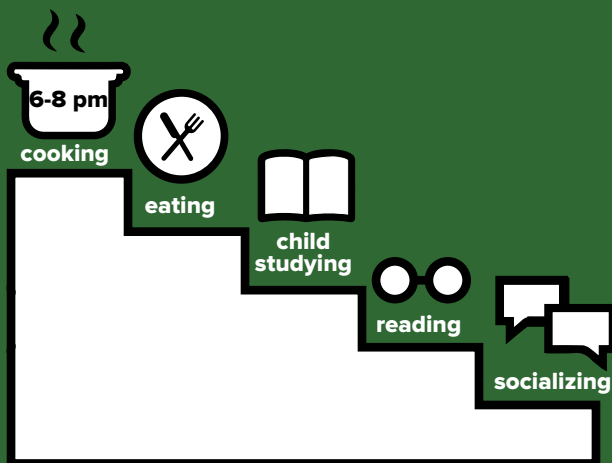
## 4.3 INCOME

A large part of the population lives in (relatively) dry areas with an agricultural-oriented occupation (74%) as their main source of income (Tanzanian Market Intelligence, 2013). The average GDP per capita per year is estimated to be \$488 and in Kigoma, one of the poorest regions even is \$290 (section 1.1: Introduction). The occupations that they have can be characterized as daily routine activities, during daytime hours and seasonal. Next to the fact seasonality influencing the income, the place where agricultural activities are employed also has an impact on the height of the income. The difference between rural and peri-urban households can be seen in figure 4.3: Comparison households rural vs. peri-urban.

In Tanzanian households every household member is expected to contribute to bring income if the person is able. Men work mostly in the formal sector, while in contrast women are the entrepreneurs working in the informal sector. Since women are also expected to take on the time consuming labor intensive chores of taking care of the household and work in the field little time is left to work on themselves and benefit their family with that. For example, the dependency on firewood causes them to lose up to six hours on average per day (figure 4.4: Household use of energy sources).

WHAT	TIN LAMP (koroboi) 27%	HURRICANE KEROSENE LAMP (chemli) 37.2%	CANDLES 16.5%	DRY CELL BATTERY LAMP (chemli) 19.3%
WHERE	kitchen main room	kitchen bedroom living room	everywhere	bedroom living room
COSTS	up front recurring	up front recurring	recurring	up front recurring
LIGHT QUALITY	poor	medium	better	best
HAZARDS	health fire	explosion fire	fire	quality short lifetime
VIRONMENT	polluting	polluting		disposal polluting
USE		power shortage special occasions	emergency back up	sporadically

Figure 4.1: Sources used for lightning



NB: In case of security the light is only used at the moment that something happens to save charge.

Figure 4.2: Lightning Usage Purpose

## 4.4 POTENTIAL MARKET

Being aware that the described target group does not say anything about the potential, a calculation is made to describe this. in figure 4.5: Calculation Potential Market Arusha Region.

HOUSEHOLD SIZE ARUSHA	4.4	
POPULATION ARUSHA REGION (total)	1,694,310	
POPULATION ARUSHA CITY (urban ward)	416,442	—
HOUSEHOLD LEFT (rural + peri-urban)	1,277,868	
POTENTIAL HOUSEHOLD	290,425	

Figure 4.5: Calculation Arusha Region Numbers from National Bureau of Statistics (2012) and National Bureau of Statistics (2014)

Looking at the greater Arusha Region without the the population of the direct Arusha City, the potential amount of households that can be reached is 290,425. This is the maximum amount of households that the proposed innovation would be possible to get sold to. The Arusha City, which is described to entail mainly urban wards, with a few mixed wards is excluded. Be aware that describing urban, peri-urban or rural is mainly done based on population density. So the potential can be indeed higher, but for a first indication the 290,425 is calculated. This population is assumed to fall in the average or lower category region with a GDP of \$488. Next to that there can be different sizes than the size of on average 4,4 in Arusha, which means that there are less households.

## 4.5 TAKE AWAY

- Create awareness knowledge (Rogers, 2003) about the new innovation. Subsequently, this will assist in lowering uncertainty and enlarging the possibility for innovation adoption. There is awareness under the target group that the use of kerosene has several negative effects This means that the principles knowledge is there in one shape of form. BOP consumers are will adopt alternatives which can provide good lighting, are cheaper, and do not pose health or other hazards, as do does using kerosene fuel. Certainly if they can get assistance in finance.
  - Provide financing that assists in covering high up-front purchase costs. This will take away the largest barrier that keeps alternative products out of reach of this target group. Note that low income households often fall between two stools; not being able to borrow from MFI's in peri-urban areas where the income is higher, but they don't have any property because they're renting and don't have land. In the rural areas they are not eligible because they do not have enough income.
  - There are different daily habits that are currently polluting, but that can be turned around in cleaner habits. It would be an interesting too look at opportunities to guide change through offering a clean energy generation solution. There is potential to create new opportunities by (1) being more affordable, (2) assisting in change of habits and (3) being more reliable in energy generation than other sources that are currently used.

	charcoal kerosene		free forest firewood
MAIN SOURCES of ENERGY			
KEROSENE (\$) LIGHTNING	\$0.50	—	—
CHARCOAL (\$) COOKING HEATING	\$0.60 - \$1.25	—	—
FUEL/MONTH (\$)		\$ 18	\$ 9
FINANCING NECESSARY		no, but want it	yes

Figure 4.3: Comparison households rural vs. peri-urban

SIZE		2-4	4-6
HOUSEHOLD HEAD		—	—
HOUSEHOLD MANAGER		—	—
BUDGET SPENDING		—	—
FINANCIAL PLANNING	based on seasonality	—	—
DAILY FOOD EXPENSES(\$)	2 meals 7 members	\$12.50	\$1.25
GROCERIES		buy food	produce own food

Figure 4.4: Household use of energy sources

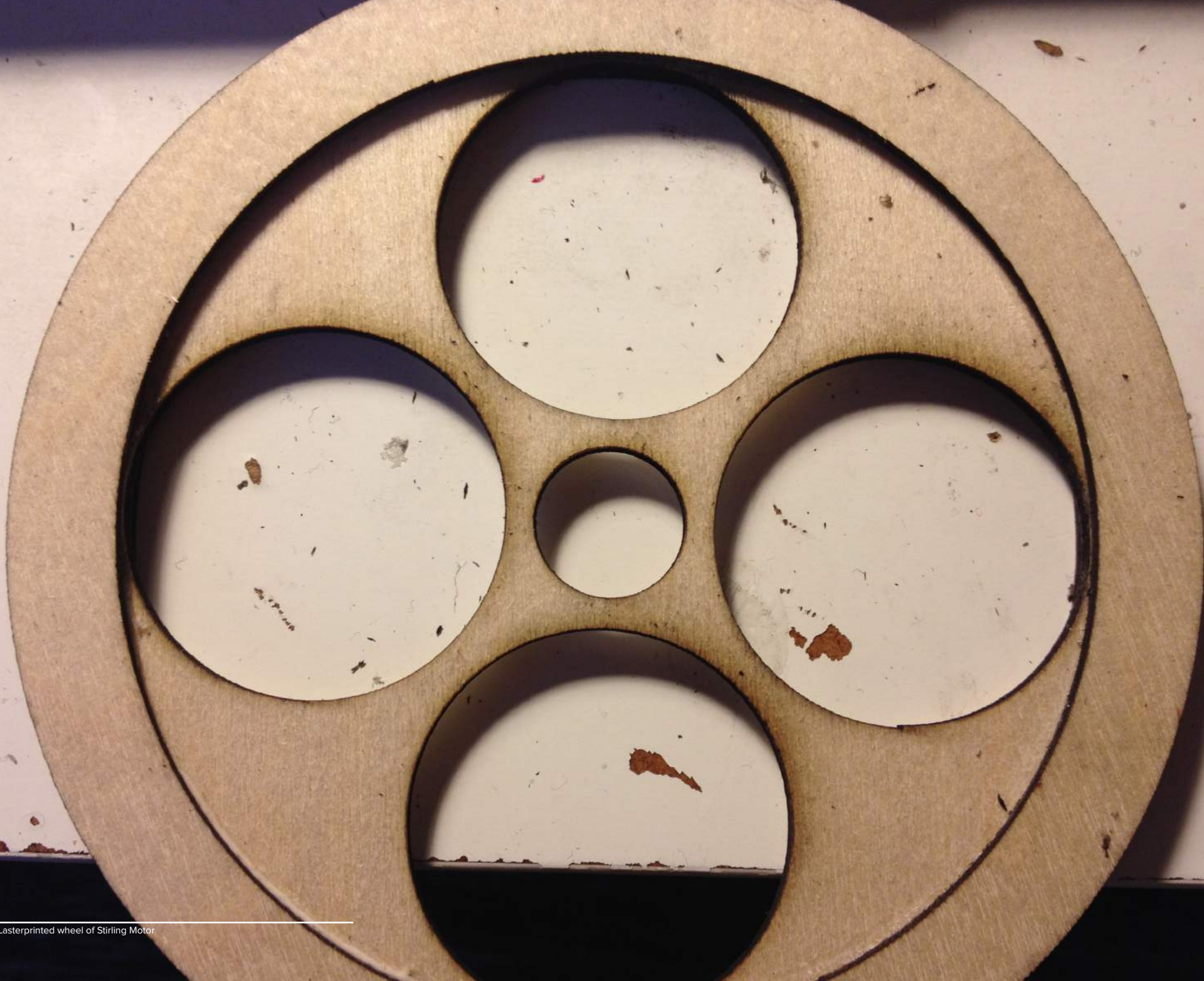


Image ii : Lasterprinted wheel of Stirling Motor



# MARKET 5. ANALYSIS

Chapter five describes the journey of the design looked at with a market perspective. The chapter starts off with framing the solution area and looking at what is already available on the market in this selected space. Then it moves on with a trend analysis, which is used to select interesting development that are globally and locally happening and could be used as source of inspiration. and this all forms the base for the first innovation directions that could be pursued.

## 5.1 SOLUTION SPACE

The research started by doing a feasibility study regarding a concept, that falls in the category human powered energy system. The concept is focused on generating energy through a stand alone cycle solution. The researcher herself has been part of the development of this concept and was focused on doing more thorough research to see whether the limitations regarding affordability and design could be improved, while maintaining the essence. [Appendix A: Feasibility Study](#) contains this journey of which the final conclusion was that while affordability could be improved this would impact efficiency adversely. Personal ethical considerations from the researcher added on top of this resulted in the decision to open up the solution space to mechanically sourced energy solutions.

The focus of the solution space in this thesis is on the generation and conversion methods and not on energy storing mechanisms.

### 5.1.1 MECHANICALLY SOURCED ENERGY

Mechanically Sourced Energy is about how the input energy is converted into electrical energy. The definition mechanically generated energy describes the energy that is generated through setting in motion a device by an actor doing “work”. Through a force acting on an object, this object changes in form, moves, or displaces. The input actors all possess some form of potential and kinetic energy. Kinetic energy is apparent in different forms; vibrational, rotational, translational. Potential energy is the energy stored in a body or in a system due to its position in a force field or its configuration ([Coffey, 2010](#)). The sum of these two forms of energy is called mechanical energy and gives the actor the ability to perform the so called work. This form of energy - mechanical energy - is thus caused by the motion and/or the position of the actor.

Having stated that the mechanical energy is dependent on an actor that is doing the “work” and an object the work is done on and which due to the force applied is undergoing a change in the form is displacement, deformation or movement a few finding can be stated, namely:

- That the input force should be bigger than the reaction force of the object which is undergoing the

work. Only when doing so a change in the object will be apparent. Next to that the object owns qualities that allows it to change in form.

- The input actor can have a wide range of manifestation forms such as the human body, heat, nuclear transformation or chemical reactions.

This causes the term mechanically generated energy to only refer to the object - and thereafter the conversion to electrical energy - that is undergoing the movement, which subsequently indicates the focus of this part of the thesis. Namely to find an optimal object that can undergo the work it is subjected to by the input actor, while simultaneously offering an efficient conversion to electrical energy. This category consists of a wide range of products; from human energy system to thermal energy products.

### 5.1.2 ALTERNATIVE ENERGY SOURCES

Within the category of alternative energy source all other energy generation and conversion mechanisms are included. These include chemical energy (solar), potential energy, elastic energy (in materials), magnetic energy, nuclear energy and gravitational energy. These groups of “other” types of energy are focused on a different conversion method. Note that in case other ways of energy conversion would be more efficient there was the freedom to improve technology and look at other conversion methods

## 5.2 CURRENT OFFERINGS

By looking at what is available on the market the researcher tried to get an impression of which conversion techniques current offerings on the global market are using, what their unique selling point is, what the selling prices is of specific offerings. Keeping the market into mind an overview is made regarding current offerings available and commercialized to consumers. While making the overview the notion of selecting possible conversion techniques that would be already available in Tanzania or in general in BoP contexts or could be transferred to that context. Search terms that were used were: human powered energy, heat powered energy, mechanical energy, clean energy.

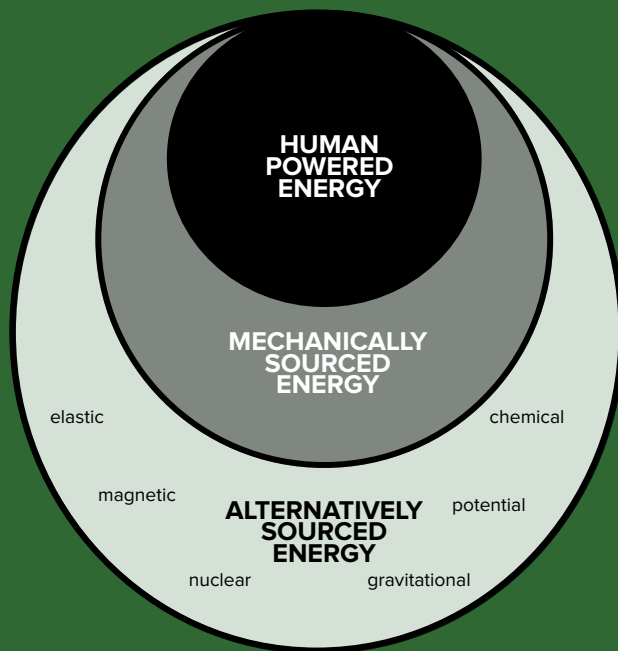


Figure 5.1: Energy Categorization

## HEAT INDUCED



### BIOLITE (STOVE)

What: More sustainable cooking stove with charge possibilities.  
For: Rural population  
Price: Starting from €109.95  
Capacity: 2W



### ACE 1 Ultra-Clean Cookstove

What: Sustainable smokeless cook stove with charge possibilities  
For: Rural population  
Price: \$150  
Capacity: LifePO4 6.4V/5Ah



### TEGSTOVE

What: Portable stove through which energy can be generated  
For: Campers in the UK  
Price: £299.98  
Capacity: -



### POWER POT

What: A pot for energy generation  
For: Campers in USA  
Price: \$99.99  
Capacity: 1A on demand USB power for mobile device

## SOLAR (RETAIL)



### ABZE SOLAR - MAMA LIGHT

What: Retail solar lamp  
For: Rural Africa (Mali/Burkina Faso)  
Price: \$30  
Capacity: -



### JUABAR

What: One time input human light generator (20 minutes)  
For: Rural Africa (Tanzania)  
Price: -  
Capacity: 50 W panel 34Ah 12V battery



### WAKA WAKA

What: One time input human light generator (20 minutes)  
For: BoP Worldwide  
Price: €29  
Capacity: 80 hour LED light

## WALKING



### SOCKET

What: Football charger  
For: rural Africa  
Price: \$99  
Capacity: -



### SOLE POWER

What: Walking powered charger  
For: USA hikers and one for one rural africa  
Price: \$199.99 (expected)  
Capacity: full iPhone/2 miles

## CYCLING



### NURU ENERGY

What: Pedal Powered Charger  
For: Rural East Africa and India  
Price: \$175  
Capacity: 60 Wh cycling for 2 hours



### ATOM SIVA

What: Pedal Powered Charger  
For: USA bicycle commuters Rural Africa in the long run  
Price: \$119 (discount) | \$149.99  
Capacity: 1650 mAh in 2-3 hours



### AMPY

What: Walking powered charger  
For: USA active people  
Price: \$99  
Capacity: 1800 mAh battery. Depending on movement

## ONE TIME LIFT



### GRAVITY LIGHT

What: One time input human light generator (20 minutes)  
For: Rural Africa (Kenya)  
Price: \$5  
Capacity: Depending on movement

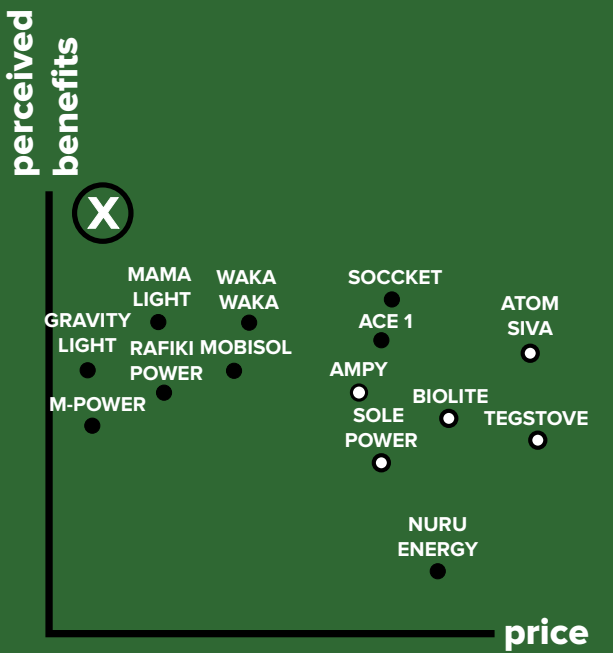


Figure 5.3 Price vs. Perceived Benefits

The selected offerings are structured in figure 5.2: Market Offerings Based on Conversion Techniques, based on what their conversion techniques. In the figure it is apparent that the researcher went as far as looking what is available outside of the direct scope of mechanically sourced energy as this also can be a source of inspiration. In the selection there were some solar products which could be learned from in terms of design of, system, business model of strategy.

In the overview of products, the international focus is resembled a lot is going on and being done by NGO's, startups and established companies to deal with the ongoing problems global energy problems. When there is interest to implement the products in developing countries like Tanzania there seems to be an easygoing way of choosing the one for one model, which at first sight seems to be a warm gesture but can end up in so called "product dump" as this is actually form of charity. Local systems get disrupted and when products break there is no replace or repair system in place. Moreover, the products are not always developed with the local context in mind resulting in product being unfit for the context and thus short term success. Key success can be attributed to involvement of the local market and use of existing informal channels through which of the sales already happen, according to H.R.H. Princess Djigma, CEO of Abze Solar. She also stresses that the prices are disproportionately looking at what the local market can afford.

The offerings were than categorized based on price on one axis and on perceived benefits for the customers that are described in chapter 4: Customers. The goal was to find out how the selected offerings were lacking and which aspects of these innovations could be transferred to the future concept. It also aided in forming an idea about what is currently missing for customer's product wise. As not all concepts were focused on the BoP context the ones that did, had an advantage and are indicated with a closed background (see figure: 5.3 Price vs. Perceived Benefits). Perceived benefits are described as:

- A multifunctional product: offering not only light, but also charging possibilities for the phone and more.
- A portable product: Easy to pick up and go and use for different tasks.
- Easy to use: Is it the energy generation worth amount using the solution?

### 5.2.3 CONCLUSION

Note that in the image also the product offerings from three

solar companies in Arusha are included (see section 6.3: Interviews Businesses) Juabar was left out as this offering didn't give a clear indication of the price.. As can be seen in figure: 5.3: Price vs. Perceived Benefits most product vary in price range. The offerings also range from effort that needs to be done with the human powered solutions to making solar harvest "free energy". However, it seems that there is a trade of of either not being portable, only providing lightning or having to put in a great deal of human power, which results in a solution that is not effortless. Designing a product that fulfill this gap and has a though through strategy behind it is therefore essential.

## 5.3 TRENDS

Another creativity endeavor entailed looking at the trends when it comes to sustainability and clean energy, overall and in Africa.

### 5.3.1 CLEAN ENERGY BEATS FOSSIL FUELS

Since 2013 there has been a shift when it comes to adding electricity capacity; 143 GW of renewable electricity capacity was added versus 141 GW of fossil fuel burning plants, says an analysis of the [Bloomberg New Energy Finance \(2015\)](#). This means that what is added in terms of new electricity plants or solutions uses clean resources. With the election of a new vigorous president in November 2015 and the fact that the energy sector in Tanzania has already been making an effort to implement renewable energy strategies ([Tanzanian Market Intelligence, 2013](#)), there is a possibility for (small) enterprises to capitalize on this and come up with new solution, invest and educate with the goal of uplifting the country. Under the National Strategy for Growth and Poverty Reduction (NSGRP), development goals focus on rural transformation through investment in environmental infrastructure and market opportunities for SMEs says [Tanzanian Market Intelligence \(2013\)](#) with a specific focus on energy policy reform. Resulting in bringing together public and private partnerships, the so called PPPs. These PPPs in turn are used by the Tanzania Energy Development and Access Project (TEDAP) to deliver clean off-grid solutions and make entry of clean energy solution in the local markets easier. Resulting in the investigation of various household level technologies such as solar photovoltaic (PV), solar

thermal, biogas for cooking, bio-waste for small-scale power generation, micro-wind turbines for water pumping and a plethora of solar lighting products (Tanzanian Market Intelligence, 2013). Shortly, this means openness from governmental institutions as well as the market for new solutions.

### 5.3.2 FROM CENTRALIZED TO DECENTRALIZED ENERGY OFFERINGS

The UN Sustainable Development Goal number 7, Ensure access to affordable, reliable, sustainable and modern energy for all, describes what the ambition is for the coming years. However, there should also be awareness that the best way to actually reach this goal is through decentralization of energy sourcing as well as energy offering; the so called distributed generation. This type of sourcing in combination with financing possibilities and social tools that empower the locals, specifically females through entrepreneurship, is increasingly adopted. Example of this is the year 2002, in which the mobile phones use passed the fixed lines use in developing countries as well as high income countries (Feldman, 2003). Mobile phone use in general has rocketed in Tanzania with a mobile phone penetration of 67% in 2014 and a rise 22% in internet users in 2014 (Reuters, 2015). The main reason why telephone use means more than only communication with other is the fact that phones have had multiple purposes: paying through mobile banking services like the local M-Pesa, listening to the radio and even receiving information about supply and demand of livestock crops. Offering new energy products service system with corresponding strategy that will change contextual problems can therefore contribute to creating local opportunities.

### 5.3.3 INDOOR POLLUTION AND HEALTH RISKS

According to the World Health Organization (World Health Organization) 4.3 million people a year die prematurely from illness attributable to the household air pollution caused by the inefficient use of solid fuels for cooking (World Health Organization, 2016), which is twice the number of people dying yearly from AIDS: 1.5 million in 2013 (Max Roser, 2015). The World Health Organization warns that if (global as well as local) policies will not change, the number of people using polluting resources will not have changed by 2030, which means an ongoing stress on the health as the use of these solid fuels is causing the problem. Besides the health risk the search for polluting sources is time consuming, influencing productivity, poses risk for injury and a risk of encountering violent situations.

Climate change is also at risk as black carbon and methane are emitted. The use of current resources such as kerosene as a source of light, means exposure to particulate matters and risks such as burns, injuries and poisoning. However not using this also means no progress, because there is e.g. no trade, or chance to study. The World Health Organization is there to interfere and assist countries into the right direction, but cannot do it alone. Therefore, small scale solutions that focus on tackling problems and contributing to Sustainable Development Goal 7 and Sustainable Development Goal on Health would kill two birds with one stone. Note that just making a new clean or more efficient cook stove to reduce the hazardous emissions and improve the health is not necessarily the solutions. With clean cook stoves as with other “on first sight easy innovation opportunities for the BoP, which are easy to produce and use” it’s not one-size fits all (Molnar, 2014).

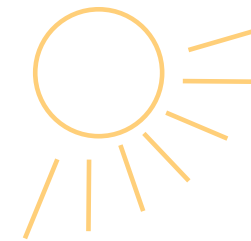
Adoption requires making it fit for the local environment (culturally, socially and economically) and investing for a long period of time to reach a sustainable use. Molnar (2014): “research has shown that stoves ill-suited to meet specific household needs often go unused, negating intended health gains and wasting financial investments”. **After 30 years of effort from philanthropic institutions only one third of the target market has adopted an improved cook stove, leaving approximately 1.6 billion traditional consumers of biomass without a clean stove** (Peters and O’Dell, 2014). This means changes in promotion and distribution, and strategy. Differences in taste of food prepared with clean cooking stoves e.g. not smoky flavor, cleaning and food preparation method and time have been earlier complaints in certain contexts. Stove models therefore need to have the ability to get adapted to the needs and cooking traditions of various cultures internationally, nationally as well as on regional level. The needs are specific to the context; customs, food availability in the context and corresponding preparation scheme.

Another problem is the price of the cook stoves. For a family that earn \$488 per year or less, which can be qualified as extreme poverty according to the World Bank, a cook stove of 50\$ or more is 10% of that annual income: a significant part. Subsidizing or providing the cook stoves for free, as aid organizations have been doing in the past also doesn’t form a solution as this doesn’t contribute to the feeling of ownership hence taking care of a product well (creating pride in ownership) and market-distortion (Molnar, 2014).

## 5.4 INNOVATION DIRECTIONS

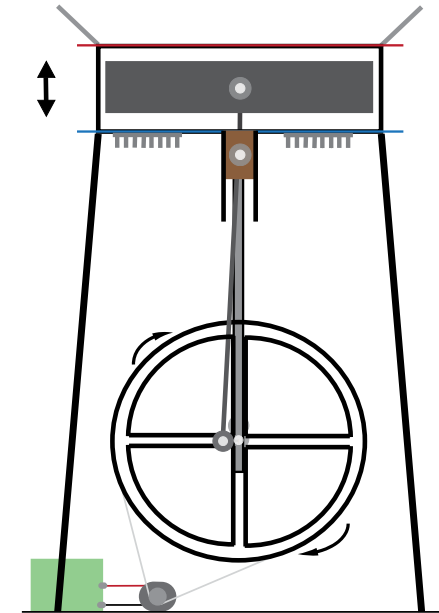
Use of polluting resources during cooking poses a treat to the health of a great amount of people. However clean cook stoves are currently not necessarily the answer. Look at the use of the energy generation solution in a way, shape or form or to which can be used as stepping stone for gradual change in behavior was therefore an interesting solution.

Richard Bekking from the ID Studio Lab at the department of Industrial Design, DUT, therefore has advised the researcher to look at other opportunities such as heat to electricity conversion. Stirling Motors were said to do so. Taking this as a solution there was exploration of heat induced mechanisms such as Stirling Generators and Steam Generators (see [Appendix B: Concept Generation and Prototyping](#)) through which a generator could be set in motion (mechanical energy) and energy could be collected.



### 5.4.1 STIRLING HOT AIR GENERATOR

The Stirling motor is a hot air motor, which can be set in motion due to concentrated heat in the form of fire (ranging from candles to alcohol fire burners). The motor can be executed in different shapes and forms with each configuration having its own pros and cons. As the motor is set in motion due to temperature rising and pressure getting build in one room the piston starts moving and the the machine is set in motion. The linear movement is translated into a rotating movement of a wheel. The idea was to attach a pulley of some sort to this wheel which is connected with a generator which as a consequence results in heat through mechanical conversion is translated into electricity (figure 5.4a: Hot Air Generator Concept Conversion Steps). As the objective was to find a new technology efficiency improvement was outside the scope as this would be the following step. The different configurations led to a wide range of options of which the Low Temperature Differential Stirling motor was used as part of a system. Other configurations worked at a higher input temperature and were sensitive in use. Small iterative experiments showed that the smaller the system the more accuracy comes into play and the harder it is to set the machine in motion. Next to that there was not enough power to set a generator in motion. Another iteration cycle was required.



**SIDE VIEW**

Figure 5.4b: Hot Air Generator Concept

generation	thermal energy	-sun - fire	hot air
	mechanical energy	wheel turning	
conversion & storage	electrical energy	generator	
	modification	diode bridge	switching regulator
	storage	battery power bank	
use	regulation	5V/1A USB	
	electronics	light mobile radio	

Figure 5.4a: Hot Air Generator Concept Conversion Steps

- + Using heat, meaning there is no dependency on the sun only (charging during the night is also possible)
- + No use of extra sources (such as water)
- + No need of pressure regulation
- Remaking a Stirling motor is labor intensive and really precise, which result in lowering efficiency.
- High amount of conversion steps

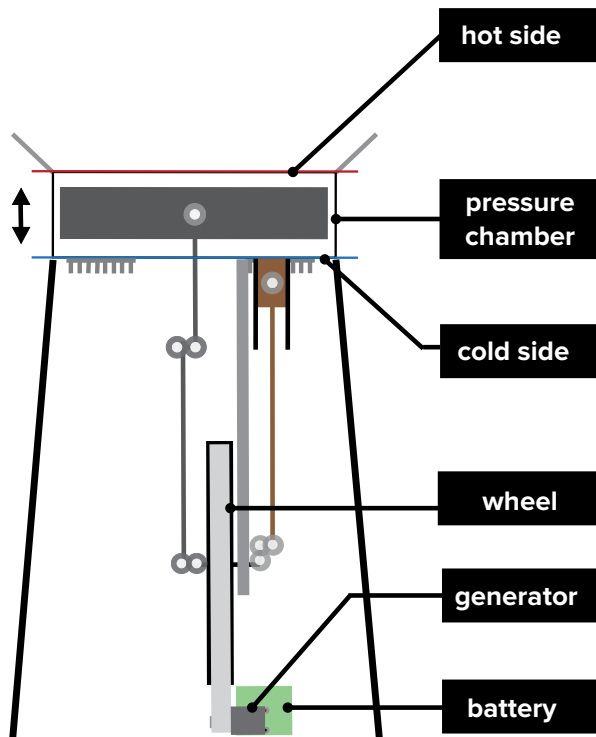
#### 5.4.2 STEAM GENERATION HYDRO HEAT INDUCED

In the following iteration cycle steam was thought of as replacement for air. The new idea was to fill a basin with water, close this off with the option for air or fluid to escape through only one small opening. When heat would be concentrated on this basin the water would change phase and turn into steam. The small hole ensured pressure. Fixating a turbine generator so the steam could set this in motion result in electricity generation (see figure 5.5a: Steam Generator Concept Conversion Steps and figure 5.5b: Steam Generatr Concept p. 38). Again in this iteration cycle efficiency was left outside the scope of the project as the focus was pure to validate of the technology worked in practice.

A small prototype resembling this idea was made to show that the technology worked. This was used as functional prototype to get the participants acquainted with other ideas than they already knew and to use this as a boundary object (Carlile, 2002) during these conversations. As there was no element that automatically controlled the pressure that was build up the prototype was exclusively used as conversation topic and not to use for a trail.



image 5.1: Functional prototype of the Heat Steam Generator Concept



FRONT VIEW

generation	thermal energy	-sun - fire	water into steam
	mechanical energy	blades turning	
conversion & storage	electrical energy	generator	
	modification	diode bridge	switching regulator
	storage	battery power bank	
use	regulation	5V/1A USB	
	electronics	light mobile radio	

## 5.5 TAKE AWAY

- Cooking might be an interesting opportunity to look at. Note that other options, such as use with solar collectors that concentrated the heat still are an option. Try to indicate based on observations what would work best.

- + Using heat, meaning there is no dependency on the sun only
- + More powerful than Stirling, due to working with water and steam
- Use of water as extra resources. Water is scarce in certain regions
- Pressure needs to be kept constant through a pressure regulator (expensive), otherwise it can be dangerous

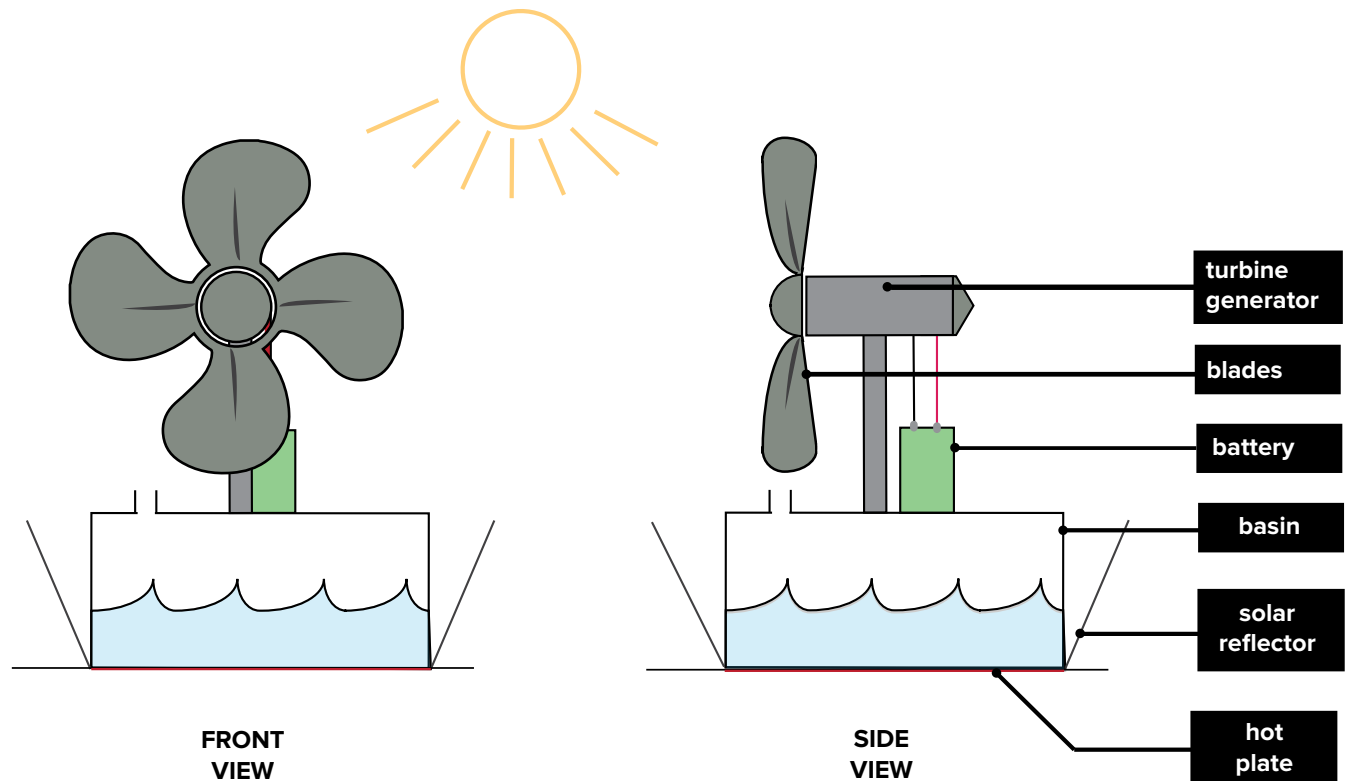


Figure 5.5a: Steam Generator Concept Conversion Steps

Figure 5.5b: Steam Generator Concept



# FIELD 6. RESEARCH

In chapter six the data regarding the conducted field research is included. The research, executed in a peri-urban area, called Sinoni in Arusha, Tanzania was meant for the researcher to get some clarity regarding the local context. Being in the context as a resulted in increased empathy and clarifying misconceptions. Within this peri-urban area different classes of the society were represented with low income households as well as (lower) middle income households living in the same community. Next to that it served as a way to get insights in the daily energy use, appliances use and application methods for the concept. As a second research path, informal interviews were conducted with local businesses involved in the clean energy business. Objective here was to learn about their market strategy and how they operationalize their daily activities.

TUNACHAJI SIMU

Image 6.1: Text on Shop. Tunachaji Simu - We charge phones. Used as promotional message toward clients.

## 6.1 OBSERVATIONS

As sample contextual research field Arusha was selected. The area consists of urban, peri-urban and rural areas. One of these peri-urban areas is Sinoni a mixed ward peri-urban ward on the outskirts of the town with a dirt road leading to the community. This site was selected with the help of the interpreter, Mr. Manda. The researcher resided within this community for a period of two months where she conducted exploratory research (observations and in-context immersion) and interviews to learn about the daily lives of the households. This was done to get an understanding of the experiences with energy resources and create empathic ties so that the proposed design and strategy would be rooted in community. Sinoni formed a mix of low and middle income households. These were also included in the research as they were often more successful and thus functioned as role models and hence could be used as OLs in the community. The goal of doing contextual research was to test assumptions, overcome bias and summarize the information by means of personas, who represent the group, while being fully aware that there are differences in living situations and experiences. Resulting, this would serve as handhold when shaping the designing and proposing and proposing the strategy.

### 6.1.1 OBSERVATIONAL PLAN

As an observational technique in-context immersion was applied, which meant living in the community and taking part in activities and social practices as to understand it. The observations were therefor planned in greater lines. As the researcher would already be part of the community, since she would live there the plan was to have two people that were acquainted with the community transfer information about the why of the practices. This would be the interpreter and the community leader. Spontaneous visits would be planned as part if the research. The goal was to get close to the subjects and make small observations without them knowing. The activities topics that were important were:

- Electronic appliances. Which appliances do they use most often? What is the worth attached to it? For example: are phones exchanged easily between people.
- Cooking practices: What kind of cooking stoves are used? For which tasks are they used used or are they interchangeable? To which extent do the implications affect their lives?

- Social Structures: How are hierarchical structures set up? What affect do socials structures (or the lack thereof) affect the community? What are the implications of social structures?
- Sharing practices: In which way are they aware of the fact that they are sharing things? Which things do they actually share? How do social structures influence sharing practices?

### 6.1.2 OBSERVATION DATA

The observational research consisted of spontaneous visit initiated by the researcher in the first phase of her stay in Sinoni. The objective was then to get acquainted with and learn from the selected household. Over time the community members started inviting her because she became part of the community. Activities that were participated in were mainly cooking experiences; learning what comes into making local dishes. These was used as form of in context immersion and increased the empathic ties. Moreover, this offered the opportunity to check if what they said corresponded with what they actually did

The different instances of in context immersion were (1) when January Kayombo, the OL (section 6.2: Interviews), invited the researcher to participate in a walking safari to get to know the community, (2) use of electronics was observed (3) sharing basic needs, (4) multiple instances where the researcher was asked to participate in cooking experiences by one of the interviewees (Mama Lawrence).

(1) The walking safari, which was led by the OL was used to ask questions about the main electricity network by TANESCO. There was observed how the connections from the main grid were made and how there was an opportunity for the community members to charge their phone (see image.6.1 Text on Shop and image 6.2: Phone Charging at Stores). What was not clear at the start of the walking safari was to go to a funeral. The OL explained that due to a strong sense of community it was normal and even expected to visit funerals even though “you don’t know the person. This shows how strong our community is”. – January Kayombo. Consequently, the funeral was very crowded. The OL explained that this is the norm at funerals as well as during weddings.

(2) When visiting different households their use of electronics was observed. The main appliances that needed electricity were light bulbs and mobile phones. The mobile phones had multiple functionality like for playing music, listening to the



Image 6.2: Phone Charging at Stores



Fetching Water



Prepare water for cooking



Turning the ugali (local maisflower dish)



Harvesting beans



Pluggin beans



Breaking Firewood



Starting the fire



Grabbing Beans



Putting beans in to start cooking

radio while working and use as torch for tasks at night. As the phones did not need charging every day, in contrast to most smart phones, people could bring it to households that did have a connection to TANESCO or to the OL, who had a solar connection. There was no charge for this. Phones were used until it was all empty, which caused people to be unreachable sometimes. As phones did form connection lines, payment lines and a source of light they are cherished.

(3) One of the households (section 6.2.2.1 Low Income peri-urban household | Chadema Family), who were interviewed later did not have the social ties to the community. They moved there three years and felt that they were not always part of the community and did not always receive help. *“We don’t feel part of the community, because we do not really receive help”* - Mama Chadema when asking to describe is she feels part of the community. As a result of this they did not have the option to charge their phones for free, but always had to leave it at a shop to be charged, whenever they had money. This family also had to walk quite far to fetch water from the well. As there was no running water the only opportunity to obtain water was either from wells further away dug by the government or by wells dug by community members. Using the last option meant that you’re supposed to have close community ties with that member. Otherwise they were dependent on either going further away or having to pay.

(4) Community members became more trusting over time and started to invite the researcher to participate in daily activities. One of the women (Mama Lawrence\*) who had a local shop where people around could do groceries wanted to participate and exchange knowledge about cooking local dishes (ugali, beans and vegetables) and the snack, called half cake, she sold daily at her shop. As she had a piece of land where she cultivated beans, grew the green vegetables and so on she could earn extra income by selling this. She would let people pick the leaves and charge them for it. Her friends and people who she invited did not have to pay. Her having her own vegetables saved costs and allowed her to stay around the house. When she did need other vegetables, she sent her oldest son of eight years old to go get some vegetables at other shops. Often from people who grew other vegetables. Daily she cooked two big meals, which were lunch (eaten at 2 PM) and dinner eaten at (9PM). In the morning she would cook tea and eat some small snacks. Her youngest son of 1,5 years old would eat porridge over the course of the day.

\* The researcher observed that it’s a habit to not call parents by their name. Instead they are called after their first born. So the mother of Lawrence would be called Mama Lawrence, while in fact her name was Irene. His father was called Baba (Father) Lawrence). This seemed to be a form of respect and an expression of status: this person has children.

Next to that it was mango season, which meant that they ate a lot of mangos whenever they felt hungry. While she did have a kerosene burning stove, she cooked and fried with a charcoal stove. Cooking things for a longer time happened on 3-stone fire in an open shed with wood as fuel. As Mama Lawrence wanted the researcher to participate she invited her to come in the shed and light the fire, but this resulted in teary eyes. When asked if she did also experience it she said: *“Yes, it hurts my eyes, but I’m quite used to it.”* Water for taking a shower and beans directly harvested from the land. Hence, the beans were hard, were cooked on this fire for over 2 hours. The firewood was also taken from the trees or fallen branches. In the household of the OL gas was the standard for cooking and whenever the gas was finished and there was no money to buy a new gas tank or when things that should be cooked long, like beans, were cooked the charcoal stove was used.

### 6.1.3. CONCLUSION

Having strong community ties is essential to survive in a community where there is lack of access to electricity. Having other to depend on makes it possible to at least have access to electricity and hence use your main electronic appliances; light, phones and sometimes a radio. These form your connection lines to outside the community. Next to that it means that you have the opportunity to get free resources such as water, vegetables and more. Different time consuming cooking practices are used: charcoal cook stoves, kerosene, 3 stone fire and whenever you have money gas. Cooking time and money for fuel heavily influence the type of cooking stove that is used meaning that whenever a total new cook stove would be offered this should be considered. It seems to be a valid thought that energy can be generated during cooking as cooking takes up 2 to 4 hours. Next to that all household cook. Using this as change capitalist would be a possibility, but needs education alongside with it. A pitfall would be that people would decide to cook longer or more with the polluting sources.

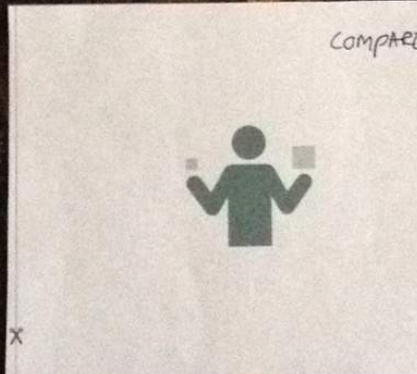
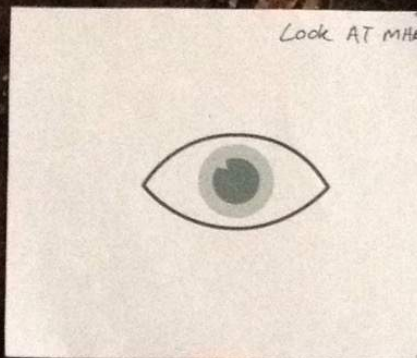
## 6.2 INTERVIEWS - USERS

With the help of the [IDEO Human Centered Design Toolkit \(2009\)](#) an interview guide was set up, which would provide the researcher with structure during the inquiries. This guide also offered tools, such as images that could be used to lower the communication barrier during the interviews. The full interview guide can be found in [Appendix C: Interview Guide Users](#). The interviews were used to gain information regarding their current energy situation and what constraints them from



Image 6.4: Household of OL cooks beans using charcoal

LEARNING  
SIFUNZE



moving forward. Direct after getting settled in the community with the help of the interpreter certain low and middle income households were selected to be interviewed. Considering that there was a language barrier an interpreter was present to lead the interviews. Conducting individual interviews aided the researcher in understanding the contextual situation, since group interviews would result in a discussion in Kiswahili. This would be unproductive and did not contribute to the goal. Hence this interview type was discarded. To make the participants feel at ease the interview were conducted in their home environment and in Kiswahili. Next to making the participants feel comfortable it also ensured that there was an opportunity for collection of data when it comes to used energy resources, but also to get an impression of the living space. Contributing to familiarizing with each household.

### 6.2.1 INTERVIEW GUIDE

The following topics were discussed;

- General Household information
- Owned products
- Sharing practices
- Energy Situation
- Hydro Heat Concept
- Future aspirations

The researcher also inquired about indirect related subject such as income, decision making about new purchases, family and feeling within the community. Topics like: considerations to use certain energy resources and what the interviewees knew about it (dis)advantages were also a matter of subject. While these don't seem directly related they do aid in fathoming the situation. As suggested by Patton (2002) the interview was sequences so the interviewees would have to answer simple, light question at the start with the harder, more sensitive topics towards the end. The interpreter informed the participants up front that the inquiry would be about their energy situation and that the researcher would address a new energy alternative that she would be proposed towards the end.

### 6.2.2 DATA USER INTERVIEW

The sample contained six different households in the Sinoni area. An elaboration of the interviews and the extended data can be found in [Appendix D: Data Extension Users](#). The researcher in first place assumed that the answers would vary greatly and thus that she would have to interview a high number of participants. However, similarities were starting to show

up after the fifth interview causing her to go more in depth with these families by observing and being part of their daily live. The interpreter was aware of the interest in interviewing low income families in the peri-urban area, but also choose to involve the OL as this would in the future be a person, who have to be identified when introducing the innovation in other communities as this person would play a key role. Both female and males were invited to participate in the household interviews. The (1) customer group (low income living in peri-urban areas) and (2) the opinion leader can be described by the following characteristics. The customer group - low income peri-urban - mostly earns their income from cultivation of vegetables, fruit and kettle hurdling. This made it hard for them to estimate their monthly collective income. Due to their connection with the city they have more opportunities to find small daily jobs that they can do and sell their crops. Unreliable income leads to them on average living below the poverty line. Hence, they choose to engage in several activities to that they can still earn money in low season. Stories (image 6.4: Low income peri-urban household) were made in the form of real life store of the interviewees. As there is low data on actual living experiences informed intuition (Moore, 2002) will be used to build a use scenario. Using the actual data as a persona aids when designing. It summarized the group for whom the new design is made.

#### 6.2.2.1 LOW INCOME PERI-URBAN HOUSEHOLD

The Henriette family consists out of five family members; parents and three children (one missing in image 6.6) who live in a two-room house. The children go to secondary and high school, but help around whenever they come home. On their piece of land, they have their sheds where they keep their animals and have the opportunity to farm. Their daily income comes from selling milk, eggs and whatever crop that is ready to get harvested and sold. Mama Henriette is sowing and repairing clothes as an extra source of income. Family dynamics make it possible for the wife to make purchase decisions regarding the household products e.g. groceries. Father Henriette gets involved when making the bigger purchases. New purchases are done based on evaluation of friends who have the new products that they also aspire to have. The family owns a small service based solar panel from M-Power (section 6.3: Business Interviews) with which they can light three lights bulbs in and outside of their house. Their final purchase decision was made when the people from M-Power came to their house, explained the product and convinced them to get connected to the network. Cooking daily takes up on average two hours. Per month the family spends 65.000 TSH on kerosene,

Image 6.5: Decision making process visualized with cards

## THE HENRIETTE FAMILY

Household:	Head: Men or Together
Age:	20 - 60 something
Nuclear Size:	3-5 members
House:	1 or 2 room house
Monthly Income:	100.000 - 150.000 TSH
Savings:	None
Occupation:	Street seller (snacks)   Farmer   Community Technician   Shopowner (F)
Cooking:	Kerosene   Charcoal   (Fire)wood   Gas
Light:	HurricaneKerosene Lamps Tin Lamps   Candle
Electricity (charging):	Small Scale (service based) solar   Batteries
Owned Products:	Mobile Phone   Radio   Light
Sharing Practices:	Water Wells   Mobile Phones   Food   Tools
Future Aspiration:	Ownership of Motorcycle   Car   Television   Fridge   More Land and bigger houses



## JANUARY KAYOMBO (OL)

**Household:** Head (Democratically)  
**Age:** Late 30's - 50's  
**Nuclear Size:** 2-4 members  
**House:** 3-bedroom house with bathroom and toilet inside  
**Income:** 8000,000 - 1,200,000 TSH  
**Savings:** 10-15%  
**Occupation:** Tourism industry | Micro-enterprises | Entrepreneurs | Educational jobs | Nursing  
**Cooking:** Gas | Charcoal (long time)  
**Energy:** Solar | TANESCO connection | Battery torches  
**Owned Products:** Smart Phone | Radio | Television | Music Installation | Fridge | (Old schools style) iron  
**Sharing:** Water Wells | Mobile Phones | Food | Tools  
**Future Aspiration:** Financial improvement and stability | Better education for the children | Finish building his house | Car





charcoal (50,000 TSH) and solar (15,000 TSH). The family lives in Sinoni for a long time and feels really settled and part of the community. Awareness of consequences of kerosene and biomass use was there, but their situation does not allow them to change their choice.

The Chadema family lives together in a one room slum type of house, built from scrap material and rented out to them for 20.000 TSH (\$10) per month. The young family of five consisting of two children, mother grandmother and grandfather stores all their belongings in this room. Grandfather doesn't have a stable employment resulting in him having to take every job he can. Mother and children make snacks during the day, which they try to sell in the evening. They depend heavily on strangers from the community who sometimes support them. The young family dynamic makes it possible to negotiate purchasing decisions between the adults of the family. In new purchase decisions they are mainly influenced by what their friends advice them. Final purchase is done based on the opinion of these friends, without consulting an objective external source. They were not always part of the community, live at the periphery of the community, are poor and thus do not always get the support they need. This leaves them to not always feel part of the community. The energy sources they can afford are kerosene for their hurricane lamp during the night, candles and charcoal on which they spend 45.000 TSH each month. They were not aware of health and hazardous consequences of using kerosene, but could also not change to another alternative.

#### 6.2.2.2 OPINION LEADER

The Kayombo family is headed by January Kayombo, who has two daughters living with other family members in other parts of the country. Unfortunately, his wife passed away recently and they both have lost a child earlier on in their lives. As a consequence, he is the only one permanently living in the house he is building. Choosing to accommodate a child with family is something that happens often in Tanzania – so not exclusively done by men. He decided to do so for the sake of better education and a more stable environment for his children. Over the past few years he has managed to buy land and build a 3-bedroom house in Sinoni. January has an outstanding track record of doing community work: he often reaches out to people who are in a difficult situation and invites them to live with him until they are back on their feet again. This results in him having someone living in his house; currently his cousin lives with him. His aiding a person in the community gave him the possibility and made him accepted in the community. He is working in the safari industry as a guide/driver, which results in him being

ing away for long periods of time, especially in high seasons. His work in the industry has exposed him to a lot of foreigners and aided in improving his English. Considering that he is the head of the house, he also decides which big purchases will be done, but he says “my wife often decided what happened in the household and my child stimulated me to even start building this big house”. He chose specifically to purchase a (120W) solar panel from Mobisol (section 6.3: Interview Businesses) as ‘TANESCO has higher investment cost and is less reliable’. Monthly payments for this are 80.000 TSH, which he has to pay off in 3 years. Next to that he is aware that solar uses “free power through the sun” - January. In low sun conditions the battery runs out and he uses candles at night. He also purchased the products that go along with the solar panels; a music installation system with radio and a television. In this manner, he is exposed more to things going on in Tanzania and around the world: it builds awareness and openness to new innovations. When purchasing new products our services he is influenced by friends (mostly from outside the community), who use new products, which he also wants to get. To make his final purchasing decision he always talks to the sellers to get more of an understanding of product facts and negotiate prices.

#### 6.2.3 SUMMARIZING

The two stories describing the lives of the families represent two different situations of low income peri-urban households. While the Henriette family with hard work and by putting their children through school seems to have the possibility for a bright future, the Chadema family is caught in the so-called poverty trap (Sachs, March 2009) with no self-owned house and own property. Their main income is spend on food and electricity, which leave them with little to no savings. Their family size puts a strain on the low income they already have. However, the community driven culture in Tanzania (section 3.3.2: Culture) aids families in some cases with opportunities like buying food and having to pay later. Farming might seem to be unreliable but in this context it ensures food security for the nuclear family with the possibility to sell whatever is left. Men and women both help and work daily with the difference that the women are responsible for the household chores: taking care of the children, cooking, washing clothes and cleaning the house. The shops that are present in the community are owned and run by women aided by their children. This is done next to household chores. Extra income is earned by saving whatever possible and for example building one-room houses and rent these out to others. Other modes of employment are inter alia boda boda driving: men get the opportunity to be motor taxi drivers. The motorcycles are often not owned by them, but by a boss.

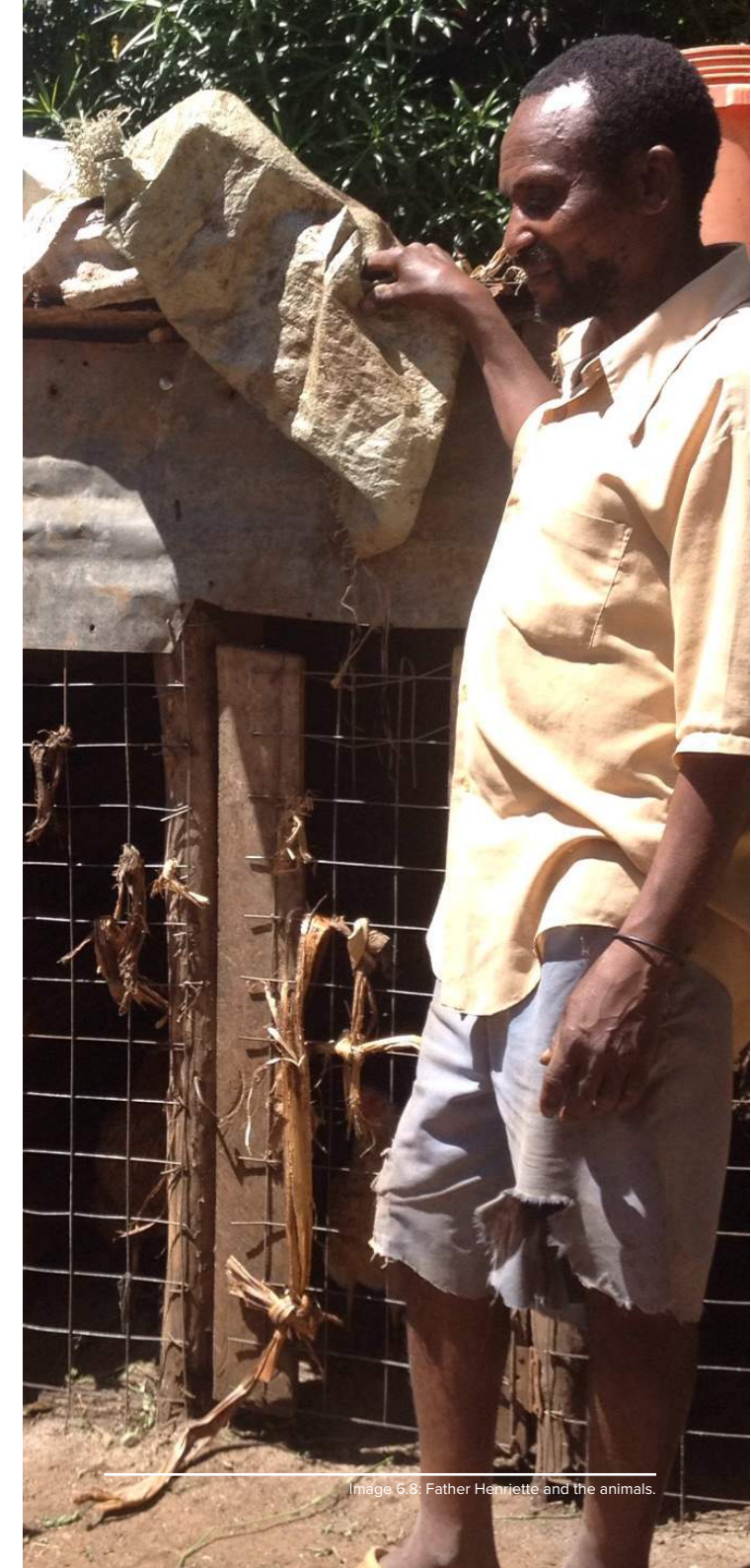


Image 6.8: Father Henriette and the animals.



Image 6.9: Slum home of Chadema Family

#### 6.2.3.1 ENERGY SITUATION

Energy sources that are currently used are: charcoal and firewood for cooking and as a heat source during the night, kerosene used as a source of light in the evening, occasionally a solar electricity connection for lightning mainly and candles. The OL in the community did have a big solar panel. Some other middle class community members could afford a connection to TANESCO. The main electronic appliances of the low income interviewees were lightning bulbs, their phones and whenever possible a battery run radio, while higher income members owned televisions, music radio installations and even fridges. The trickle down effect (Veblen, 2007) results in the low income households also aspiring to have these appliances. The used energy storing option is the battery, next to power banks gaining popularity, as this ensures a back up for the unreliable network.

#### 6.2.3.2 TANESCO

Although the interview plan did initially not entail questions about TANESCO, interviewees did start talking about it whenever asked what energy sources they were using and why (not). From conversations these conversations the researcher learned that it's quite costly to get connected to the grid. While it's a given in the Netherlands that every house is connected to the grid, TANESCO only installs main connections and whenever you want to get connected you pay for installations of the poles that need to be placed in between (from the main grid to your house) as well. The installation cost (300.000 - 500.000 TSH = \$140-\$235 per pole) for the poles also differs depending on the area in which you live.

On top of that TANESCO works with a prepaid system (similar to mobile phone prepaid service), meaning that the household connected to TANESCO have a meter installed and need to "top up" the system by buying vouchers every month in certain assigned shops. Part of the money they pay for the voucher is subtracted as monthly service fee, which is paid once per month. In case the paid money is finished earlier on the customer is supposed to buy extra finished if he has money. The customers are also able to pay the costs through mobile banking services. Customer experience with TANESCO is not too positive as people state that the network is too unreliable e.g. customers suffer too often from power cuts.

#### 6.2.3.3 OWNED PRODUCTS

The most important property that the interviewees had were their phones as this means communication with each other and with friends and family living outside the community. This could

also mean opportunities for work in some cases, such as for the boda boda driver, who inter alia depends on getting call request from clients to pick them up. The community plumber also mentioned a similar necessity. Main source of communication is through the phone (when family members and friends live far) or by visiting each other. To get outside information (news) a battery powered radio is used whenever possible.

#### 6.2.3.4 SHARING PRACTICES

The following products or resources were shared in the community:

##### *Water*

Government wells are available freely. There are also wells dug by families around the Sinoni area. The latter well is free to be used by community members, while families who dug their own well were free to close it whenever they want, because they "owned" it. Social structures were in play as friends or family members were always free to come and fetch water while other community members would have to pay or had to walk further to the government wells.

##### *Money*

Money is shared between the people whenever there is a funeral, when someone within the community is getting married. During the ceremonies money is collected from all attendees. In general, everybody is trying to survive, so sharing money is quite hard and involves long discussions and (informal) agreements between members.

##### *Insurance*

Money is shared in the form of a sort of insurance fund. A group of people (up to 10 people) put in an amount of money (around 40.000 TSH) every month, which is meant to support a different person every month. In case another person gets problems earlier on in the month the money is given to this person. In this way the community tries to form their own type of insurance. Here it also applied that mostly friends choose to take part in this insurance fund as they trust each other.

##### *Phone Charging*

When charging phones at a shop customers were required to pay 200 TSH (\$0,10). This mostly happens whenever they are somewhere outside the community. Within the community social structures are in place giving some the opportunity to charge phones in households that have solar or grid connections.

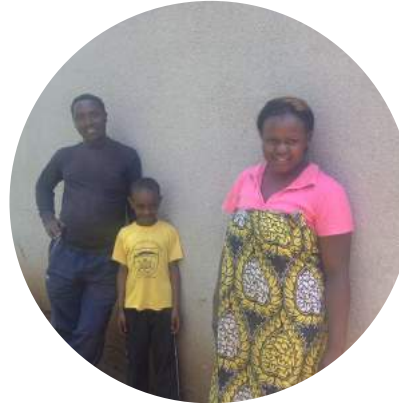
**THE  
AMANDA  
FAMILY**



**THE  
FRIDA  
FAMILY**



**THE  
LAWRENCE  
FAMILY**



**THE  
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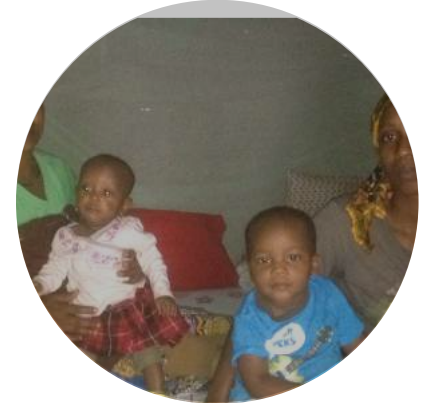




Image 6.11: Mobisol Manufacturing HQ in Arusha

### 6.2.3.5 HEAT STEAM CONCEPT

The functional prototype was used to explain the innovation idea. The initial reaction from all participants was to know more. Interest was fuelled as during interviews questions were asked like: Can I already use it?, How long does it take to charge?, Which things can I charge with it? Can I charge a fridge? Is it better than my solar? Is there a chance that there are short cuts? How much does it cost? The participants all seemed to be interested in the fact that this worked with heat and thus could be used at night as well to generate energy. Mainly the families, who did have service based solar panels wanted to know more as they are not always satisfied, because in low sun conditions they do not have enough electricity to power all their lights. Hence, they understood the benefits. However, they were still reluctant and wanted to see more. From this the there was concluded that the continuing to work out the concept more so that these questions could be answered. It seemed that the observability and trialability would play an important role [Rogers \(2003\)](#).

### 6.2.3.6 FUTURE ASPIRATIONS

The interview ended with the question what they hoped for in the future and would like to have. Printed cards were offered for them to select and aid in answering these questions. The most heard answers contained the motorcycle and car for transport and to make money from using it as taxi. It was also said to offer a sense of security as in emergency situation it could be used. Next either owning a house or land to build a house and rent it were said to be aspirational matters in their current lives. Main topic that was stressed is that the future of the children was a priority and any financial gain would contribute to better education, hence a better future prospect.

## 6.3 INTERVIEWS BUSINESSES

Next to user research another path was followed, which included interviewing businesses operating locally within the (clean) energy market. This route was set out to yield and increase experiential knowledge regarding the energy market, how they operate and why. Apart from that the initial idea could be shared to get feed-

back on. This avenue can be characterized as informal and was based on referrals from previous spoken interviewees. The data was collected in the form of pictures, videos and notes.

### 6.3.1 INTERVIEW GUIDE

A semi-structured interview guide, see [Appendix E: Interview Guide Businesses](#), was set up using Patton's (2002). Depending on how each interview progressed and depending what the interviewee more or less questions were asked about any particular matter. This resulted in an evolving interview manual.

### 6.3.2 DATA BUSINESSES

In total three with companies dealing with different sizes of solar companies. Other interviews were held with a local innovation incubator, AISE Twende, who works with people with good ideas that can be commercialized. The researcher got the opportunity to sit in at an interview conducted by a MIT student working for the International Development Innovation Network (IDIN), who did research about how innovations come about in other contexts. In [Appendix F: Conducted Business Interviews](#) an overview of the interviews is given.

### 6.3.3 CONCLUSION

Due to the fact that investment costs for connection to the main grid are high there is a great push from both NGO's as well as startups and multinationals for the use of renewables. This rAISEs awareness under the population even though the penetration for clean energy alternative, such as for example solar is low ([Tanzanian Market Intelligence, 2013](#)). The interviewees mentioned that they are considering solar as opposed to connection to the grid as they mostly have to pay low up front fees and are able to pay it in installments.

#### 6.3.3.1 BUSINESS LANDSCAPE

The companies in Arusha works with different business models; subscription based - Off Grid Electric- or ownership based - Mobisol and Rafiki Power. These companies seem to be part of the main players in Arusha (and are working in other parts of Tanzania as well) and are expanding rapidly. While Off Grid Electric is focusing mainly on the lower income population from both rural and urban population, Mobisol seems to focus on the middle class in the urban area (while doing some work in the rural area) with panels ranging from 80W - 120W - 200W. Rafiki Power, a daughter company of the German E-On, operates on a higher level and offers offers rural villages micro-grid solar solutions in the form of solar home systems. Looking at

	mobisol	m-power	rafiki power
product	solar panels	solar panels	solar home systems
size	80-120-200 W	5-10W	3-9 KW
sort business	retail	retail	community
business model	ownership based	service based	community purchase
costs initial	128,000 tsh	15,000 tsh	?
costs recurring	39,000 tsh	5,000 tsh per bulb per month	pay for use
segment	middle income	low income	rural low income
ensure payment	sim in charge controller	lock in device	social control
payment style	mobile banking	lock in device	social control

Figure 6.1: Comparison Solar Companies.

figure 6.1: Comparison Solar Companies it becomes apparent that all companies have chosen a segment to work with. From the interviews conducted it was apparent that Off Grid Electric and Mobisol had training courses in place to turn Tanzanian employees into OLs, who can sell their products. Rafiki Power had another additional approach, which is find the OL in a village that had potential for a micro-grid to be installed and give this person the opportunity to grow his business. The person with a shop would now be able to run a freezer (as this is better to use than a fridge) on the system and sell cold drinks, which have an obvious added value. As for now the start up is looking to provide milk cooling systems. As other people see how the OL benefit from this they become more open to the micro grid being installed.

#### 6.3.3.2 PAYMENT PLANS

Talking to representatives from these three parties that the biggest struggle is the creditworthiness of customers: assessing this and offering some sort of pay plan is key. "Financial and physical access to the product is key". This was done through offering the opportunity to pay through mobile banking. A way to ensure full payment directly is considering to sell in season that customer receive the money from selling their crops was named as a possibility. Having a way to track payments and cut of access is one of the used methods to control products misuse.

#### 6.3.3.3 COLLABORATE

There are incubators such as AISE-Twende small scale entrepreneurs, working on clean energy innovation, do not feel as if they have an opportunity to get their products out there. While this is a signal for AISE-Twende to get out there more, it also means that there is an opportunity for foreign entrepreneurs to work with local entrepreneurs as they know the market better and can function as some type of opinion leader in the process.

#### 6.3.3.4 HEAT STEAM CONCEPT

As the companies were mainly into solar and were focused on their products they were not directly enthusiastic about the product. They did offer advice how to use and sell the concept: "as an addition while cooking", "with solar collectors during the day". The most hear fear was that people would not cook more of longer, because this could offer them electricity. This was something to look out for and which could be emphasized through education. They all saw the product as a retail household level product, which should be positioned as such and could be retailed through exciting retail challenges.

## 6.4 TAKE AWAY

- Opinion leaders in community can be recognized by their community work and the extent to which they are exposed to influences from abroad. For this case it means an authority figure who can speak English and in his daily life is exposed to news from outside the country as well as foreigners.
- Start small with a solution that is enough to generate energy for light at night and telephones. Looking at a detachable power bank and light might be interesting as this offers freedom for the users.
- Devices has to be detachable easily as cook stoves are used interchangeably.
- Aims for the sales price level should be 60.000 TSH as this is the amount of money spend monthly on all polluting sources. Note that investing in the proposed solution does not mean that all polluting sources are replaced as charcoal and candles will probably still be used. It simply means a replacement of kerosene as a light source at least. In long term this could mean the replacement of kerosene as a cooking source. 60.000-80.000 TSH is also the price of the mobile phones most low-income adult own. As this a product that they currently own the researcher expects that if they are convinced off the benefits they might be interested to invest this amount of money in the solution whether it will be at once or in installed payment.
- Solution has to entail an educational plan.
- The reaction of the business representatives confirmed the fact that (1) creating a solution that could be cook stoves is an interesting area to look at (2) offering a payment plan with the solution is essential to make it work.



**CREATE**



# CONCEPT 7. (RE)DESIGN

Within chapter seven the focus lies on proposing an improved product design based on the earlier take away point in previous chapters and a research conducted by the Global Alliance for Cook Stove (GACS) in collaboration with IDEO in 2012 (GACS and IDEO, 2012). The emphasis lies on concept development in conjunction with use scenario and not on technological improvement such as optimal efficiency use as this is not part of the assignment.

4. GAS



3. KEROSENE



2. CHARCOAL



1. 3-STONE FIRE



## 7.1 DESIGN GOAL

As stated in section 1.3: Assignment the whole assignment entailed “Designing a feasible product-service system and an accompanied market strategy for clean energy generation in rural Tanzania”. Within this chapter the emphasis lies on the first objective, which is to design a concept that embodies the vision the designer has for the product-service system. Conducting background research, has contributed to strengthening the case for the new search area. The thoughts of how the design should work have evolved over the course of desk and additional field research. The desk research showed that the product should mainly be more affordable. From the field research it was clear that cooking is an important part of the day as it feeds the family. GACS and IDEO (2012) in their research suggested to look at improvements to existing cook stoves, for which this new functionality can also be seen as something new. Using it strategically by designing a product that turns a hugely negative (use of polluting sources) into a less negative (less use of polluting sources) and in long term positive (a switch to clean sources). In short, the goal is to design something that will inhabit behavior change.

## 7.2 CRITERIA

Roozenburg and Eekels (1995), forms the base of the design process and is also used as first step in the design courses at the faculty of Industrial Design. While the approach in their book Product design: fundamentals and methods entails an extended criteria list about multiple aspects of the to be designed product configurations, a scaled down version is used in this design cycle and the categorization is done based on product and service.

### 7.2.1 PRODUCT

The main criteria set up for the to be proposed energy are based on the take away points:

- Enough electricity for the use of min electricity demanding products; light, mobile phone and radio. Making it fulfill the multipurpose wish of the BOP customers (chapter 5: Customer)
- Part of daily routine, meaning that no extra activities

- should have to be performed to generate the energy Fit with the clay lined cook stoves. GACS and IDEO (2012) determined that the market is flooded with cheap cook stoves such as the the metal and the clay lined. Most people choose for the clay lined cook stove.
- Should not make their cooking activities heavier or pose more obstacles to daily activities.
- Should be as simple as possible to increase under standability; clear use cues. The thing that matters is how easy or how quickly they can cook so using the innovation should not complicate things.
- Should have a price comparable to their phone.
- Ability to store energy, should be offered as part of the product
- Ability to grow with the electricity demand of the users, meaning that the product should be modular.
- Should be portable so can be used during different tasks and affordability of only one still make it useful (Chapter 4: Customers)
- Should be seen as a replacement of kerosene, meaning that an educational message should go along with it.

### 7.2.2 SERVICE

As part of the whole solution the product should entail a service that not only offer the regular product service, but also will aid in change of current habits.

- Must provide insights in fuel savings.
- Repair services within the warranty period.
- Replacement service within the given warranty period.
- Upgrade to cleaner cook stove. (Image 7.1: Cookstove Progression)

## 7.3 (RE)DESIGN

Based on the criteria for the product and the services another iteration cycle was made based on the Heat Steam Generator, which lead to the design of LITA. Looking at what could be improved on the Heat Steam Generator: there were too many conversion steps before electricity was generated (see figure 7:1 comparison Heat Steam Generator and LITA). This caused the designer to look outside the scope of mechanically generated energy and see if there was a way to improve on this. This

*Electricity, which is seen as the number 1 source of cooking is left out of the equation as this is hard to attain for low the target group at the moment.*

Image 7.1: Cookstove Progression as described by GACS and IDEO (2012)

resulted in the choice for a so called Thermoelectric Element (elaborated on in [Appendix G: Thermoelectric Element](#)) and use this to generate energy.

The concept is named LITA. The name LITA is chosen due to the fact that it is neutral and does not have negative connotation in Swahili. The name is female as this fits with the product and appealing to women. Sources are not unanimous about the exact origin. Some report that the name has origins in Latin (joyful), Hebrew (fruitful) and even in Kiswahili itself (leta is bring). All these meanings coincide with the designer's intention. Most important of all, the name has tightness with personal aspect of the designer's life.

### 7.3.1. LITA

LITA is part of a full modular solution (see figure 7.2: LITA Modularity) that would be formatted over the timespan of a few years when the roadmap presented in section 9.4 Strategic Roadmap would be followed. Intention behind the product is to gradually change cooking habits of the low income household in peri-urban and rural Tanzania by offering an initial solution that can be attached to the current cook stove while cooking. LITA can be attached to any cooking stove. The thermoelectric element ensures that when there is a high enough temperature difference between the two sides of the element electricity will flow. This electricity gets stored in a battery after passing a voltage regulator. Instead of storing the energy in a battery the device at hand can also be charged directly. The LITA can be used to charge a phone, use with a radio or to use to charge a LED torch. The torch can be taken of the LITA and used for executing tasks that were identified as most important (section 4.2: Needs) during the evening. While the price of the elements forms the main barrier for the cost price of the product this technology is chosen as it functions with heat: an input source which can be used over the course of the day and is not bounded to use during the evening. In figure 7.3: Use Scenario LITA the envisioned use scenario of LITA is sketched.

### 7.3.2 COSTS

In section 6.4: Take Away there was stated what that the maximum sales price of the proposed solution (LITA) should be 60.000 TSH (\$28). A first cost price estimation (figure 7.4: Cost Overview LITA) based on the components needed to make one LITA. Note that the prices are based on estimation of production on larger scale. There can be seen that the electronic elements, in particular the thermoelectric element put a strain on the price. Next to that the designer expects that

the material used for the outer shell needs more investigation as this requires a heat sensitive material. Note that the cost price seems low but that a margin should be taken into account, since parties in between will take part of that. Limiting the amount of steps in between and trying to negotiate margins limits price increase.

### 7.3.3 NEXT STEP

Second step of the full solution will be to collaborate with local parties in the cooking industry, such as cook stove vendors and fuel sellers. Objective of this collaboration would be to develop adjustments to current cook stoves or develop a full clean cook stove fitting with the needs of the customer group. Forming a partnership with cook stove makers as well as fuel sellers' aids in development of context appropriate cooking stoves, which are locally made. Fuelling the local economy through educating multiple parties, resulting in better products for the customers. Currently these parties do not collaborate, which makes it difficult to design a cooking stove that is truly beneficial. Together with the same parties a network can be formed in which repairing and replacement services can be offered to the customers. Besides, through collaboration all parties can come up with plans for promotion or fuel buying plans as this is crucial in the success of new and/or improved cook stoves.

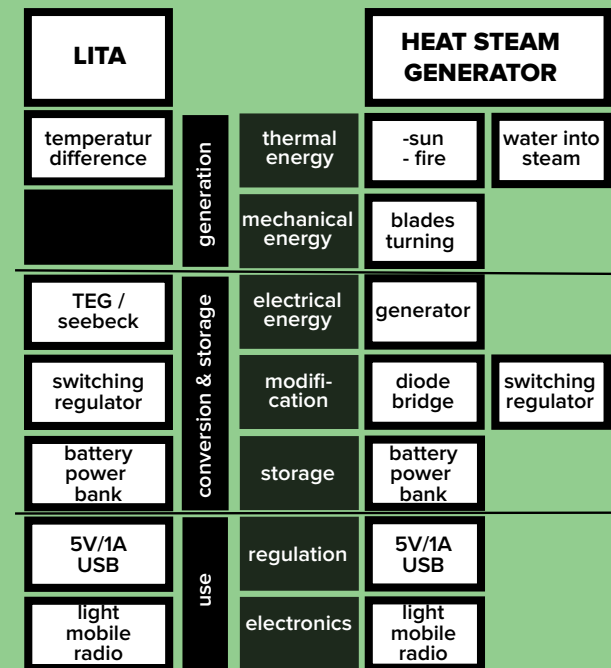


Figure 7.1: comparison Heat Steam Generator and LITA

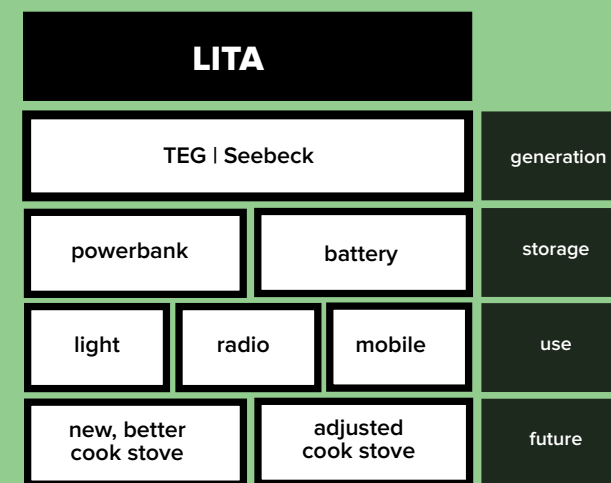


Figure 7.2: LITA Modularity

COMPONENT	COSTS (€)
peltier seebeck	4
wiring	0.20
voltage regulator	2
copper plate	0.50
cooling fan	2
USB female	0.50
outer shell	2
<b>TOTAL</b>	<b>11.20</b>

NB: In this cost overview the cooling fan is included, but this does not necessarily have to be part of the components, when the water alone proves to cool enough.

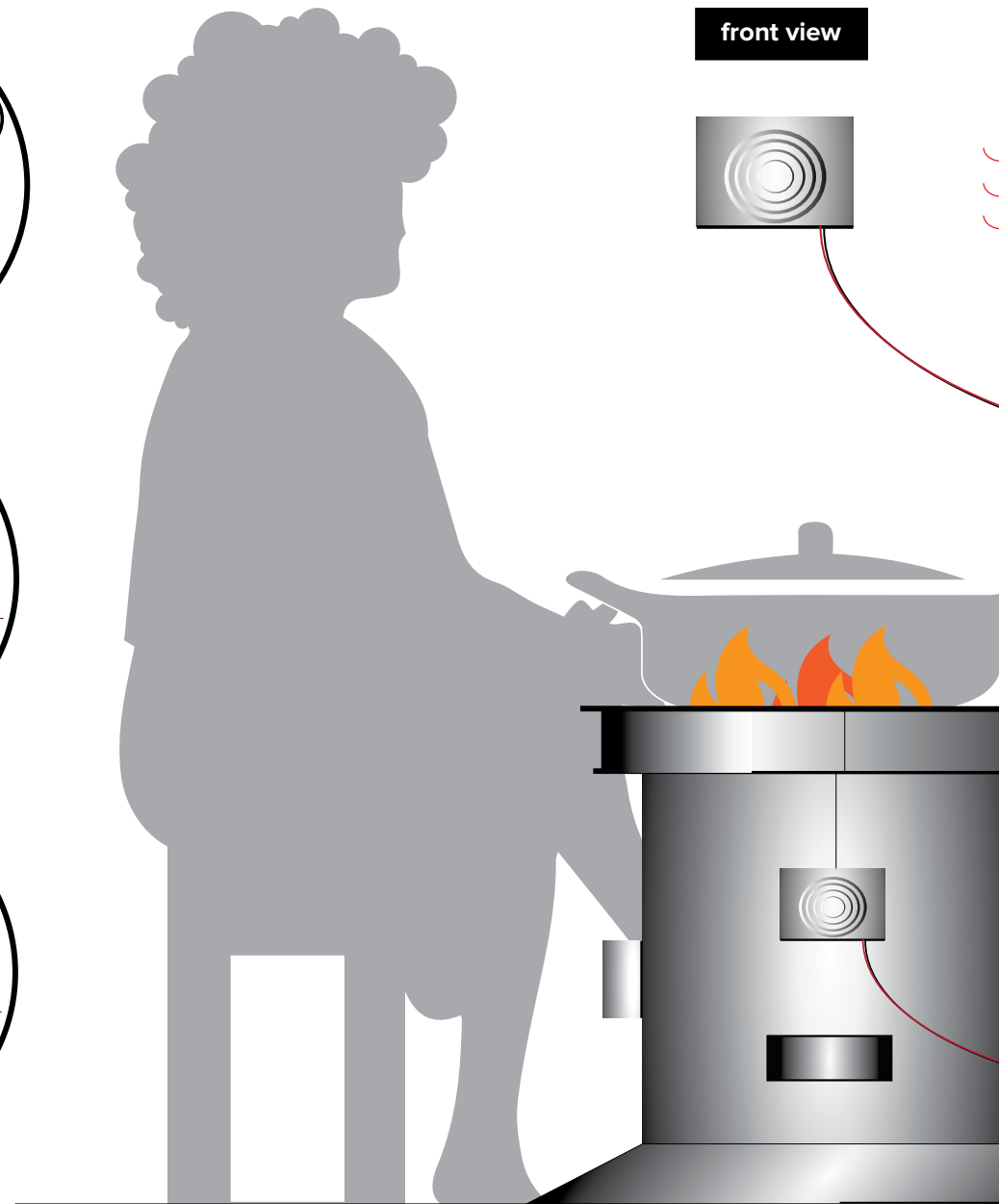
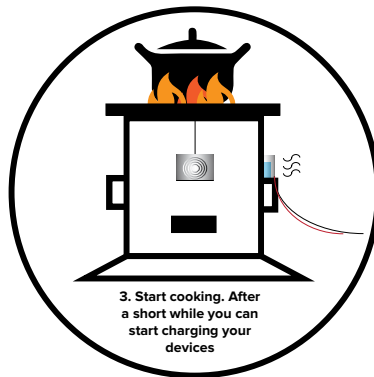
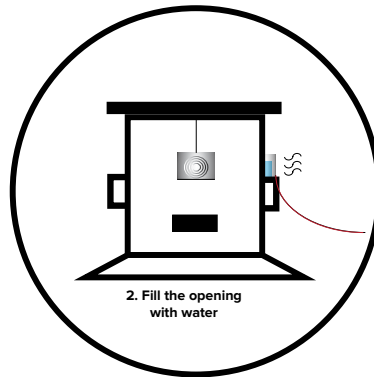
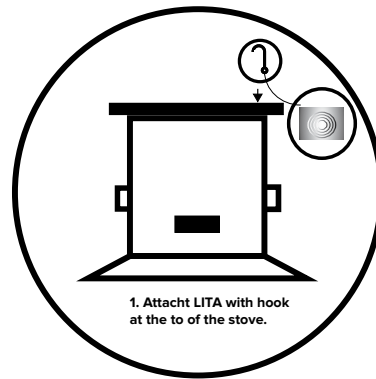
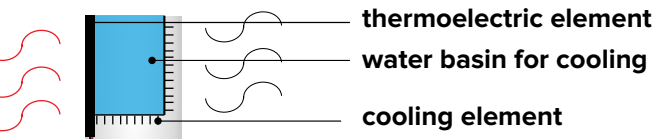


Figure 7.3 Depiction Use Scenario LITA

figure 7.4: Cost Overview LITA

side view



**LITA**   
*usiku maono: radhi kwa macho*

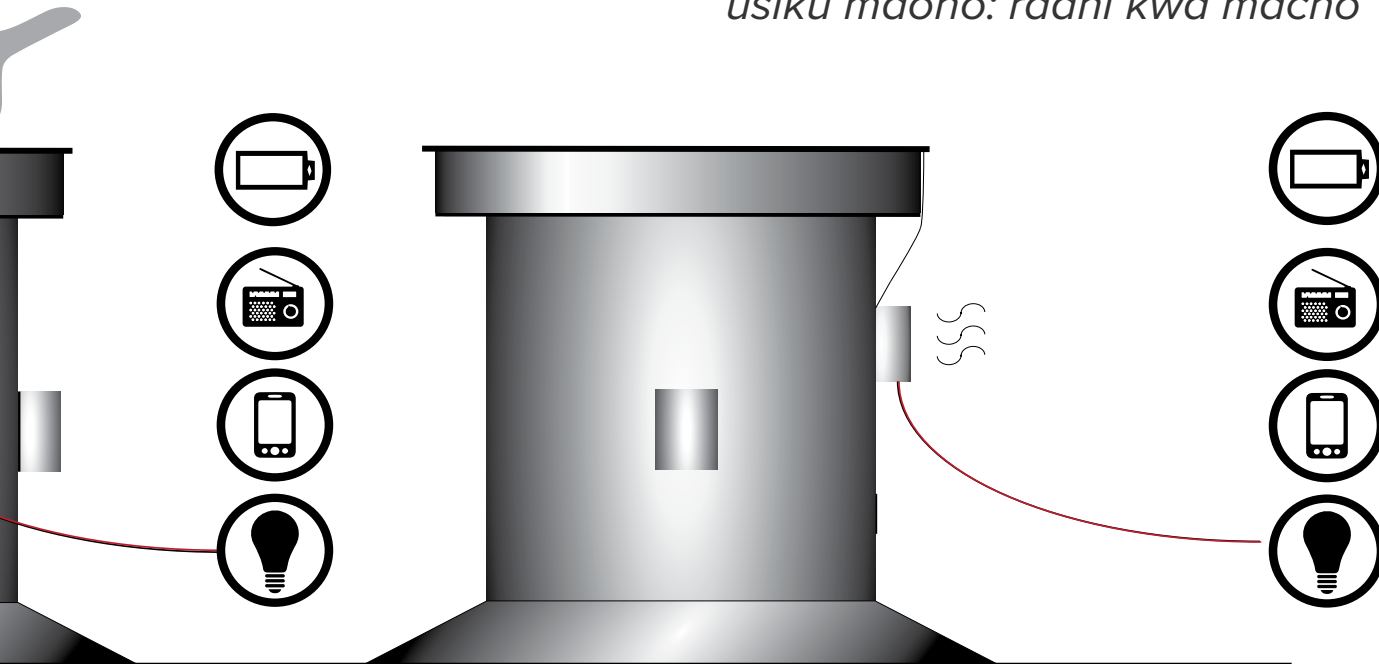




Image 7.2: Testing with Chris Mushi in the AISE-Twende Workshop



**IMPLEMENT**



# 8. POSITIONING

Now that the design is clarified chapter eight goes deeper on the market as a preparation on for the positioning and later on forming the strategy in chapter nine: strategy. To get some insight in the market described as “the clean energy market focused on peri-urban and rural households in Tanzania” in which the proposed concept will be introduced. Next to defining the market, the industry is analyzed with the use of Porter’s five forces (1979) model. Subsequently, a competitor analysis is done as a cross on to get an idea of what the direct and indirect competitors of LITA would be. All is synthesized into a product positioning plan.

## 8.1. MARKET DEFINITION

Now that the design and its use are clarified, it's time to look at the market again in more depth, specifically at the clean energy market. The market definition that is chosen to characterize the market is: "The clean energy market focused on rural and peri-urban households in Tanzania". This entails all local, national, global and international players who offer their clean energy generating and storing products to customers living in peri-urban and rural areas in Tanzania. Clean energy in this case refers to the process of energy (electricity) generation using resources that can be replaced by nature at a for-humans reasonable speed. This entails resources like the sun, the wind, water, waves and heat (solar or geothermal). Using energy from clean sources ensures no pollution of the atmosphere and a reduction of the CO<sub>2</sub> footprint.

### 8.1.1 MARKET SIZE

Some insights in the size of this market: [Tanzanian Market Intelligence \(2013\)](#) calculated with estimates of the Tanzanian government that the number of households without grid connection is 7.8 million. Looking at alternative lighting products alone the prices of products ranges between \$5 and \$250. The lower end products, which are mostly sold and can be afforded by the customer group that this markets serve, are assumed to be sold for \$50. Hence the research team of the [Tanzanian Market Intelligence \(2013\)](#) estimates that the demand was \$9 million dollar in 2013 and will be \$80 million in 2018. Note that this is an estimate of the demand of alternative lighting products only, excluding the multitude of other clean energy generating and storing products.

### 8.1.2 CHALLENGES

Within the clean energy market for rural and peri-urban BoP households the following issues are occurring according to [Ministry of Energy and Minerals \(2013\)](#);

- Due to the fact that TANESCO is operating only twenty diesel-based mini grids the rural electrification is low; only thirteen rural communities in Tanzania are provided with electricity (mini hydro grids) by faith-based institutions. The rest of the communities resort to the acquisition of privately procured or donor-supported solar home systems. Even though there are enough clean resources, investments have to be made and an attractive climate has to be created as to attract business. In 2013 only 4,9% of the energy came from clean energy sources. This didn't include large hydro power plants.

- The policy regulatory framework that pushes for new clean energy to be used more is not fully in place yet and incomplete. This results in a long and complex processes to get clean energy projects prepared and approved. Incentives to switch or invest in clean energy larger than 10 MW are not in place yet. Furthermore, government institutions did not create clarity regarding whether or not the grid will be expanded, resulting in apprehensiveness to invest in the development of mini-grids. Additionally, there is nothing in place to reduce the use of biomass; meaning no regulation regarding logging of forests. Hence reforestation rate is only 25% ([Energypedia, 2015](#))
- Tanzania in general is missing expertise in engineering, design testing and quality assurance skills when it comes to implementing new clean energy solutions. This applies for government, company and customer level, whereby the government plays an essential role in including this in policy and regulation. This results in a whole missing ecosystem that normally would enable clean energy alternatives to be used regularly.
- The financial ecosystem is not used to finance clean energy projects. These project mostly have high total capital costs; lows costs and long-term debt. The institutions are not use for equity financing and don't take risks, which is something that characterizes clean energy projects. The rural population on the other hand cannot pay to get access to the electricity grid, mainly due to high upfront costs. Also, the informal nature of the current clean energy industry causes it to be hard to get financing to improve current biomass production, which means that the main way of energy sourcing is not improved.

## 8.2 INDUSTRY ANALYSIS

The five forces model from [Porter \(1979\)](#) is used as a tool to analyze the industry. Since it is seen as a strong strategic model in various business literature sources. For each of the five forces the strength will be indicated and there will be elaborated upon why the particular indication is given.

### 8.2.1 COMPETITIVE RIVALRY

As stated previously in this market there are products ranging in a wide price category from \$5 to \$250 ([Tanzanian Market Intelligence, 2013](#)), which are being produced by an equal range of companies that offer clean energy alternatives that differ in inter alia quality, price, promotion and distribution. Performance of solar lighting products, which is only a part of the clean en-

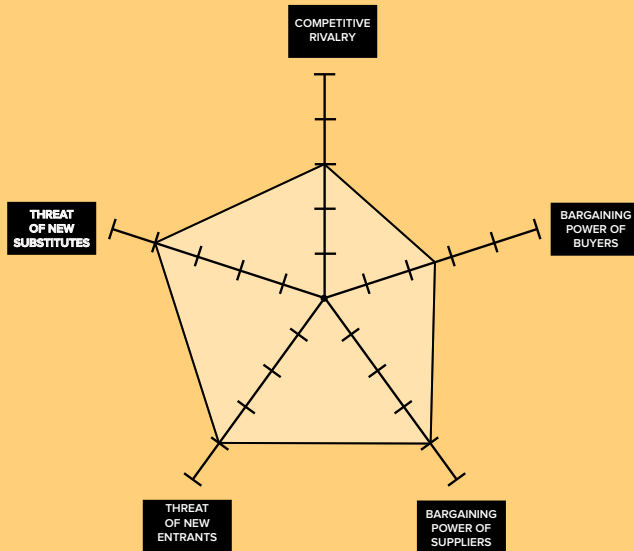


Figure 8.1: Porter's Five Forces Industry Analysis

ergy alternative market, was measured through customer feedback and consisted of: durability, light quality, fragility, price of devices, cost of powering devices and light-on time. Customers seem to be mostly sensitive for the price; 50% of the distributors reported their customers were meanly satisfied with the products or services.

Firms are not highly dependent on each other since there is still a great market that is still without clean access to energy resulting in a large playfield for current market parties. [Tanzanian Market Intelligence \(2013\)](#) reports healthy direct competition, even though demand is not satisfied fully and is still growing quite rapidly. These parts of the market are still un(der) served and unaware of products, services and their advantage.

The market that is currently met in needs is segmented on the aforementioned characteristics, causing firms to offer specific products and services to their customers. Between the bigger firms, such as Mobisol, Off Grid Electric and Rafiki Power, the competition is healthy. However, 63% of small scale entrepreneurs (i.e. dealers) sell a wide range of solar products, meaning there is no specialization based on market segmentation and thus fiercer competition. [Tanzanian Market Intelligence \(2013\)](#) also mentions suggest that another fact is: stocking doesn't happen in large portion: companies rather have a wide range of products stocked lowly, which is a timely matter in a fierce competing market. Due to the fact that these products have higher similarities and can be substitutes for each other there is more of sense of rivalry, especially if one firm improves its product and/or service c.q. position ([Mullins and Walker, 2010](#)). Competition on price is essential to these small scale entrepreneurs as most other product characteristics are rated similarly: 20% of the dealers selling products with prices between \$5 - \$20 ([Tanzanian Market Intelligence, 2013](#)). They are more affordable and mostly unbranded. However, this also goes along with mostly with lower quality. Hence, in the long run this results in more costs due to reparations and replacements.

In short there is a mix of competitors in the Tanzanian market whereby a few big firms choose to target specifically based on segmentation making the competition less fierce. Smaller dealers in contrast cause themselves problems by offering undifferentiated products for similar prices, which they do not stock sufficiently, resulting in high competitive rivalry. This comes down to a medium score for competitive rivalry.

## 8.2.2 BARGAINING POWER OF BUYERS

The power of high-volume customers can put a strain on the industry since they can wield their power on the industry; seeking to reduce prices, demand improved quality and extra services resulting in an unattractive industry. In this market the customers are seen as the buyers. Due to set prices there is no room to bargain with the larger firms. They often design, brand, (manufacture components or whole products outside Tanzania with partners), assemble and sell their own products. The dealers on the other hand buy and sell products from mostly the Asian market. (Re)branding is uncommon for them. Products are sold to customers directly or to other retailers. Due to a large group of dealers with undifferentiated offerings the customers have more bargaining power than with the bigger firms as they can threaten to go to other dealers. As in Tanzania working with long-term contracts is not common there are few switching costs here. Most importantly the dealers compete on price making it easy for the buyer to simply search for the dealer offering (often low quality) products for the lowest price. Thus, the bargaining power of the buyers depends on who they buy from but in the lower segment with smaller dealers the bargaining power rises. In the upper segment with bigger firms there is no room to bargain with set prices and even firms researching their clients (c.q. buyers) trustworthiness.

## 8.2.3 BARGAINING POWER OF SUPPLIERS

This determinant is measured by the increased prices, sale's terms and condition. Suppliers in this case are the Asian industry that is taking care of the manufacturing of components, in certain cases the assembly of the components into a product and the transport of the product to Tanzania. There are lot of different suppliers who can take care of the front end work of the production chain, making it possible to switch suppliers. However, the costs are high and there are often contracts in place. Besides, differentiation is quite low due to the fact that suppliers copy each other and therefore offer more or less similar products. The dependency on production outside the country is high, making the chance that forward integration will happen high since the production plants can decide to also choose to sell their own product without the use of the current retailers in Tanzania. Even if they don't decide this, they do have the power and are a key component in availability of the product and the continuity of sales.

## 8.2.4 THREAT OF NEW ENTRANTS

The threat of new entrants is the fourth determinant and comes down to new parties entering the industry and wanting to gain market share. Hence, a higher threat for new entrants and thus making the market less attractive. The industry is open to more parties making clean energy products, as long as they do not violate patents. As a consequence, the market is open to any local, global and international company that want and can penetrate the market. Moreover, many unbranded products are even high in similarity because of the lack of intellectual property protection. The larger players have the ability to protect their specific technologies, but this does not prevent others trying to copy them. The fact that there are many un(der)served markets with low awareness and even ignorance towards for example advantages of solar lightning (Tanzanian Market Intelligence, 2013), results in low awareness about quality levels. This combined with price sensitivity of customers causes it to be easier for new entrants to access the market and serve customers with low quality, low prices products and services.

## 8.2.5 THREAT OF SUBSTITUTES

Substitutes can be characterized as alternative products which fulfil the same function. When prices increase too much - for example when supply exceeds demand - customers switch to low priced products. The main alternative for clean energy is biomass (firewood and charcoal) and kerosene. These products are in the same product price category and offer the same function; light. Secondary products in this case are generators and connection to the grid. Note that these options require upfront and running costs. Upfront costs are decisive in this case because most of the target group cannot afford this. Switching cost for biomass are low making it is relatively easy to switch. The threat of substitutes is therefore high, with biomass being a solid competitor.

## 8.3 COMPETITOR ANALYSIS

Once the proposed product is introduced it will have to compete in a new market. Therefore, it is interesting to look at current offerings in the market. Competing products are not only there in the same product category, but on different levels as Lehman and Winer (2005) propose in their framework: products compete on product form, product category, generic and budget. While the products in the second ring (see figure 8.2: Product Competition) compete directly with LITA the outer rings

are indirect competitors. This aids in creating awareness and consequently understanding of the fact that other products do not necessarily have to possess similar properties or qualities, but can still be considered as a substitute, thus competitor.

### 8.3.1 PRODUCT FORM

Similar look and feel, meaning sustainable energy generation during cooking practices. Since there are no add-ons used to generate energy specifically during cooking LITA can considered to be unique. Note that there are bio stoves with build in multiple functionality: clean cooking as well as electricity providing (section 5.2: Current Offerings). These products do not offer function as accessories, but rather as replacement for current cook stoves.

### 8.3.2 PRODUCT CATEGORY

Similar level energy generation and storing products. This level entails the multifunctional cooking stoves and other clean energy sourcing solutions such as solar, hydro and wind. The conversion methods in these products differ, but the end goal is the same. Next to that storing of energy is also a part of this group: power banks and the whole array of batteries and other mechanisms to store energy are part of this category as storing mostly comes simultaneously with electricity generation. LITA offers an in-between category as part of a service and strategy to educate people about the waste of using polluting materials.

### 8.3.3 GENERIC

General competition between daily used home-products. During interviews with local customers it was clear that aspirations were in great deal material as this results in more status (section 4.1: Target Group Description) and progress, which is part of the culture. Next to what they already have - mobile phone and lightning and sometimes a radio - the customers looked forward to having a television and fridge (in that order). In the process they would have the possibility to upgrade their current belongings; mobile phone to a smartphone, a whole music system instead of a radio to increase the volume and owning a motor bicycle or even a car. While sounding materialistic, the end goal was to have this and use it as entrepreneurial measure such as getting more jobs, selling mobile phone credit through better phones with more lines, or owning a motor bicycle or car with which an own taxi company could be set up.

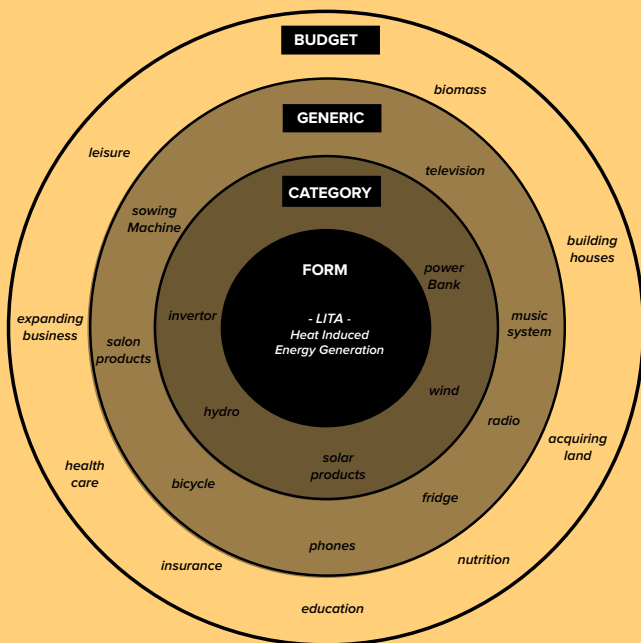


Figure 8.2: Competition Circle LITA

### 8.3.4 BUDGET

Comparable products in the same price range: In this level a wider range of product or sort products can be put. As investments in energy products are big and often cannot be done without financial assistance it's easy to get put on hold and rather invest in short term needs. Next to that emergency expenses or foreseen large expenses for the children, which are the next generation and thought to be a form of insurance for a better future, mean that these expenses have more priority. This shows it is critical to think about how to compete with those indirect products or services, which to the customers might have more priority. Especially since price sensitivity is the reason why low-income customer are still using polluting materials, while they now what for constraints it poses on themselves.

### 8.3.5 CONCLUSION

Two main things that people look at are multi functionality and affordability of clean energy products (chapter 4: Customers). This will be the two important factors to distinguish the product on. Knowing this, the positioning statement should entail how LITA distinguishes itself from the other (in)direct competitors. There can be concluded that LITA scores well on multi-functionality as it can be used during cooking practices, but essentially only requires heat. Regarding affordability LITA will have to watch out as *short term oriented people would really have to be convinced visibly of the worth of investing in a product that in long term* could offer them energy in a cleaner way rather than using kerosene. Portability, which is part of the multi-functionality would be a key factor in this as customers often can only invest in one product, meaning that they want to have the ability to fulfill their task based activities with one lightning product. This functionality is also included in LITA with its modular system.

However, LITA forms a new product, which cannot be placed in the mind of costumers and which requires explanation. Without power the main competing products on the generic level, which are small televisions and fridges, do not fall in the same price level. This makes them stand further from the new solution. Work supplies, like tools for farming or for the wife do pose more threats as those are not only investments, but they also bring in money which is an easier consequence to oversee as this will contribute to the family income. On the level of energy products, solar competes in the same product category

and biomass on the budget level, respectively championing when it comes to multi functionality and affordability.

In short, LITA will experience the fiercest competition from products in the second and the third ring. Many of these products have similar functionality (second ring) or may be desired more (third ring). It seems that apart from relative advantage, all other perceived attributes can be influences in one way or another. Including options that deal with this aspect could influence the perception. For example, when demos of LITA would be offered or one week trails the perception on this attributed could change. Hence, it would be essential to include knowledge regarding this aspect in the strategy.

## 8.4 PRODUCT POSITIONING

LITA will have to show that it has more application options than current small income level specific solar products that offer only light and that it is worth the investment because it will save on kerosene, which currently seems cheaper due to lower short term expenditures. While on paper this can be explained people would have to be convinced through ability to test the product. This can be done by means of the OL using the product and reporting back to others by means of money which is daily saved and would be spend on kerosene. Note that in communication with the customer's status 'lowering' words like cheap should be avoided, as Tanzanian culture is a masculine culture (section 3.3: Culture). The focus should rather be on what the product can do and making the exterior look like something that the middle income group would want to own as well. Through the trickle down (Veblen, 2007) effect the low income customers would be interested in this as well. Next to that it should educate people about the opportunity to upgrade their cooking habits through multiple steps. On top of that LITA can generate energy during the night when they currently already cook and during the day when solar is concentrated on it. As a resulting the researcher came up with the following positioning statement:

*For the low income rural and peri-urban population LITA is a multifunctional clean energy supplier that gives the target group the opportunity of generating energy during daily cooking practices while persuading them through education to use cleaner resource during this and other practices unlike competing clean energy sources.*

*“For the low income rural and peri-urban LITA is a multifunctional clean energy supplier that gives the target group the opportunity of generating energy during daily cooking practices while persuading them through education to use cleaner resource during this and other practices unlike competing clean energy sources.”*



Image iv : Interpreter Manda explaining something to Chadema Family

## 9. STRATEGY

In chapter nine the market introduction strategy is included: how to turn the proposed concept into a business. This entails thinking through the value proposition of the business model and its implications: recognizing the key elements that will make the business work. This flows naturally in the marketing mix with corresponding strategy. As there is not startup yet in place to calculate a solid business case, a roadmap is set up including the next step. The proposed lean pilot that is part of this strategic roadmap included the to be expected pitfalls that the team working on this post graduation should keep in mind.

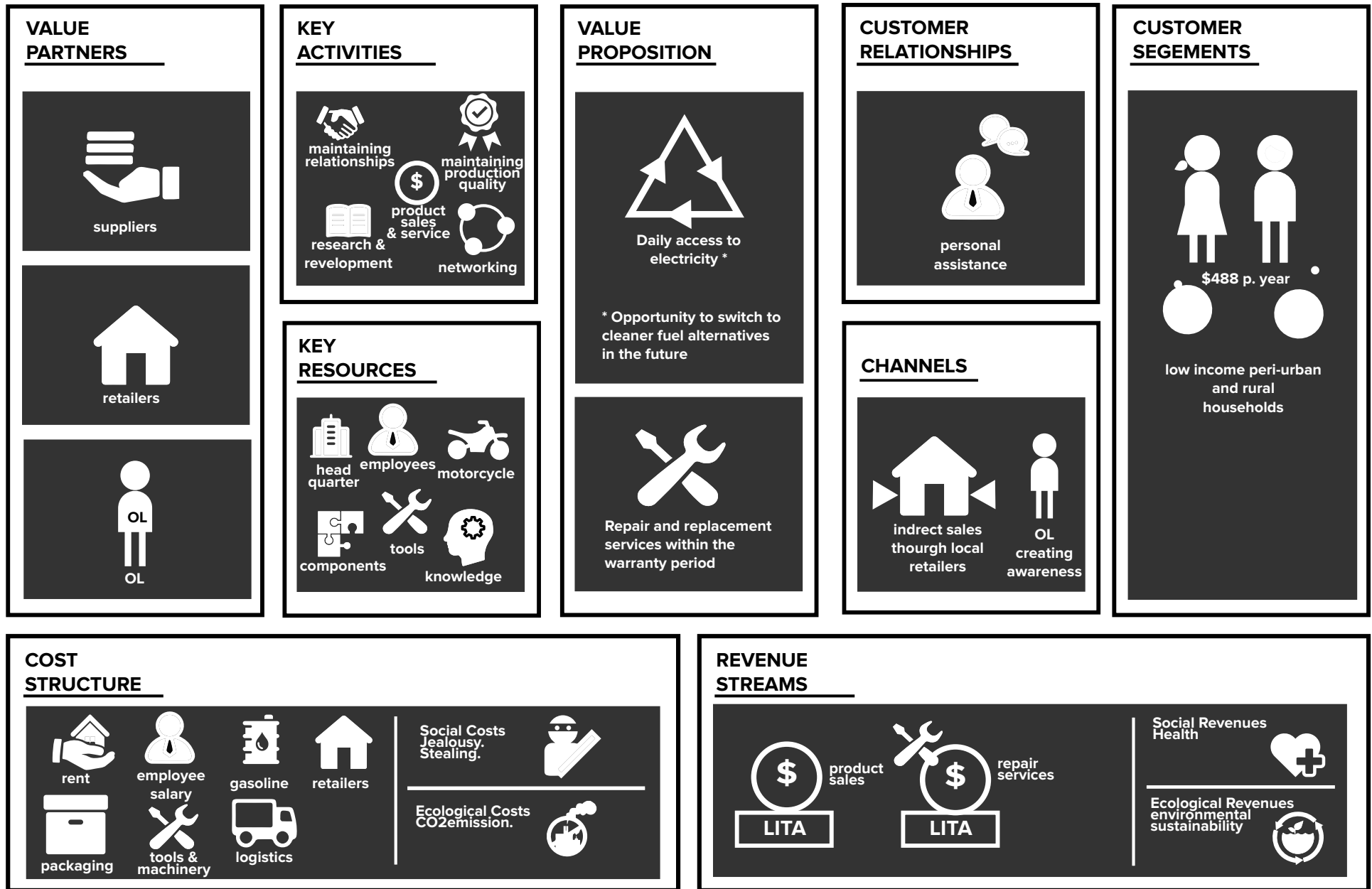


Figure 9.1: Business Model Lita



## 9.1 BUSINESS MODEL

The previous chapters entailed the proposition for a strategic product-service system, which is meant to serve as solution and as a way to guide current customers into their choice for the use of cleaner technology. Due to the fact that LITA belongs in a new product category, which can be described as accessories for cooking stoves and that is currently still ill researched, efforts have to be done to make this new the first thing that comes to mind. It is therefore essential to position the product well as opposed to competing alternatives featuring the unique selling point: affordability, daily access to electricity and educational capacity. The business model around this value proposition will be a big factor contributing to the success of this product. Main elements within this business model are the partnerships and the distribution channels as these respectively have an essential role in the formation and the diffusion of the innovation. The business information is summarized in the form of an initial market introduction plan and made operational in a road map in which a pilot is included that can be conducted post graduation to validate assumptions within the proposed plan.

The bigger trade system behind LITA is set up with the use of the Business Model Canvas created by [Osterwalder and Pigneur \(2010\)](#). The designer chose to use the Canvas, which is adjusted by [Vastbinder, Kroesen, Blom and Ortt \(2012\)](#). Using this Canvas visually gave an overview of the whole network system that should be set in place to realize the value proposition and that would aid with strategy development, especially in strategic choices of reaching the customer. Imminent within this all is the fact that the product itself is strategically used with a certain end goal in mind: changing the cooking habits through relating cooking with the ability to generate electricity.

### 9.1.1 CUSTOMER SEGMENT

Low Income customer living in the rural and peri-urban areas of Tanzania without proper access to electricity (section 4.1: Target Group Description). Here it is important to note that even though women mainly use the domestic product, because the household chores are their responsibility they are often not the only one paying as decisions are made together with their husband. This implicates that women have to be convinced that they want it and which men are convinced that they also want to pay for. Women want to see how the use of an innovation

would mean: use of lights in the evening while they are cooking (2 up to 4 hours), run their shop, sew or braid hair for others (which happens daily between doing chores). The fact that their wife's productivity or that their children can study longer could be a critical factor that convinces the men in turn.

### 9.1.2 VALUE PROPOSITION

LITA can be used to have access to electricity daily, which results in opportunity to use task based lightning (e.g. a torch), phone charging and radio use.

Through local assembly collaboration with retail parties such as vendors of cook stoves and cook stove fuel, the economy will be stimulated and the connection between producers and customers is intensified. The parties promoting and selling LITA in the community also get trained to fulfill repair services for LITA as well as for the stoves, which means the stove sellers can earn extra money, but also offer more extensive after sales service.

### 9.1.3 CHANNELS

As it will take too much effort to directly invest into setting up an own extended sales force a select network of the OL in the community will be identified and trained, following the Innovation Diffusion theory of [Rogers \(2003\)](#). As this person is more prone to new things he also is the one people looked up to as a role model in the community when it comes to the use of innovations. Selecting a person that is part of a community contributes to building trust: awareness of new products was initiated through social structures such as friends who also have the product and tell about the benefits. Even though final purchasing decisions seem to depend on objective company facts, the customer wants to really visually see (perceived observability) the benefits. Translating this in either financial or in relief of discomfort (e.g. red eyes and coughing) during cooking (section 6.1.2 Observation Plan Data, mama Lawrence) makes it hit close to home. Previously the philanthropic communicate has relied on sending out the message filled with only objective data, while this doesn't sell, certainly not if you're living on less than \$2.50 a day, [Peters and O'Dell \(2014\)](#) suggest.

The OL can be used as a person who can try out (evaluation) the product and lobby – create awareness - thereafter. Purchase and delivery will be done initially indirectly through existing channels of partners, such as small local grocery shops, fuel sellers and cook stove builders which will be retailing LITA. These channels are channels that are already in place and which people know and trust. Next to that there is



Image 9.1: Inside a shop

sort revenues	amount (€)
selling LITA	28
add-ons	variation
reperation fee	4
spare parts	section 7.3.2: costs
total	14.000

opportunity to increase sales volume whenever there is success and agreements can be made regarding margins. Next to being partners in the quest for improvement. After sales will be handled through customers visiting these touch points. The retailers will be trained to sell LITA actively. When problems occur after sales clients can get in touch with these retailers and whenever they cannot solve the problem they can get in contact with the LITA community representative. Next to that NGOs and microfinance institutions can be explored and used as third parties to sell LITA to the customer base for an agreed upon price. The research is aware that here a higher margin can be achieved. However, there is not as much room for growth as with the retailers. Next to that each NGO has its own objective already. When the network is set up in the long run own stores and web based sales could be set up.

#### 9.1.4 CUSTOMER RELATIONSHIP

Personal assistance in buying the product: with the product a guiding manual will be provided that can be used during sales by the salesperson and left with the customers after the information sessions. Reparations or replacements will be done within the warranty period by the LITA team, making it possible for the customers to have someone to rely on and to show that the product is a quality product. Interviews in field research showed that the customers often have a lot of questions and concerns regarding the product being unreliable or failing e.g. *“Does the product suffer from shorts?”* i.e. short circuit cuts. Building trust can therefore only be done by showing the customer that the company is there and open for feedback.

As part of a solution in the long run it might be interesting to look at the possibility to track the data in LITA through a chip in the final product to sense when reparations should be made.

#### 9.1.5 REVENUE STREAM

An overview can be made concerning the financial expectations. The following activities will contribute to the Revenues Stream:

- Selling LITA

The core business of LITA constitutes of assembling, distributing and selling LITA. As a result, the main activity which money will be earned from is from asset sales. Due to the fact that the product is modular, thus extensible, add-ons for the product will be sold, such as power banks and extra lights. Customers can use the product freely after use, but when they misuse the product or when the product breaks outside the warranty period they can choose to repair it. It is only than that other money earning activities come into play:

- Spare Parts | Reparation fee

As part of a service for when the product breaks within the warranty period reparations get done freely by the reparation service. However, when the product doesn't work anymore due to misuse or after the warranty period customers can still call in the services of the LITA team. In this case they have to pay a reparation fee and they have to pay for installment of new spare parts.

In figure 9.2: Revenue Stream Estimation an overview is made regarding the expected revenues when phase 4 of the roadmap (section 9.4: Roadmap) will be followed and 1000 products will be sold after 5 months. This does not include the reparation fees and income from selling spare parts.

#### 9.1.5A | SOCIAL REVENUES

Besides, financial revenues the implementation of LITA also has social advantages. The product can benefit their health situation and relieve them from hazardous situations when using kerosene. Avoiding chances to get burned for example.

#### 9.1.5B | ECOLOGICAL REVENUES

Clean energy sources such as the LITA are crucial for ensuring environmental sustainability. Customers will be stimulated to use LITA instead of hurricane kerosene lamps resulting in a reduction of one of the most polluting energy sources with a large environmental impact.

#### 9.1.6 KEY RESOURCES

The value proposition requires the following resources:

Physical - Building functioning as headquarter. Here assembly can be done. When starting in Arusha city only, two motorcycles can be used to travel up to different communities and to set up the distribution networks.

Intellectual resources are the customer database that will be acquired over time, partnerships that have to be kept intact and the company knowledge about technology with the possibility to apply for patents.

Moreover, an initial group of employees will have the task to promote the product-service system, form partnerships, deliver the product and perform after sales activities.

Financial resources entail the cash and more importantly the lines of credit that are managed through partnerships with the micro-finance institutes whenever LITA has to applied with a loan.

Figure 9.2.: Revenue Stream Estimation

### 9.1.7 KEY ACTIVITIES

LITA will indulge mainly in production, which entails (re)designing, procurement of components, assembling and selling the product. Parts that have to be produced, such as the body of the product, will be outsourced. Next to that the brand has to be build so it comes up first when thinking about cooking (accessories). Deliver and provide service after sales to the customers will be delegated to other parties (section 9.1.8: Key Partnerships), such as the third party NGO's, micro finance institutes and current retailers of cook stoves. To be able to rely on these parties, capacity building has to be provided in the form of training and making them valid partners. Note that while this seems easy it will cost effort, time and thus money to translate knowledge. However as stated before the costs are expected to be lower than when setting up own channels. Moreover, customer already know these channels and the retailers. Additionally, LITA will still have a say over the product. Lastly, managing the quality to assure consistency is essential as a warranty is extended to the customer for a certain period of time. Not being able to attain this will affect the product and the brand. As such a quality check and assurance will also be part of the key activities.

### 9.1.8 KEY PARTNERSHIPS

The key partners to make this work are the manufacturing companies, the community OL and the retailers. LITA will leverage their position within the community and closeness to the customers. This would likely result in assistance in creating awareness and increasing trust about the benefits of the product. Not to forget, micro-finance agencies, who are essential in assisting in finance will also be important partners. They will be necessary partners as they are established already and can assist in pushing the product. A market pull strategy here will not work as this is a new product in a new product category. Waiting for the pull would result in heavy investment and mass marketing. Instead it's essential to give the first little push. Partners are chosen on their ability to promote and indirectly through the retailers.

### 9.1.9 COST STRUCTURE

The financial costs are to give a first guest of what each monthly cost post will cost item will take up whenever a first batch of 1000 products will be sold over the course of 5 months (section 9.4: Roadmap). This does not include investment cost

for the motorcycles, which are estimated at €2500 based on searched on Zoom Tanzania. Based on conversations with the interpreter, who has a better vision on living cost in Tanzania the guestimation for the cost structure is set up. Figure 9.3: Cost Structures features the monthly costs that will be made. Assumption is that the costs will be evenly each month.

#### 9.1.9A | SOCIAL COSTS

Next to financial cost LITA also has social costs. This in general can be described as jealousy. People who do not have the system, because they cannot afford it may lash out to others or even resort to stealing. The same envious behavior can occur against partners as the partners that will be involved will increase income or gain knowledge. Next to that the retailers of cook stoves will get the opportunity to adjust their cook stoves and in that manner have an advantage over competitors. The fuel vendors on the other hand will get the opportunity to transition from selling current polluting sources to cleaner sources that work with LITA.

#### 9.1.9 B | ECOLOGICAL COSTS

The fact that motorcycles will be used as means of transport to visit communities will result into CO<sub>2</sub> emission. The same counts for shipping and flying in components also increase the ecological costs as also these means of transport mean the emission of polluting sources. Next to that a recycling system for the broken components should be put in place, because if this is not present the customers will reside in their current behavior. This makes it imminent that there has to be though about sustainability in the broader sense.

1000 products	sort revenues	costs total
variable	LITA costs	1120
	gasoline motorcycle (2200 TH/L)*	180
fixed	distribution (retailers)	500
	salaries (2 people)**	2500
	rent (buiding)	170
	marketing (promotion)	200
	overhead	1000
	TOTAL	5670

\* Starting in the Sinoni area – Engosheraton Gardens (5 kilometers from Clock Tower the city center, Google Maps) with serving 500 people. This place away 5 km from town. Based on the assumption that a motorcycle on average runs 60 miles per gallon (Property Casualty 360, 2014), which is equal to 25 km per liter and one liter of fuel costs €1, so €4 to fill a tank with which you can drive the 25 km (1 gallon is 4 liters). If every day, the person drives 10 kilometers that comes down to driving for almost 3 days. The researcher scaled this down to 2 days to have a margin. Every month €60 will be paid for 1 motorcycle so €120 for two. Including possible reparation cost or more money spend on gas this comes down to €180.

\*\* Average salary after net tax is \$1219,94 (Nunbeo, 2015)

Figure 9.3: Cost Structure Estimation

## 9.2 MARKETING MIX

Within this section a summary will be made regarding the communication of the product-service system to the outer world. The 4P's are addressed and there will be proposed how to market the product. Starting with the product and what it entails and subsequently continuing to elaborate on the set price and why this price is chosen. Following the positioning explained in section 8.4: Product Positioning, the promotional aspect is explained and how it is routed in different aspects of the research. Concluding the choices regarding the place are detailed. This section can be seen as a summary that shows the essence of the proposed concept and strategy behind it.

### 9.2.1 PRODUCT

LITA is a new product in a new market. The target group is not yet familiar with generating energy through their current cooking practices. It does fit in the category of alternative energy generation. LITA mainly serves as an educational purpose and guidance to slowly change habits: as a first step no kerosene is needed to switch on lights during the evening. The next step is to change the current cooking habits, which the customer group is currently forced in due to the lack of availability and affordability of fuel types. LITA is meant to be a smart and accessible solution which can be used daily and that tackles the lack of access to electricity.

### 9.2.2 PRICE

A sales price of 60.000 TSH (€28) is chosen and regarded as acceptable for the customers as this is what they currently pay for their kerosene (section 6.2.2 : Data User Interview). Also, their phones fall into similar price categories. Next to that the average price of other clean alternative such as solar varies between 5\$ and \$250 (Tanzanian Market Intelligence, 2013). This shows that LITA falls in the lower regions of that wide range. There should be aimed to keep the sales price below 60.000, by losing unnecessary parties within the value chain without making it too burdensome for the parties left over. A way to persuade the customer group is by having demos done by retailers in the pre-purchase stage. When they are on the verge of deciding, they could be offered a trial period in which a part of the total sales price is paid in conjunction with a back guarantee if the customer is not satisfied. This shows the customers that the LITA team is quite serious about the product and the benefits it offers. If the sales price falls in the higher range

(60.000 TSH – 80.000 TSH) the initial price can be lowered through collaboration with micro-finance agencies. They offer small loans and can watch over the payment process. Retailers can also be trained to offer layaway plans and payment through mobile banking services.

### 9.2.3 PROMOTION

GACS and IDEO (2012) suggest that even though people understand the effect of cooking with polluting sources and indoor cooking they cannot afford to think about the health consequences as their financial status depends on it. If they would see immediate changes in their use comfort (less coughing or no teary red eyes) they might consider to use a cleaner option. The message therefore has to be shifted from factual benefits to how their personal discomfort would dissolve with the use LITA. This could be something in terms of: LITA. Night Vision: a pleasure to the eyes. LITA. usiku maono: radhi kwa macho | This message is two-folded as LITA itself ensures that there is light during the night, meaning no need to use kerosene hurricane lamps or tin lamps. Next to that the light provided by the LITA would be brighter but not hurtful to the eyes. This message can hang in places where cook stoves are sold in the form of posters and flyers.

Promotion on micro level will be done by a (female) opinion leader identified in the community, the so called mama, who gets a lot of respect and has authority in the village. The family that she is part of is a few steps forward regarding innovation and as she is a (strong) woman, she can display her cooking skills, while showing which benefits the product brings her. GACS and IDEO (2012) also reports that introduction through these types of channels aids as this is rooted in the community. Showcasing LITA at local markets, churches and in community groups ensures familiarity to the customers. In collaboration with the local retailers such as community grocery shop owners, who are mostly women she can work and split the commission that is made by selling the product to other members of the community. The retailers will be provided with visual material with the slogan and an image that entails the message. Also a sample of the product will be provided so that interested customer can feel and see what it is. Trying out the product can be only done either during the awareness phase when the opinion leader is available. She can “positively snob” about the innovation. Another moment will be pre-purchase at the retailer. The women will learn some techniques to feed into awareness and persuade potential customers to try and buy LITA. Using the information interpersonal networks is the best way to start creating demand and promote the product.

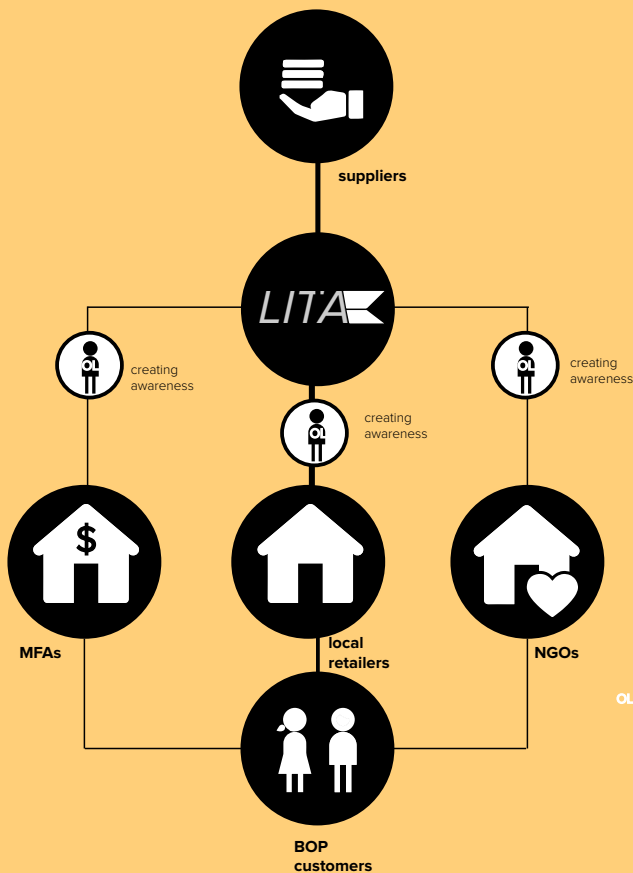


Figure 9.4: Entrepreneurship-based Distribution model. Adapted from Tanzanian Market Intelligence (2013)

### 9.2.4 PLACE

LITA could be sold at the community retailers and small kiosk as women almost daily come there to do their groceries for the day or for a chat. Next to that places were cook stoves and were fuel for cook stoves (charcoal and kerosene) is sold are supposed to be included as partners. They can educate customers, who want to do an initial or a recurring purchase, about LITA and its benefits with a much needed showcase. This might light the spark in the minds of the potential customers.

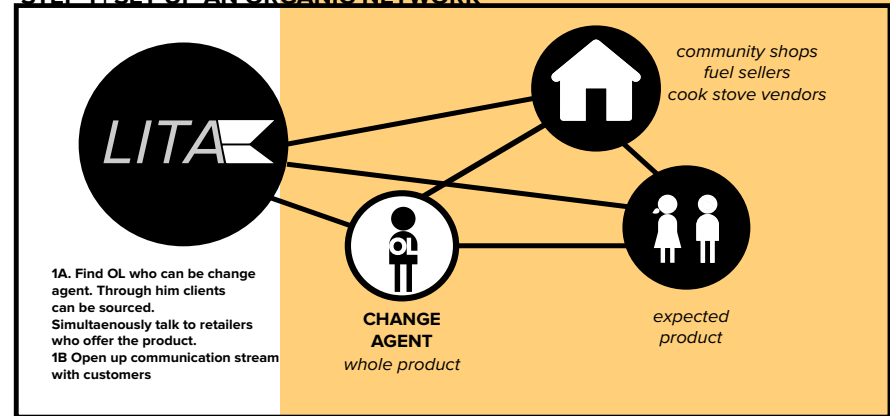
## 9.3 LIMITATIONS

With the set up business model and the market introduction strategy there are a few limitations that have to be taken into consideration when pursuing further development of LITA.

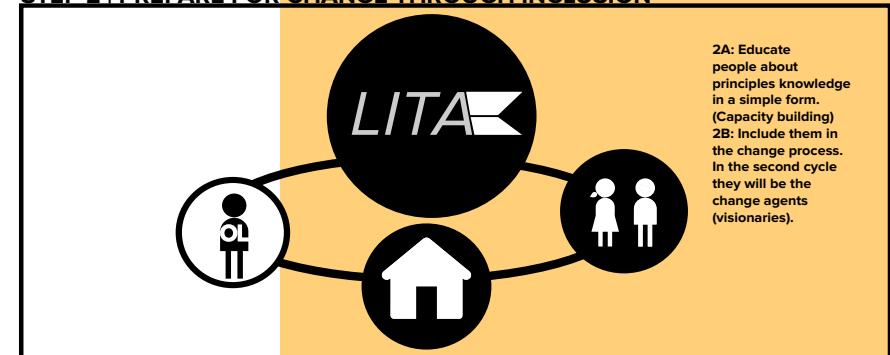
- The short term minded culture (section 3.3.2: Culture) which is a reflection of the contextual situation (unstable and low income) makes the customer group price sensitive. As a result, the focus, when further developing the product, has to be to keep the production cost low and the value chain short and lean to reduce the cost price as much as possible. The higher the cost price, the higher the sales price and thus the lower the chance that customers will want to invest.

- Adoption of new innovation is something peculiar. As a consequence, it's essential to take into account the guidelines that Moore (2002) and Rogers (2003) lay out in their books about respectively marketing innovation and innovation diffusion and (chapter 2: Theoretical Framework). While this has been done within this thesis. The assumption was that the theory from Moore (200) about high tech product also apply to low tech product in other cultural settings. Although, the theory from Rogers (2003) has been more thoroughly researched by inter alia a large group of scholars in different instances. It will be interesting to see if included advisory elements of these two innovation expert are applied well enough to make LITA succeed.

### STEP 1 | SET UP AN ORGANIC NETWORK



### STEP 2 | PREPARE FOR CHANGE THROUGH INCLUSION



### STEP 3 | IMPLEMENT FULL SOLUTION (CLEANER WAY OF COOKING)

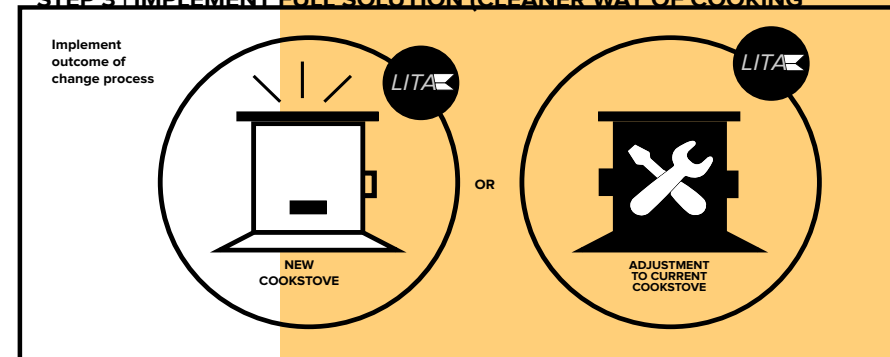


Figure 9.5: Explanation proposed strategy

## 9.4 ROADMAP

With the awareness of limitations in the market introduction plan a strategic roadmap is set up. This plan is meant to be brought into practice as activities are described and elaborated on per phase. The roadmap entails 4 phases, with each phase having its own objective: starting with a pilot, going forward to building a business case with the trial data acquired in phase 2, moving forward to a null-series for which seed money needs to be collected and ending with scaling up with LITA to the greater Arusha District. The road map is build up like this to offer enough time to gain feedback and iterate on that. Note that while in every step of the way there should be reflected, at the end of each phase there is actual time build in to: reflect, learn from it and a possibility to reconsider if necessary or move forward with the next phase. For each phase a large time span is chosen as this ensures that there is a possibility to get to know the market, improve the product best on this knowledge and decreasing the chance to fail. Even though there is a possibility that the product gets copied, this will confirm the legitimacy of the new product category. LITA will always have the first mover advantage with it being the first brand that was active in this domain and will have established contacts and contracts with stakeholders.

### 9.4.1 PHASE 1 PILOT

The first step in the roadmap would be to set up a pilot in which over a longer period of time (6 months) the innovation adoption can be tested in practice. This can be through building a team of local (Tanzanian) designers working at the Twende in Arusha, a local incubator, and (master student) designers from the faculty of IDE, who are interested in sharing expertise and who like working on BoP projects. This results in an opportunity to set up an international collaboration exchange between the DUT and this organization, which is already working with MIT. A collaboration with Yes!Delft, the DUT incubator means professional guidance in a dynamic environment in which multiple start ups reside. A business oriented local who has experience and knowledge with employing entrepreneurial activities in Arusha, Tanzania is essential as a member of the team to find interesting contacts and stakeholders to work with and negotiate contracts.

Goal of this is to develop the design further. Within the pilot the new assumptions that are embedded in the proposed strategy can be tested. Within this thesis advice is laid out regarding the product-service system that should be set in place (technology), the customer group (people) and how to approach them (market). Collaborating with local designers is essential as they have insight in the context and can introduce LITA to the customer group, while the Dutch designers might have more insights in simplifying the product, professionalizing future production and doing quality control. Design wise there are some things unclear (such as material choices, aesthetic choices, electronic specifications), that can be solved over the course of the roadmap. It is essential not to totally engineer the product but to keep in touch with customers. Hidden Design (Tomico, Winthagen & Heist, 2012) is proposed as a method to conduct the pilot research, since this allows for the group

to tweak the design during the pilot with the test group based on feedback without the test group knowing. This provides the rawest data about sufficiency of the technology, adjustment of the innovation strategy and gives insight in financial possibilities of the customer group e.g. payment plans. Essential is here to already have set up initial parts of the service behind the product in collaboration with the cook stove vendors, fuel vendors, local shops in the community as to gather information regarding the touch points, how to establish them and what the costs will be.

Amount of products: 20  
Where: Arusha, Sinoni | Delft, the Netherlands  
Who: Households (mainly housewives).  
Team: All members  
Timeline: 2 months, starting in September 2016



Figure 9.6: Strategic Roadmap

### 9.4.2 PHASE 2 BUSINESS CASE

From the pilot the team will get to know more contextual specifics about inter alia the financial situation and the financial structure that should be applied. Next to that the technological specifications can be detailed more and more, which is an aspect that influences the price heavily. Knowing the maximum sales price on one hand and the technological aspects i.e. cost price as well as what the value chain will look like, will aid in reaching a compromise about the price/quality ratio. Simplicity, reduction of conversion steps, hence components are key in this process. Assembly and sourcing of local components locally might also aid in the development. Note that 'economies of scale' forms a crucial measure within this: increasing volume results in lower fixed costs per unit. Variable costs would have to be managed correctly.

Knowing more details about the data through the initial pilot focused on assessing adoption of the product and technological specifications the break even volume and return on investments can be determined. From here further steps in terms of product service design and development can be taken. During this phase in conjunction with in field data collection, seed capital (estimated at €10.000-€15.000) should be collected to be able to execute the actions in the third phase.

Amount of products: Add 20 extra products  
 Where: Arusha, Sinoni | Delft, The Netherlands  
 Team: Tanzanian Team collection of data. In the Netherlands business case building and collection seed capital.  
 Timeline: 4 months starting from November 2016

### 9.4.3 PHASE 3 LAUNCH THE NULL SERIES

Produce and sell a fully finished first version of LITA to the customers in a rural ward in Arusha. This in turn will be a test for the adjusted product service design and will still form a way to collect feedback. While the first pilot could still be characterized as a pilot with the users receiving the products for a reduced price, the null series will be the real deal. It will be the first time really entering the market in collaboration with partners and other stakeholders who get paid. This will give more of an opportunity to generalize results and form a first step to develop a cook stove or cleaner way of cooking in general that fits with the context and most expectantly means a reform of activities from fuel vendors as well. In this phase there will be clarification as to whether the path of total reform of the cook stove is even necessary or that offering new accessories that will reform the current cooking habits will be enough.

Amount of products: 150  
 Where: Rural Ward Arusha  
 Who: Households (mainly housewives).  
 Team: All members  
 Timeline: 5 months to set up production and capacity building from March 2016. Promotion will be set up from July 2016.

### 9.4.4 PHASE 4 SCALE UP PRODUCTION OF LITA

In case the launch of the null series proves to be a success, sourcing capital should be collected based on testimonials and presented achievement in numbers. Only when in the previous phases customers have said to be satisfied with the technology, the "bigger" sales can start in this phase. The expansion will be in preselected rural areas in Tanzania where mainly people with a low income are living, starting with expansion to the Arusha District (section 4.4: Potential Market). This phase is focused on reaching a modest volume of 1000, which is 0.3% of the potential market (section 4.4: Potential Market) in the year that this phase takes place. Having prove of amount of items sold aids in negotiating new deals in the future with bigger parties that sell complementary products. Procurement of resources, production, assembly and personnel would have to be accounted for with this capital, which is guesstimated to be €50.000 working with an average product cost of €11.20 (section 7.3.2: Costs). From here on the more locals will be hired to further set up things locally for which they will receive a salary.

Amount of products: 1000  
 Where: Selected rural ward in the Arusha District  
 Timeline: 5 months, starting in November 2017

At the end of this phase (2017), new goals can be set for the 2-5 years from then. At this point there can be though about reaching break even volumes. Taking LITA into full production too early can lead to overseeing certain aspects and thus failing. Opening up the market for clean cook stoves can only be done by investing in research and setting up pilots to find out what customers really want to buy, as Peters and O'Dell (2014) state. More importantly, there is no start up or full grown project yet in place to validate the current assumption quickly. This will require time and thorough research.

## 9.5 CONCLUSION

The business aspects proposed in this chapter form a summary of the customer, market and technology research answering the questions stated in [section 1.3: Assignment](#). The provided roadmap is written in a way that it can be operationalized and is moldable over the course of action. Starting with a longitudinal pilot at the end of this year (2016) on the one hand to foresee initial scaling up to reach 0.5% of the potential market at the end of 2017 on the other hand. If followed through by a to-be-set-up team, gradual change of thinking about design facilitating behavior change can be facilitated.

While offering new products overall happens with a good intention it sometimes doesn't fit with the contextual situation and capabilities of the customer group. Even though this strategy does not mean direct switch to clean resources, it offers an alternative for the use of kerosene lights for task based activities at night. Secondly, there would be the opportunity on the longer term to possibly adjust or replace cook stoves for ones that are cleaner. Another option is to facilitate the use of different sources, which is distinctive for the current situation. With the proposed positioning in relation to competitors and distribution through different existing trusted channels that are routed in the community, cost would be saved. Lastly, through the use of these channels gradually new customers will get accustomed to a solution from a new product category, enhancing diffusion of the innovation and enlarging the possibility for success.



# 10. RECOMMENDATIONS

Chapter ten gives some insights into the thought process of the researcher. There is explained what should be investigated whenever this project would be continued in the future. As part of the further proceedings the team that might pick up the project post graduation could investigate the recommendations.



Image v : Mama Amanda and her new house (under construction)

## DESIGN OF LITA

Within the embodiment of LITA research is lacking in terms of more efficient Thermo Electric Generators, optimal heat resisting material, making a design that fits on practically each stove and user feedback. The prototyping of design up to the second iteration phase (steam heat generator) was fully executed, leaving. The last iteration cycle for LITA was cut off at proposing a design that on paper works but has to be optimized in practice. Developing the design in conjunction with setting up a pilot in which users are exposed to a first version of LITA would be in line with what [Ries \(2011\)](#) provided. In his Lean Start Up Methodology the author talks about a Minimum Viable Product, meaning the minimum configuration, equal to inner circle of the Whole Product Concept ([Moore, 2002](#)). As in this thesis it's clarified that the technology is working the next steps would be to optimize the technology so it benefits the user best and to make an appealing design. This can be done through conducting more experiments regarding specifically:

## DYNAMIC STRATEGIC ROADMAP

At first sight it might seem that the strategic roadmap is something rigid that should be followed step by step. This is incorrect, the plan is just meant to be a first step for further development of LITA post graduation and to provide insights in the designer's mind about strategic future prospects. There is freedom to adapt the plan. It is therefore recommended to set out different paths and evaluate them periodically to see what works best.

## COLLABORATION WITH STAKEHOLDERS

Within the marketing plan, ideas are exposed to collaborate with existing channels as developing an own channel is challenging in many ways: high investments and promoting a product in a new category, to new customers via unfamiliar channels. Doing all three can be characterized as a disaster waiting to happen. As the proposed collaborations are essential to avoid having to invest in this aspect. This part of the proposition is peculiar, but could also result in much more. Talking to these parties will give more insights in the value chain and how much each party would increase the price (i.e. keep as profit) as the proposition is done based on assumptions. The decision was made not to already calculate a business case as too much of the detailed financial aspects was missing to build a reliable business case.

## PROMOTIONAL MESSAGE

The promotional message and positioning may be changed in case there is a better way to approach the clients. Recommended is to test different promotional messages with different groups and assess what works best. Retailers are supposed to be involved in the promotional message and offering try outs, meaning that they need to be trained in actively selling the products. In this case again there has to be estimated how much the capacity training costs, how much commission they expect in return, if and what they are willing to do to sell the product and how to track sales.

## FINANCIAL PLAN

The most essential of the plan comes down to the payment for LITA. Through designing and fighting for a sustainable value chain selling price can be kept low and customers can buy the product at once. However, it might happen that there should be a payment plan in place. Instead of collaborating with external parties it's recommended to look at in house financing plans and try to think what it means in terms of who would have to be trained, how to make sure that clients pay of the loan and possible how to use the mobile banking trends in Tanzania to benefit from it. Note that this also has an impact on the business model as income is based on credit and break even points will be realized later on in the process. Investigating whether it would be useful to try and sell LITA through on time cash payments in the seasons that most people get their money would therefore be something to look at.

## EPILOGUE

In conclusion, I would like to share what my experience was with my graduation project. I will address the assignment, my process and what I've learned.

When I started formulating the assignment I had a clear vision in mind. I was focused on further developing the human energy system concept that I've been working on since 2013. The fact that I've been working on that project for a longer period of time resulted in me seeing it as a "my baby". Initially I followed the assignment, which was detailed as A BOP Business Case: Implementing Mechanically Generated Energy in (rural) Tanzania. As a start I reviewed this concept with the aim of making it more affordable. This would result in an inefficient and an - to my personal believe – (ethically) irresponsible product.

After heavy considerations I decided to "kill my darling" and I jumped into a new adventure, not knowing what I was in for (again). With blank pen and paper I started and looking for a gap and was aided in my journey by wonderful people around me both in the Netherlands as well as in Tanzania.

Working on my own project was a great pleasure, because this is my passion: working on solutions for, with and in the BoP. I have to admit that at moments it was also tiresome. As I was in charge of everything, I had to stay sharp and critical and make ALL the decisions my self as well. Note that normally clients can also give you a hard time.

During the process I went from exploring ways to generate electricity, making the prototype, seeing if it works and back again to the drawing board. Prior to my field research in Tanzania that was the routine I followed and all the assumptions in my notebook were growing. Hence, my visit gave me a lot of clarity and helped me develop even more empathy for the loving Sinoni community that I was part of for two months. From the first day when I tried to find my way to the last day when the community members did not want me to and could not believe that I was already leaving. Being there helped me understand the essence, which I then translated to my work. This to me makes it more believable as it's rooted in the context.

There are times that I wished I did more, but than I also realize I did a lot already. Setting up and executing my own field research abroad. Fortunately, I've worked on projects in Tanzania before, and thus I already knew my way around. However, I never worked on such a big project alone before. Executing qualitative research, analyzing results, developing a prototype and testing whether it worked technology wise and iterating, analyzing, synthesizing and designing a corresponding market strategy made every day quite eventful. Though the project is serious I also tried to dose and balance my creativity to make it work for me at the right moments, because designing has to be fun and joyful (LITA).

Even though there are already total solutions being offered I believe in the fact that with the help of inclusive design, in collaboration with other stakeholders a context appropriate solution could be developed. I am also aware that this can empower so many more people than only the final users and I hope that this can be reached through this strategic plan. Filled with enthusiasm I will continue with this strategic endeavor and hope to form a team to execute the first steps of the roadmap. Who's in?

Deborah Xaviera Sumter



Image vi : Henriette Family Enterring Their house

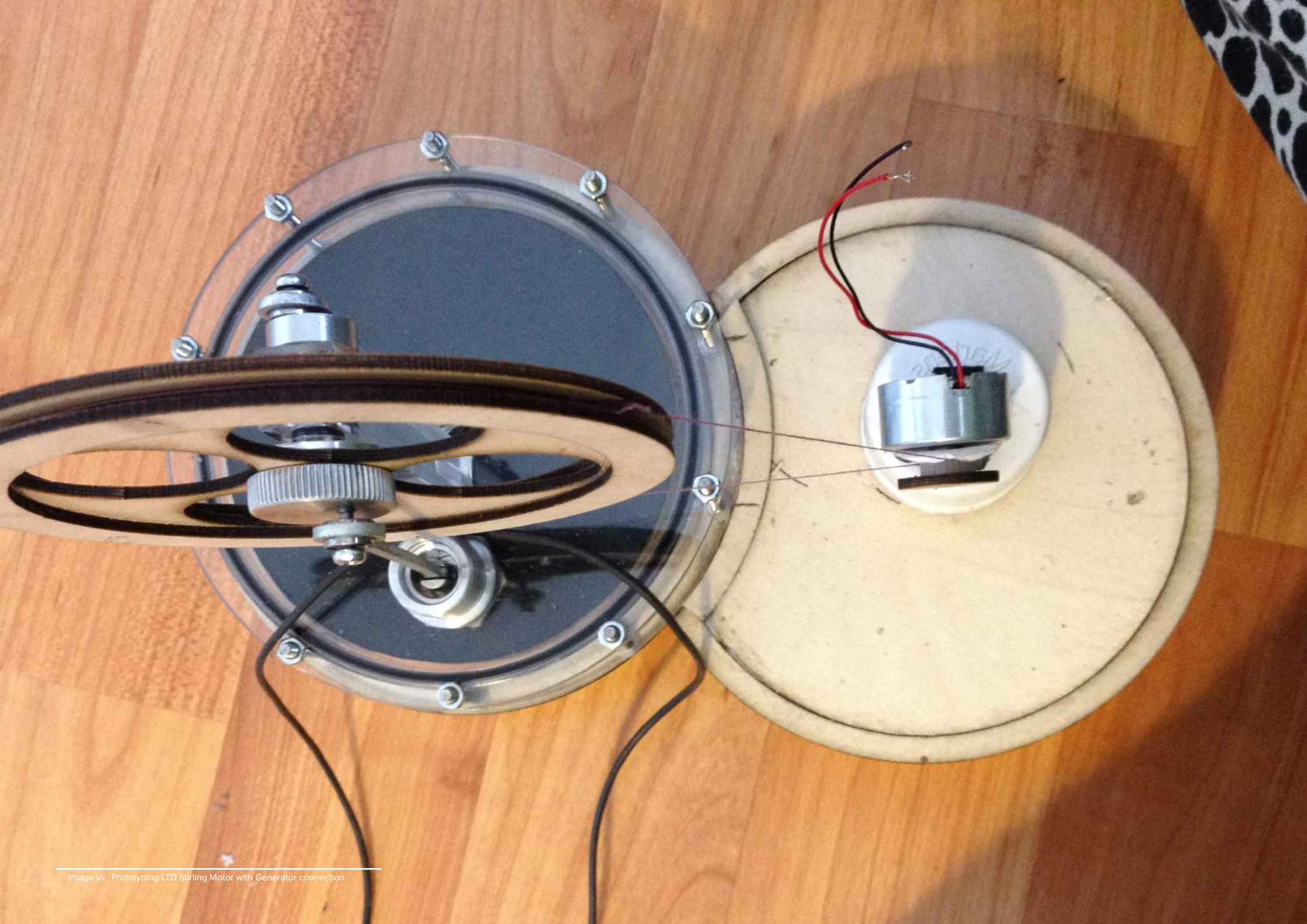


Image vii : Prototyping LTD Stirling Motor with Generator connection





Image A.1: RiziQi Prototype 1.0 at University of Dar Es Salaam



## APPENDIX A: FEASIBILITY STUDY

Within this paragraph the origin of the human energy concept, RiziQi is explained. The working principle is discussed together with an overview of the limitations. Most importantly the feasibility study discussed why technology wise continuing with the development of RiziQi was discarded.

### A.1 HISTORY

In 2013 two master students of the Industrial Design Faculty, Strategic Product Design and Design for Interaction, went to Tanzania on an internship. During the stay they had to deal with energy shortages, which influenced their productivity. Imagining that on top of that daylight is from 6am to 6pm, due to the geographical location of Tanzania, near the equator, a problem was identified; the loss of at least two to four productive (!) hours on a day. While the random power cuts for them were not welcome, they could be dealt with through the access to alternatives. In contrast, for local inhabitants the unreliability of the network combined with the overall lack of access to the main electricity grid influenced their daily lives. This experience in combination with the earlier stated statistics made it evident that alternative energy sources needed to be offered. As means to offer a solution the two students developed a human powered energy and a testable prototype in collaboration with the University of Dar Es Salaam. Specifically, this entailed a concept in which a bicycle as a source of energy. With a need assessment study (Powerhub report, 2013) showing that from there was an actual need for an alternative that was cleaner than the current offerings, such as kerosene and charcoal, and cheaper than high capacity solar systems, the students pursued the further development from a project into a business. The first steps being to gather support and funds when returning to the Netherlands. As of the start of the research in September 2015 regarding this master thesis the students didn't succeed yet to turn the project into a business. This thesis therefore has the sole purpose of serving as an additional arguments on whether to pursue this project and to only make a redesign of the concept or to make to explore a different alternative with a corresponding introduction plan, which fits with that idea.

### A.2 WORKING PRINCIPLE

In light of the earlier sketched energy problems an energy alternative (human powered) energy concept called RiziQi - Golden Purpose - was developed during a project in collaboration with the University of Dar es Salaam in 2013. The so-called Electrical bicycle - popularly known as e-bike-, which

has gaining popularity in the Western society, but isn't within reach price wise due to an average price of €1800 for a large part of the Tanzanian population, served as inspiration for the creation of the human energy concept called RiziQi. While the e-bike is used to support the bicycle rider during pedaling the students reversed engineered the so-called HUB motor that is part of the e-bike system. This causes the motor - now used as a generator - to be driven and thus to generate energy. A charge controller is included in the electric circuit to protect the batteries (240Wh) from getting damaged. A charge controller also displays the status of charging. The energy is than stored in the batteries, which in turn can be used to provide energy for several appliances (see figure A.1 : Depiction of RiziQi system). The first test executed by the University of Dar Es Salaam with prototype 1.0 showed that charging the batteries took 45 min of normal cycling in stand alone position. (see figure A.2: charging time RiziQi)

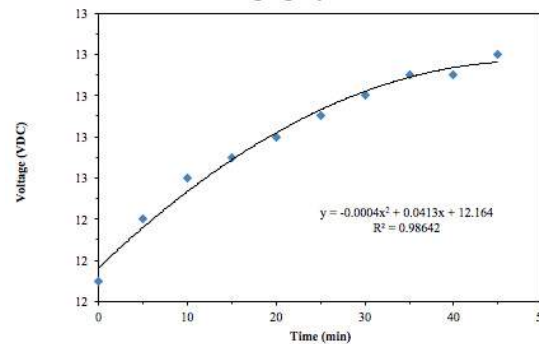


Figure A.1: Charging time RiziQi

### A.3 USE SCENARIO(S)

The vision for the concept of RiziQi was to become part of a product-service system that offers the rural communities an opportunity to store and share energy. One of the main elements of the vision was to also make the system hybrid so that the system could be used in conjunction with other clean alternatives, such as solar technology, which could lead to the amplification of the current use of clean alternatives. The main benefit being that human powered energy is always available and allows for possibility of generating a relative great amount of energy in a short amount of time. The team had the following use scenarios in mind:

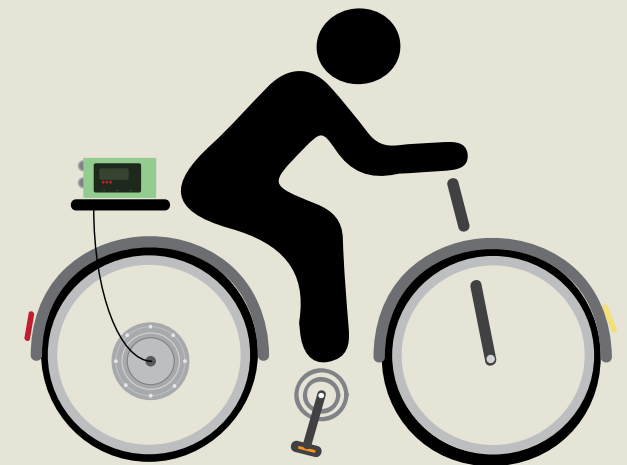


Figure A.2: Depiction of RiziQi system

As part of the further development the use system would have to be reviewed, next to the technology. Due to the high cost and thus selling price (€200) of RiziQi the team imagined the system to be used (1) or shared (2) within one community. These two use scenarios seem the same, but have one fundamental difference.

(1) In the first case one entrepreneurial individual who is fortunate enough would purchase the system and subsequently either charge the 240Wh batteries, from where a splitter could be placed to charge smaller appliances. He could also have the opportunity to directly charge smaller appliances. This is similar to how it currently works when a person in a village has a solar panel. In the second case each member of the community pays for the purchase of RiziQi, meaning there will be a sense of ownership and thus responsibility through social control. In this case RiziQi would be either placed somewhere within the community where everybody has access to it. This situation would be comparable to the use of water wells. Community members currently in peri-urban villages have access to this. Each of them have a small energy storing device which can be charged through cycling.

(2) Another option would be to have shared ownership with each community member watching over and taking care of the system for while.

(3) The last option in this category would be determined by the local social cultural situation, which could mean that even though everybody paid the most important social cultural figure or the person prone to innovation in the village would “own” and manage the system’s use. Within this sharing system it would also be possible for the (opinion) leader to be responsible for charging small capacity storing devices which can then be shared within the community.

The team expected the strongest business model to be selling to one person in the community, who would be responsible over the system and a certain amount of energy storage devices. Next to that each member of the community would have the ability to buy extra energy storing devices. Note that there was awareness that this blueprint also was highly affected by the local social system, and prejudice could influence sharing practices.

#### A.4 FORESEEN IMPACT

As extracted and summarized from Sumter and Zandvliet (2013) in their PowerHub report impact on the following levels could be expected:

On a personal level RiziQi can impact a person’s life due to the fact that more productive hours are offered through access to a healthy source of light. Having permanent access to electricity anywhere and in a short amount of time also can be an incentive for entrepreneurship, fulfilling profit on the people, planet, profit triangle. The people themselves health wise benefit from using RiziQi, as it will offer a form of physical exercise, which contributes to people.

Creating jobs in rural areas is the key according to [Alliance for Rural Electrification \(n.d.\)](#) to preventing mass migration to the urban areas. According to [Grid-Arendal \(2013\)](#) “about 70 per cent of urban residents in most cities in Tanzania live in unplanned settlements, slums or squatter areas”. As stated before a relation could be cited between fulfilling basic needs and access to electricity, making this a social impact that RiziQi would have. Analyzing the figures of the ever expanding population in developing countries in relation with the fact that 90% of the population in Tanzanians use biomass as their primary energy supplier the benefit to the planet of using RiziQi can be recognized as well. RiziQi could be used as a replacement for all these non sustainable energy sources, which cause climate change due to CO2 emissions. Note that as to date RiziQi is not fully developed and piloted, a thorough impact assessment needs to be done to determine whether these hypothesized assumptions are correct.

#### A.5 LIMITATIONS

Due to the fact the product was created first and the implementation possibilities were looked at from there the innovation can be typified as technology push. The system doesn’t attend completely to the needs of the population. Copying solutions to fit in BOP markets, by just offering a cheaper solution cannot happen one on one. A careful consideration of the (cultural) context is necessary to be able to successfully implement a new solution in the BOP market. It is essential to get a deep understanding of the local situation so that a product (service system) can be made that is accepted according to the local needs. Besides, the expected cost price of €200 isn’t competitive enough looking at competing clean alternatives. Energy storage makes up a large part of this price, which makes it even more eminent to investigate how energy storage can be made more affordable. Next to being expensive the design has its functionality limitations being that energy generation can only be done in stand alone position as pedaling to move forward and to save energy will put a strain on the body of the cyclist. Looking at opportunities to amplify the functionality and make a new design, which is usable in more cases is therefore

key. Moreover regarding the design the (affordable) storage of energy will be the core part of giving people the ability to run small appliances, while not having to keep peddling. Finding out which appliances are essential in the daily lives of the target group will form the serve as a base to understand what the properties are of the energy storage that needs to be made. Last but not last, the distribution of the product (service system) in rural off-grid areas in developing countries forms a bottleneck. Contextual research needs to be done to get more acquainted with the infrastructure and design a strategy to overcome the obstacles that this currently poses. This results in an assignment, which poses the researcher work in a solution space in which difficult tensions will arise when choosing for one or the other solution.

## A.5 (RE)DESIGN

As a starting point the technology of RiziQi was studied to see whether a pricereduction could be possible. This was seen as the most imminent aspect of the concept. If scaling down the costs of the system was not possible the concept would be discarded. Aim was to keep the same efficiency rate: charge two 120 Wh batteries in 45 minutes. The scope was to charge during an activity as this would differentiate the concept: there are already a wide range of products with inter alia crank, pulling and pedaling mechanisms which can only be used without simultaneously engaging in another activity.

The human energy concept was kept in mind and different routes were explored:

1. A system that could be used to charge while walking and while cycling. This idea was discarded as charging while walking would be extremely inefficient. The system would have to be small, otherwise the strain on the body would be too much. In case it would have to be kept small the efficiency would be low. Next to that the charging while walking could only be done with a linear magnetic induction conversion mechanism i.e. with the use of magnets moving up and down inside electric wiring. As this movement is short and thus needs to happen fast e.g. by shaking this was not within the scope. Next to that combining this linear conversion mechanism with a rotational mechanism such as that of a generator would lead to loss in efficiency, according to Richard Bekking (employee IDE Sustainable Lab).
2. Looking into energy generation through only walking would not contribute to the goal of creating enough en-

ergy for the charge of a phone, the radio and light, as it would mean barely enough energy for the light, according to Bernard Hulshof (SolarWorks). Investigating cycling only would be the best option.

3. As this opportunity was researched more often the following aspects came forward: the main components that made the price so high were the HUB Motor (€80 motor from Golden Motors, bought through Devi-Motion) and the two LifePO4 (lithium phosphate ion) batteries (roughly €100 each, bought through Devi-Motion). Although these type of batteries are the most energy efficient, because of their high energy density, they are vulnerable as well: explosion, recycling, breakage. Moreover, the availability in Tanzania (and most other BoP countries) is limited. The thought was therefore to see whether replacing these two components would aid in developing a better design.

### A.5.1 HUB MOTOR TO DYNAMO

As a first thought the hub motor was replaced by a dynamo. While this led to lower costs, it resulted in a trade of: A dynamo generates a lower amount of energy, which is specifically meant for bicycle lights (6V/3W). Next to that a dynamo results in lower efficiency as the regular dynamo works with a rubber wheel that is pressed against the bicycle wheel; friction causes energy to be generated, but also results in heat generation and thus energy loss. Using another “bigger” motor meant the same problems as the rule of thumb is: the bigger the dynamo the heavier it is to cycle. The cyclist puts in energy to move forward as well as energy to be save in a battery in case energy has to be saved while he is cycling. Therefore, only instances in human energy concepts in which such a solution was used is when the bicycle was used in stand alone situation. Resulting in the best option to being to keep the hub-motor or develop an own specific motor for this cause.

### A.5.2: LIFEPO4 TO POWERBANK

In the line of developing a more affordable solution there was looked at a energy storing solution that is currently available in the context and affordable enough. This resulted in a power bank. Note that lead acid batteries were even more common, but will not work in conjunction with a dynamo. In line with this solution a prototype was developed with which a power bank could be charged. Even though this worked the fact that the dynamo produces a low amount of current resulted in the charge time being long: over 6 hours for a 2200 mAh power bank.



Image A2 : AmlaDesigner (Jeroen Spoelstra and Boukje Vastbinder) visiting the University of Dar Es Salaam. Picture made by members AmlaDesigner



Image A3 : Linear Generator (prototype) for generating energy when walking

#### A.6 CONCLUSION

From this there can be concluded that developing a more affordable version would not be feasible. While it is possible to offer a concept working with a dynamo charging a power bank, this will take over 6 hours to charge. Next to that cycling with a dynamo is and feels heavier. The only possibility would be to develop a motor specific for this cause. As this designer foresees that engaging in this would mean high investment with as a result a product that is more out the reach of the target group as the cost will be passed through to the clients when the product will be sold. This opportunity was therefore regarded as not feasible.

Furthermore, from an ethical perspective this was regarded as not being the right direction to go into. The fact that people are without access to electricity does not mean that they should offered a product with low efficiency, Certainly, not if they also have to invest their time and energy in it. This would not be worth it and this this concept was regarded as not feasible.



Image A4 : More affordable prototype of RizIQi. Working with dynamo and charging a powerbank)



Image B1: Prototyping Process

## APPENDIX B: CONCEPT GENERATION AND PROTOTYPING

In this appendix the evolving steps of the different concepts can be found together with a depiction of the ideation. The depiction of this process starts with Richard Bekking's comment about other alternatives, such as working with heat, Stirling Motors in particular. From this the process led to steam generators and eventually to the proposed concept of LITA, which is translating the heat the temperature difference directly into energy.

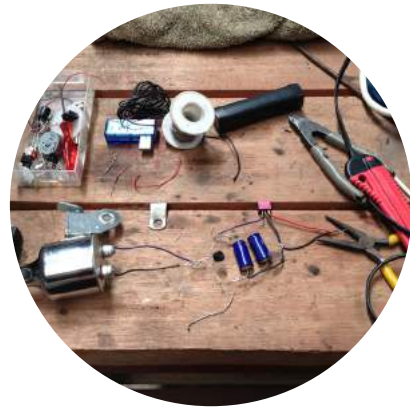
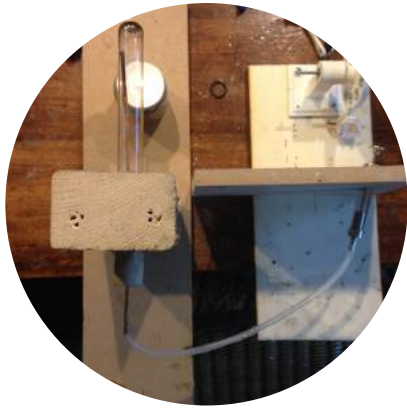
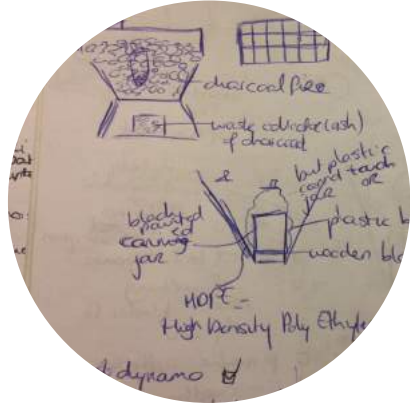
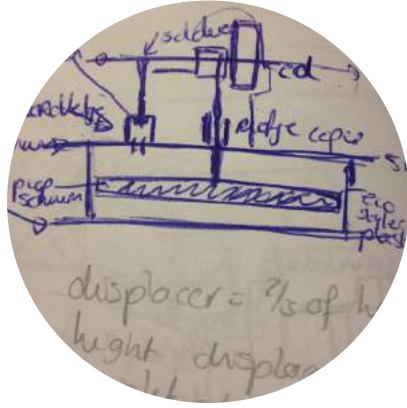
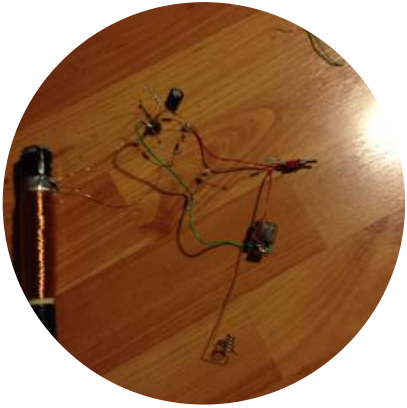
The process that was followed was iterative, meaning that in each different ideas were generated for a certain kind of technology. The Stirling motor for example could be executed in different kind of shapes. In one cycle different types of Stirling were tested and there was a switch between thinking out ideas on paper and physically making them: rapid prototyping.

This design style was chosen as apposed to the linear cycle, because the research was new to the domain and wanted to make sure that a concept was working.

A final decision about the concept was made when all technology questions could be answered to satisfaction of the designer and met all the criteria points that were set up.



Image B2 : Ideation, Conceptualization, Prototyping and Testing cycle



## APPENDIX C: INTERVIEW GUIDE USERS

The design researcher combines user-centered, customer centered research and business research (Appendix E: Conducted Business Interviews). Collecting data from different sources can be a challenge to make sense of. However, it also ensures the ability to triangulate findings and therefore offer a more complete answer to the research question.

“Which alternative energy generation opportunity for the clean energy market would entail the most feasible product-service system and what market introduction strategy should accompany it”

This research question is answered by applying different research approaches and methods. Note that there is an interplay when answering all the sub research questions (section 1.4: Research Questions), meaning that there won't be sole observation, analysis and conclusion but the optimum answer to the different question should be sought, instead of the best answer for each answer separately.

As the field research with the interviewees was conducted through the use of the research methods observations and interviewing the questions are split according to that. Some questions were both asked and observed so that discrepancies could be found. As a guideline for setting up an interview guide the advices from Patton (2002) and the IDEO Human Design Toolkit (2015) were used.

### C.1 INTERVIEW GUIDE

#### C.1.1 OPEN SPECIFIC

- What is your name?
- What is your age?
- Can you tell a little bite more about yourself?
- How many people live in this household?
- What are your daily activities?
- How do you get your income?
- Do you have any other sources of income?
- How is your household build?

#### C.1.2 GO BROAD

- Who makes decisions?
- What are the main electronics appliances that you use currently?

- How do they get this/How do you purchase new products? (Asked).
- What (other) products do you share?
- What kind of heat sources are you using currently?

#### C.1.3 PROBE DEEP

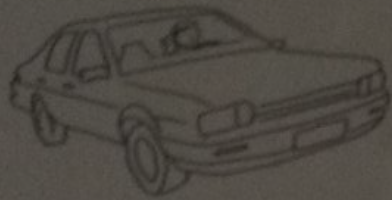
- What kind of energy (specifically electricity) sources are you using currently? Why? How does it work?
- Are you aware of any health effects of polluting materials? (Especially if they don't use it!) What do you know about clean energy? About solar?
- What do you struggle with using your main source?
- What are your future prospects regarding electricity use?
- After explaining the prototype? What do you think about this concept? Do you have any questions? Do you see any benefits. How do you think you could use it daily?
- What are your future aspirations in life? Using the cards.

### C.2 OBSERVATIONAL QUESTIONS

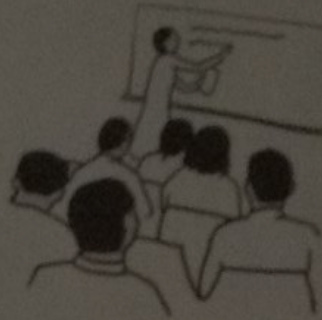
- Where do they live (immediate surroundings)?
- How do they interact with each other?
- How is their daily live composed?
- What products do they have in their household? How do they get this? (To be able to indicate their (real) purchasing possibilities in contrast with purchasing ability based on desk research)
- What (other) products do they share and what can the researcher learn from that to replicate in the concept?
- What are specifically their current energy generating/storing practices? Why?
- What are the main electronics appliances that are used currently?
- How do the villagers deal with energy storage? Is it based on charge now and use later or charge when needed?
- How is the village build up? On village level and household level?
- How does female/male roles play a role (to what level can a women be an entrepreneur?)
- How to identify opinion leaders? What role can this person play in setting up and selling the concept?
- What kind of heat sources are they using currently?
- How are cooking practices in Tanzania?



CAR  
GARI



EDUCATION  
ELIMU



LEARNING  
SIFUNZI



LIGHT - ELECTRICITY  
MWAASA



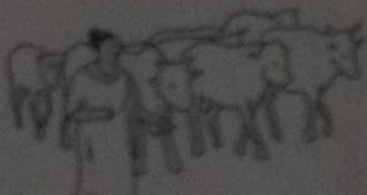
ACCESSIBLE  
UHTAFU MATAJI



PART OF COMMUNITY  
NDANI YA JAMII



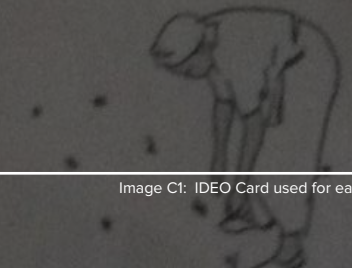
UPASAJI  
ANIMAL GARDEN



MOTORCYCLE  
PUMPAZI



CULTIVATING / AGRICULTURE  
LIKULIMA



## APPENDIX D: DATA EXTENSION USERS

Observations were done of the village by the researcher in the form of small informal talks with the identified opinion leaders, village chiefs and sit down interviews with selected village members.

The choice for small informal talks with opinion leaders and village chiefs was part of the research/design approach called Hidden Design (Tomico, Winthagen & Heist, 2012). This is a systems design approach in which the designer places himself in the community, becoming part of it and designs from inside out, basically instead of other research methods like co-designing or designing only based on desk research. When following these approaches, the studied group will be part of something which is researched (so looking in from the outside). Next to that this can contribute to answers that are richer as an extended interview set-up can make the interviewee feel that he/she has to answer to give the "right" answers. Interviewees are paraphrases based on written down notes during interviews.

### D1 INTERVIEW ANSWERS

During the interviews Data was collected by directly writing along with what the interviewees said. The interviewees and the notes are depicted in this appendix.

#### D 1.1 JANUARY KAYOMBO (JOLEEN FAMILY)

DATE 16/12/2015 11 AM

##### OPEN SPECIFIC

- What is your name?  
January

- What is your age?  
36

- Can you tell a little bite more about yourself?  
I am January. I am a safari guide working mainly in town. I am a widower, my wife passed away in September (2015). I live here together with my cousin.

- How many people live in this household?  
2. People permanently; my cousin, who I took in and I live here.

At the time the researcher was there she stayed in this house as well together with the interpreter for the first week of the research. The little brother of January, his wife and child also stayed there during this time making the total amount of people 7. Often other friends stay here as well until they get back on their feed. Next to that my daughter comes by sometimes. She stays in Dar Es Salaam with

- What are your daily activities?

On days that I have a safari I am out of town working e.g. driving a car with clients the whole day. On other days I am here overseeing the builders so they can finish the house.

- How do you get your income?

Mainly from my work as a safari guide. My cousin doesn't work (at the moment). I like to do things myself.

- Do you have any other sources of income?

No. Not at all.

- How is your household build?

I basically take care of everything or I delegate what has to happen. For example, my cousin needs some instructions so I tell him what to do e.g. fetch water, cook, go get some groceries etc.

##### GO BROAD

- Who makes decisions?

I make decisions, because I'm the one with an income. Before my wife used to decide together with me. My daughter also had a big influence on me. For her I do a lot. She motivated me to go and start building my own house.

- What are the main electronics appliances that you use currently?

My smart phone to communicate about safaris. Next to that I have more appliances such as light bulbs from my solar panel connection. I own a television, stereo installation and I have a fridge, but it doesn't work at the moment. I need a bigger panel for that to work together with an inverter. In the future I would like to expand to a 200W solar panel.

- How do you purchase new products? (Asked)

My friend living in the other area had it and he told me about how nice it is. So I decided to look into it and ask Mobisol some questions. Than I purchased a 120W solar panel after having saved for a while. I am paying in installments.

- What (other) products do you share?

There is not really that much sharing. Whenever somebody needs help, they can ask me. That is how I got this land. I helped somebody here to pay school fees for her son and as a thank you she gave me this piece of land. So than I decided to start building here. This helped me really find my place in the community.

- What kind of heat sources are you using currently? Gas for cooking and charcoal whenever the gas is finished or when we cook beans, because it takes a long time.

PROBE DEEP

- What kind of energy (specifically electricity) sources are you using currently? Why? How does it work?

A solar panel from Mobisol. I don't have a connection to TANESCO.

- Are you aware of any health effects of polluting materials? (Especially if they don't use it!)

Yes, that is why I don't like to it. Only solar and gas.

- What do you know about clean energy? About solar? Solar panels are good to use, but I choose this because TANESCO is more expensive and not reliable.

- What do you struggle with using your main source? There is not really a struggle. The panels are good. During raining season, the electricity lasts shorter, but I already knew that.

- What are you future prospects regarding electricity use? I want to expand to a 200W solar panel: add more bulbs through the whole house and connect the fridge.

- After explaining the prototype? What do you think about this concept? Do you have any questions? Do you see any benefits. How do you think you could use it daily? Not really questions. I hope it can work for others in the community. I have to see more about it and it working in real life.

- What are your future aspirations in life? Using the cards.  
Piki Piki As means of transport  
Car Also as means of transport. I already drive one as part of my job. The next step is owning one. Although I value a house



Animals

Cultivation  
Education

Electricity

Water

more than a car, because this provides me with a roof over my head. To be more independent. Growing my own food.

The same for the animals  
For myself and for my child. I want to gain more information and always learn more about the world around me. I want to have more of this. Certainly light is the most important as this enables me to see at night and study.

So I do not have to fetch water from the wells anymore. I want to see if I can dig a hole in the future and pump up the water to my house.



Image D1: January Kayombo and his main energy sources and products

## D 1.2 OSWALD (AMANDA FAMILY)

DATE 17/12/2015 1 PM

### OPEN SPECIFIC

- What is your name?  
Oswald

- What is your age?  
28

- Can you tell a little bite more about yourself?  
I'm Oswald and I'm working as a fundi (handyman/technician) in this village.

- How many people live in this household?  
3. My wife, me and my daughter Amanda.

- What are your daily activities?  
I sometimes work on my land and whenever I get a job (when a house is build), I wok as a handyman. My wife runs the household and sometimes she braids hair from women around here.

- How do you get your income?  
From working as a fundi. I also sometimes sell things from my piece of land, but now I want to sell the piece of land.

- Do you have any other sources of income?  
No, not really.

- How is your household build?  
My wife does all the activities in and around the house. I work outside the house and get the money. Whenever everything is established better, she can also participate in generating income. For example, through braiding hair.

### GO BROAD

- Who makes decisions?  
I make decisions. I talk to my wife, but in the end i decide.

- What are the main electronics appliances that you use currently?

My phone is very important, because when I don't have a phone I cannot communicate with other people or for example get work and if I don't get a job there is no income. Also when Amanda grows up she needs to study and now we only have kerorsene so I want something better, like solar or maybe a connection to TANESCO.

- How do you purchase new products? (Asked)  
I saved and bought it, like how I did with my new house. I'm saving bit by bit to try and get enough money and finish it.

- What (other) products do you share?  
We do not really share, maybe food. But mostly everyone in the community is struggling so we try to take care of ourselves and than we can help others.

- What kind of heat sources are you using currently?  
Charcoal for cooking.

### PROBE DEEP

- What kind of energy (specifically electricity) sources are you using currently? Why? How does it work?  
I only have a kerosene lamp. No electricity. When I need to charge my phone someone has to do me a favor or I need to charge it at a shop, which also costs money.

- Are you aware of any health effects of polluting materials? (Especially if they don't use it!)  
Yes, but I cannot really switch so there is no way out of this situation.

- What do you know about clean energy? About solar?  
I don't know the other things you named (wind and water), but I do know Solar. Some people that I know have solar. I also would like to save to get it. It is good, because it is more reliable than TANESCO.

- What do you struggle with using your main source?  
There is not enough money to buy charcoal and kerosene is very expensive.

- What are your future prospects regarding electricity use?  
I hope to get a connection to TANESCO, but the main connection is quite far from my house. A solar connection is also good with light bulbs so my daughter can study.

- After explaining the prototype? What do you think about this concept? Do you have any questions? Do you see any benefits? How do you think you could use it daily?

I don't think too much. I think that there can be benefits, because you are not depended on solar, but I want to see more of it. How long does it take to charge? Can you use it for your fridge? Will it be outside? I want to see that and than we can talk more about it.

- What are your future aspirations in life? Using the cards. In this instance the cards were not used.  
I want to have a good future for my family. So my wife can also work and we both can have a good income



Image D2: The Amanda Family and their main energy source (kerosene)

### D 1.3 IRENE (MAMA LAWRENCE)

DATE 28/12/2015 10 AM

#### OPEN SPECIFIC

- What is your name?  
Irene (Mama Lawrence)

- What is your age?  
28

- Can you tell a little bite more about yourself?  
I'm Mama Lawrence, I have two children and a husband. We live here together and I have a shop.

- How many people live in this household?  
4 people. Me, my husband and our two sons from 8 and 1,5 years old.

- What are your daily activities?  
I wake up to feed my youngest son, Lewis and prepare breakfast. I then open my shop and start selling things whenever people come by. During the day I can do the household activities, because my shop is next to my house. .

- How do you get your income?  
From my shop and my husband is driving a boda boda (motorcycle tax), so he goes out to get clients and drive them up and down.

- Do you have any other sources of income?  
No, only from my shop and from the boda boda business.

- How is your household build?  
I have responsibility for all the household activities. My husband goes out and work. During the day I run the shop and do the household activities so I go up and down to the shop. My oldest son goes to school.

#### GO BROAD

- Who makes decisions?  
I make decisions myself when it's about my shop. For things about the children I discuss with my husband and we decide together. Other things are decided based on the income of my husband, but I just ask him to assist and he gives me money.

- What are the main electronics appliances that you use currently?

My phone and the light bulbs, but I wish I could have a fridge to store stuff save and an oven to cook easily. My phone is important, because I can communicate with my husband. The light helps my son to study at night and give light in the house, In the building of my shop I don't have light, which is very annoying because when I sell things at night it's dark and I need to use a small (solar powered) torch. When this torch did not charge enough I need to use my phone's torch, so than I don't have both of my hands free. I also use the radio so I can listen to music and hear the news.

- How do you purchase new products? (Asked)  
For my phone I saved an with the help of my husband I was able to buy it. My solar panel... I saw somebody else had is so I talked to her and than I decided I also want this so the company (M-Power) came by and than they told me how it worked and installed it.

- What (other) products do you share?  
In this community we do not share really. Sometimes based on if I trust someone I can give them products from my shop. This is only if I trust people or when I have the experience that they are honest people. I also participate in kibati (sort of insurance fund in which people put together money monthly which goes to one of the persons every month.

- What kind of heat sources are you using currently?  
Charcoal for cooking and kerosene sometimes. When I cook something that takes long, like beans I use wood. Mainly I cook with charcoal, though.

#### PROBE DEEP

- What kind of energy (specifically electricity) sources are you using currently? Why? How does it work?  
I use solar panels from M-Power, because than I can have light and I pay a small amount of money each month. I want to use this small thing first and than get connected to TANESCO. For each light bulb to you use you pay 350 TSH per day. It works with a power box, which I can use to make my payments and to connect extra bulbs to. The panel is on the roof.

- Are you aware of any health effects of polluting materials? (Especially if they don't use it!)

Yes, but I do not have enough money to switch to gas for cooking. I also know that Kerosene is dangerous, but it is fast for cooking.

- What do you know about clean energy? About solar?

I don't know much. Only about solar: it is easy. They install it and I have it. With the other sources like solar I struggle, because I cannot always use it.

- What do you struggle with using your main source?

My solar panel is working, but not always. In the raining season the light bulbs do not give enough light and we even have to spare. Charcoal and kerosene are expensive. Kerosene costs 2400 TSH per liter and I can use it for a short time. Wood I can pick, but sometimes I use to buy it. It costs 7000 TSH per bundle and I can use it for 2-3 weeks.

- What are your future prospects regarding electricity use?

I hope I can get access to bigger electricity products so I can charge my phone here as well. It can be through connection with TANESCO or a better solar panel. The connection with TANESCO is close so poles in between are not needed, but I think it is very expensive.

- After explaining the prototype? What do you think about this concept? Do you have any questions? Do you see any benefits? How do you think you could use it daily?

Ok. That is interesting. Good that you are thinking about helping us. So how much wiring does something like this need? For how many people can you use it? I would like to have one for my household only.

- What are your future aspirations in life? Using the cards.

We already rent a boda boda, which my husband uses to get money. Next thing that I would like to own is a car so we can use it to go to church. I also would like to have enough money so we can build extra houses, which we can rent to others and make money that way.



Image D3: The Lawrence Family and their main energy sources and products

## D 1.4 NURWELLE (HENRIETTE FAMILY)

DATE 28/12/2015 12 PM

### OPEN SPECIFIC

- What is your name?

Nurwelle

- What is your age?

42

- Can you tell a little bite more about yourself?

My name is Nurwelle. I have 3 children (age 9, 13 and 16) and I live here together with my husband

- How many people live in this household?

5 people.

- What are your daily activities?

I help my husband with working on the land, but my responsibility is mainly taking care of the household. I also have recently picked up sowing.

- How do you get your income?

From the shamba (farm/cultivation) that we have. We also have some animals (cows and chicken), which we we keep in the sheds around our house. We sell the milk of the cows and the eggs of the chicken.

- Do you have any other sources of income?

No, nothing else.

- How is your household build?

What I said. I work around the house and help my husband. My husband had the core responsibility of working on the land. Also on the land that lies further away from our house.

[Husband comes back from the land and joins in the conversation]

### GO BROAD

- Who makes decisions?

We decide together actually. I mostly decide about the household budget and whenever something big needs to be bought we talk about it and decide.

- What are the main electronics appliances that you use currently?

Mainly the light actually, because our children need to study. We also have a radio that works on a battery and our phones.

- How do you purchase new products? (Asked)

About the solar panels. I saw that my friends had it and they told me that it was good. From there I called the company and they came to explain more and than they installed it.

- What (other) products do you share?

Sharing is possible sometimes. We share food with others whenever they don't have it or as part of a thank you. We really feel connected and part of the community so this makes is willing to share and help, because others help us too.

- What kind of heat sources are you using currently?

Charcoal, kerosene and wood for cooking.

### PROBE DEEP

- What kind of energy (specifically electricity) sources are you using currently? Why? How does it work?

M Power solar panels. We have three bulbs connected. It only works for light. We have to pay every month through the box that is connected in our house. We also use charcoal and kerosene for cooking. On all of this we spend about 60.000 TSH each month: M-Power - 15.000 TSH, kerosene 5.000 TSH and charcoal 45.000 TSH.

Tanesco is to expensive. We have to invest in buying a pole to get a connection to our house.

- Are you aware of any health effects of polluting materials? (Especially if they don't use it!)

Yes, but we have to deal with the situation as it is. We cannot really change anything about the health risks,

- What do you know about clean energy? About solar?

I hear mainly things about alternative ways like solar from other people. I don't know so much about other things.

- What do you struggle with using your main source?

We can buy and use kerosene, but it doesn't provide enough light so we don't use it for lightning. Now we use solar, which we can only use for lightning not to charge our phones. So this means that we still have to charge our phone with a friend or bring it somewhere outside the community to charge it and



pay 200 TSH. Also the solar lights are not bright enough: our children often complain that the light is not bright enough.

- What are your future prospects regarding electricity use? Now we do not own a television or a radio that works on electricity from “the wall” so hopefully we can expand and get a bigger and better solar panel that will make that possible.

- After explaining the prototype? What do you think about this concept? Do you have any questions? Do you see any benefits? How do you think you could use it daily?

We want to see results first than we can ask questions. We think that we would use something like this together in our own household. Not sharing it, because each household has its own management so this can result in problems.

- What are your future aspirations in life? Using the cards. In this instance the cards were not used.

House As part of the future and to give to our children

Renting Build a house and rent it out as a source of income.

Piki Piki A motorcycle: this is easier for transport.

Car We are getting old. If we have a car we can use it to go to church. Also we can use it for immediate transport and we will not be dependent on others anymore.

Light For our children to study with at night. The light we have now goes out in the middle of the night.

Radio A better radio to get information. TV would be even better

Fridge To store our food.

Phones For children to communicate.



Image D4: The Henriette Family and their main energy sources and products



## D 1.5 RISPA THOMAS (FRIDA FAMILY)

DATE 28/12/2015 2 PM

### OPEN SPECIFIC

• What is your name?  
Rispa Thomas

• What is your age?  
I was born in 1952 (64)

• Can you tell a little bite more about yourself?  
I'm Mama Frida. I have 5 children (4 boys and 1 girl). They all left the house and are married or living on their own, except, the youngest one: my daughter Frida. She goes ended form 4 and stays home to help me around the house. There is no possibility for her to go to school, because there is no money. My grandson also lives with use. My husband passed away.

• How many people live in this household?  
3. Me, my grandson and my youngest daughter.

• What are your daily activities?  
I wake up and take care of my children. My daughter helps me with my activities during the day.

• How do you get your income?  
From working on the land.

• Do you have any other sources of income?  
No, no other means.

• How is your household build?  
I am the boss in the house and work outside of the house. My daughter helps me with the household tasks and takes care of my grandson.

### GO BROAD

• Who makes decisions?  
I make decisions. When my daughter wants something she should come to discuss this with me.

• What are the main electronics appliances that you use currently?  
My phone and the radio to listen to news. Also we have 4 light bulbs, because of our connection to M-Power Solar panels.

How do you purchase new products? (Asked)

For my phone I saved and bought it, but for the solar panels I saw someone else had it and we talked about it and she convinced me to get it. Than the company came and they installed it for me.

• What (other) products do you share?

We share many things, but not money. I mostly share between friends. So really people that I trust. Also I am part of the community, so I am supposed to share what I have and when I can. So it depends on if I can share as well. I don't have savings or an additional budget so I need to be aware of myself as well.

• What kind of heat sources are you using currently?

Charcoal for cooking, Wood, but just a little bit. Kerosene a lot and we have a small gas container. This costs 22.000 TSH for the small one.

### PROBE DEEP

• What kind of energy (specifically electricity) sources are you using currently? Why? How does it work?

We have connection to M-Power, so we use solar panels. We pay about 15.000 TSH every month for the light bulbs that we use.

• Are you aware of any health effects of polluting materials? (Especially if they don't use it!)

Yes. I know, but sometimes I do not have another choice so I just use the kerosene or wood.

• What do you know about clean energy? About solar?

I don't know more things. Actually only solar, because other people talked about it and so we share knowledge about it.

• What do you struggle with using your main source?

I don't really have problems with it. Sometimes the light is not bright enough and I cannot always pay to have energy so that is only a problem. So sometimes there is no way out, so then for example my phone is not charged. So I have to pay to get my phone charged or ask others in the community.

• What are your future prospects regarding electricity use?  
I hope to get a better chance so I can have electricity.

• After explaining the prototype? What do you think about this concept? Do you have any questions? Do you see any benefits? How do you think you could use it daily?

I do not have any questions. I can only say make it work for us. I don't know yet if I would like to share something like this. It depends on the situation.

- What are your future aspirations in life? Using the cards, work and we both can have a good income

Different cards chosen were: Television, Rent, own house, motorcycle and light. Explanation:

Radio - We use this now for getting information about the news. Having a television is nicer, because you can get the images as well. Also you can have more sorts of information.

Rent - Now, my only income is from the land. I also have too much land. If I can build houses on it, I can rent this to other people.

Own House - Our current house is made out of material that is strong enough (clay) so I would like to have a cement house.

Motorcycle - We can use this for transport. For example to go to work.

Light - Having light that is bright enough.

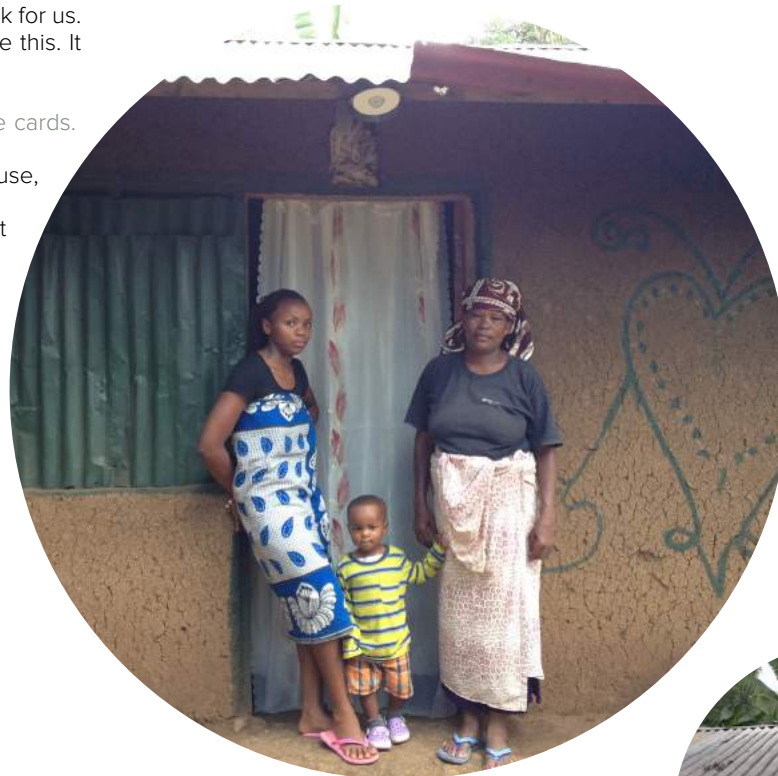


Image D5: The Frida Family and their main energy sources and products

## D 1.6 ISSA (CHADEMA FAMILY)

DATE 06/01/2016 10 AM

### OPEN SPECIFIC

• What is your name?  
Issa

• What is your age?  
26

• Can you tell a little bite more about yourself?  
My name is Issa. I am the mother of Chadema (3 years old) and Jusra (10 months old).

• How many people live in this household?  
5 people live in this one room house. I live here together with my mothers and her boyfriend. We live here in a one-bedroom house. My boyfriend left me while I was pregnant of our second child so I have to do everything for my children alone.

• What are your daily activities?  
Waking up, taking care of my children and doing household chores.

• How do you get your income?  
My mom gets fish from the market in town (central market). We fry that and sell it at night. We also make more snacks (sambusa), which we sell at night. My father does not have a steady job. He is trained to be a fundi, but at this point he just tries to do different things so at least we have some money to eat and pay rent.

• Do you have any other sources of income?  
No, only what I already told.

• How is your household build?  
I stay at home or in the community to take care of my children. My mother helps me with that. Whenever we have enough money to go to the market and by some supply my mom or I go to town. My father goes here and there just to find something he can do to earn some money.

### GO BROAD

• Who makes decisions?  
We decide democratically. Our family is quite young (my mom is 44 years old), so we talk about making our own decisions, but my mother and I are mostly in charge of the money that we earn and spend from the sales as all is focused on spending for the family.

• What are the main electronics appliances that you use currently?  
Our phones. My mother has a phone, but it is broken. My father has a phone but it often is out of charge.

• How do they get this/How do you purchase new products? (Asked)  
Trying to save some money.

• What (other) products do you share?  
We do not have enough in money to really give to other people. Sharing only happens for us during funerals, but even than it depends on whether we have money or not. We participate in a kibati group in which money is laid away every month. That is how we know that at some point, when it our turn, we can get a larger sum of money. As for being part of a tight community: we do not really feel that we are part of it, because we just got here and we live a bit further from away.

• What kind of heat sources are you using currently?  
Charcoal and kerosene for cooking.

### PROBE DEEP

• What kind of energy (specifically electricity) sources are you using currently? Why? How does it work?  
We have a kerosene lamp and we also kerosene for cooking. Charcoal is one of the other sources that we use.

• Are you aware of any health effects of polluting materials? (Especially if they don't use it!)  
No, not really, but even than there is not anything we can really do. This is the situation. I am scared that it will affect my child because most of the times by daughter is inside (carried on the back) with me when I'm cooking. We also cook later at night when the children are already sleeping. I am tired of being poor, but for now this is it.

- What do you know about clean energy? About solar? I don't really know about other alternatives. Solar also not really. Maybe a little bit.

- What do you struggle with using your main source? It is expensive. We spend 45.000 TSH on charcoal and kerosene per month.

- What are you future prospects regarding electricity use?

I cannot really think too far, but I hope that it will change. I cannot say how, because this is our situation so I cannot really hope too much.

- After explaining the prototype? What do you think about this concept? Do you have any questions? Do you see any benefits. How do you think you could use it daily?

I don't know. I would like to see more of it and really see the application of how it works.

- What are your future aspirations in life? Using the cards.

Telephone I would like to own a better phone so I can get more information and can communicate better with friends and family.

Television This I would like to have for entertainment, like how other families look at television. Also I can receive news in visuals.

House Now we are renting this one room house and we live here with 5 people. It would be nicer if we can own our own house so we can have it for ourselves.

Light This might be obvious, because you see us at night with our kerosene lamp (researcher went by at night to buy some sambusas before). It is not good for out health and the light is not good enough.

Car We only walk or go by bus so having a car is nice. We will have our own transportation then.



Image D6: The Chadema Family and their main energy sources and products

## D.2 OBSERVATION ANSWERS

Through conducting observations and engaging in in-context immersion the observational questions could also be answered.

- Where do they live (immediate surroundings)?  
Arusha Sinoni. This is a semi-urban area 3 km from the city center, which has been expanding and turned into a conglomerate of Arusha Town. The area is the perfect .... between the crowded town area and the real rural area. People living in this area often own pieces of land, which they can use to cultivate vegetables and fruits and keep hurdles of animals, like (milk) cows and chickens (for eggs).

- How do they interact with each other?  
Main source of communication is through the phone or by visiting each other. To get outside information (news) the radio is used, but the main aspiration is to own a television.

- How is their daily live composed?  
The daily lives for the women is mainly composed of working on the land and taking care of the household. Depending on the opportunities that they've got the women sometimes owns and runs a shop or sow clothes. The men also work on the land, where they are responsible for the heavy duty tasks. Whenever possible the pieces of land are used to build houses, which are rented out to others who cannot afford their own home (yet).  
In one case the man owned a motorcycle, which allowed him to work as a boda-boda driver (motorcycle taxi).

- What products do they have in their household? How do they get this? (To be able to indicate their (real) purchasing possibilities in contrast with purchasing ability based on desk research)

Cooking: Kerosene Lamp & Cooker | Chuckle Cooker  
Gas burner

Electricity: Solar Panels (bulbs) | Box from Solar Provider ← Prepaid paying of electricity access or paying of in installments

Sleeping: Bed

Living Room: Furniture

Communication: Phone | Radio  
Shower & Toilet are outside the house mostly

- What (other) products do they share and what can the researcher learn from that to replicate in the concept?

Workshop tools to set up furniture.

Water - Government wells are available and wells dug by some families around the Sinoni area. The latter well is free to be used by community members but the family is free to close it whenever they want, because they are the ones who dug the well and who "own" it.

Money - This is shared between the people whenever there is a funeral or when someone within the community is getting married. During the ceremonies money is collected from all attendees.

Insurance - Money is shared in the form of a sort of insurance fund. A group of people (up to 10 people) put in an amount of money (around 40.000 TSH) every month, which is meant to support a different person every month. In case another person gets problems earlier on in the month the money is assigned to this person. In this way the community tries to form their own type of insurance.

When charging your phone at a shop you are required to pay 200 TSH (0,10 EUROCENTS). This mostly happens whenever you are somewhere outside the community. Within the community. When charging it within the community at a friend's place food or other local practices are shared.

- What are specifically their current energy generating/storing practices? Why?

Poorest Class: Charcoal or wood is for cooking and as a heat source during the night & Kerosene (used as a source of light in the evening)

Low Middle Class: Charcoal or wood used for cooking and as a heat source during the night & Kerosene (used as a source of light in the evening)  
Small Solar Panels are good enough to keep on lighting bulbs in the evening.

High Middle Class: Big Solar Panel (120-200W), which is paid of in monthly installments or connection to TANESCO with prepaid paying model.

- What are the main electronics appliances that are used currently?

Phone and (battery) radio.

Whenever possible a television (stereo) music radio and fridge (OL). The people that don't have this yet are at least aspiring to own this.

- How do the villagers deal with energy storage? Is it based on charge now and use later or charge when needed? Energy is stored in a battery or a power bank.

- How is the village build up? On village level and household level?

As this part of Arusha is still in development the houses are spaced out and everybody, who can afford it has his/her own pieces of land to build a house on. The type of houses is different, due to the amount of money each community member has access to.

- How does female/male roles play a role (to what level can a women be an entrepreneur?)

Around the house the tasks are clearly split up in such a way that the men mostly do the heavy work outside (on pieces of land, cultivating). The women in turn are mainly working in and around the house making sure that the household is kept in order and the children are fed. Women take it upon themselves to become an entrepreneur next to working in or around the house. Jobs that were fulfilled were shop owners, selling small snacks during the night, sewing and repairing clothes for people and braiding hair. While women can be entrepreneurs, mostly the men are the first to seek a job outside the house, when the men make enough money to help starting up the (small) business of his wife the women can also start working. This business is mostly run (from) close to the house, so the woman can also keep fulfilling her household activities.

- How to identify opinion leaders? What role can this person play in setting up and selling the concept?

In this case January. Kayombo was regarded as opinion leader. Within the community he is the person exposed mostly to innovations due to his work in tourism (safari guide/driver): he meets a lot of tourist visiting with for example new cameras and

phones. His work also gives him the possibility to have multiple electronics devices in his house. Television, Sound system, fore example through which he is exposed to more news. Opinion leaders can be recognized by this trait. They mostly speak English as well. Using an opinion leader and training him to be a change agent is essential in building trust and through this the ability to sell the product.

- What kind of heat sources are they using currently?  
Cooking: Kerosene Cooker | Charcoal | Gas burner

- How are cooking practices in Tanzania?

Cooking Practices depend highly on whether there is access to the cooking fuel or whether there is money for it. Most people therefore have different cooking stoves.

Cooking often takes up some time: when cooking beans it can take up to three hours until the beans are soft. Next to that the fuels used cannot be controlled, which results in waiting until the oil is hot enough for example.

## APPENDIX E: INTERVIEW GUIDE BUSINESSES

As the researcher wants to know whether it would be feasible to make a start-up from this concept, it's essential to learn from current start-ups and NGO's working in the market how they do things, find out which stakeholders could be part of starting up the business and assist in making this a sustainable business over time.

### E.1 INTERVIEW QUESTIONS

- State your name?
- From which company are you?
- What is your role in the company?
- How did .... start? (History)
- What kind of products do you sell?
- To which segment?
- How do you deliver after sales service?
- How do you make sure people pay?
- What kind of business model do you use?
- Which activities does .... have in hand?
- How do you create awareness / promote your products?
- What are the bottlenecks that you encounter?
- How do you identify new areas to go into?
- What do you think about my concept. Does it fit with what you do?
- What is your final advice to me?

The previous questions were answered through informal interviews, which were set up while in Arusha. Although the initial plan was to get in touch with different parties already, the Tanzanian culture depend heavily on referrals to others. Hence this path or research was narrowed down and whenever there was a person willing to engage in this research track the person would be interviewed. Setting up a creative session was hard to get all stakeholders together in one place.

The set up questions aided in answering the general questions that were part of the category viability.

### E.2 BUSINESS QUESTIONS

- Identify and estimate the size of the market?
- What are potential (in)direct competitors?
- How to positioning the product in respect to the target group and opposed to competitors?
- How can the informal economy be used as a manner to deal with distribution of the product?
- What (other) sales and distribution channels can be used?
- What strategy to apply to choose and use a channel effectively?
- How to get the product in the hands of the end-user?
- How to best set-up the after-sales service and reassure that end of life is dealt with in sustainable responsible manner?

The insights in companies and advices of company employees were used to form an understanding of what comes into play when you would start up a business in this market in Arusha, Tanzania. Data was translated into a business model (Osterwalder & Pigneur, 2011) and strategic market plan with the help of the Diffusion of innovation (Rogers, 2002) and more importantly (Moore, 2002).



## APPENDIX F: CONDUCTED BUSINESS INTERVIEWS

In this Appendix only the interview questions for the company interviewee will be answered as the other business questions stated in [Appendix E: Interview Guide Businesses I section E2](#) are already answered throughout the report. Some of the answers were not directly given by the interviewees, but could already be found on the company websites. The interviewees are paraphrased as the interviewer only wrote down notes.

### F.1 AISE-TWENDE DEBORAH TIEN

NB: AISE-Twende is not a company, but an NGO located in Njiro Arusha. The organization functions as an innovation incubator and helps turn good ideas into businesses. They set up their own projects, give capacity building courses, and welcome (young) Tanzanian people with good idea to join their workspace. The organization collaborated with MIT, which means that throughout the year there are a lot of student who come there and assist the projects.

- State your name?  
Deborah Tien
- From which company are you?  
From the organization AISE-Twende
- What is your role in the company?  
Director of Development
- How did .... start? (History)  
AISE and Twende were two separate entities, which have joined forces over time. MIT's D-Lab was looking to found an innovation center in Arusha and Bernard Kiwia, the founder of AISE had already founded AISE.
- What kind of products do you sell?  
Agricultural products such as a drip irrigation kit and a bicycle maize sheller.
- To which segment?  
To the agricultural community: farmers. Mostly focused on rural areas.

- How do you deliver after sales service?  
For the bicycle maize sheller there is a 2-year warranty in place.

- How do you make sure people pay?  
-

- What kind of business model do you use?  
Based on ownership.

- Which activities does .... have in hand?  
- Incubation of innovations  
- Making and developing innovations  
- Provide workshop space to innovators  
- Offering workshops

- How do you create awareness / promote your products?  
Different projects are set up and product are marketed in different ways. AISE makes folders and also goes to community with other NGO's to talk to innovators and later on customers personally.

- What are the bottlenecks that you encounter?  
-

- How do you identify new areas to go into?  
Villages come to AISE with problem that can be solved. AISE then organizes capacity building workshops for ideation. Ideas than move on to conceptualization.

- What do you think about my concept. Does it fit with what you do?  
It could be, but it need to work out further. Cool way of generating energy though. Will you work it out on household level or will it be bigger? Is working with solar collectors interesting,\* maybe it is just useful during cooking?

- What is your final advice to me?  
Find specific application, think about the cost. Basically work it out further so there is really a case behind it.

\* During this time there was still doubt whether to use the concept with solar collectors that concentrated the heat in one place or to use it close to a heat source.

## F.2 OFF GRID ELECTRIC (M-POWER)

Due to the the fact that investment costs for connection to the main grid are not affordable, combined with the fact that there is a push towards renewables from both NGO's as well as start-ups and multinationals that are getting established in Tanzania, the population is starting to see the benefits of solar. The customer interviewees mentioned that they are considering solar as opposed to connection to the grid as they mostly don't have to pay direct investment fees, but are rather able to pay it in installments. The market here in Arusha works with different business models; subscription based (Off Grid Electric) or ownership based (Mobisol). These two companies are the main players in Arusha (and are working in other parts of Tanzania as well) and are expanding rapidly. While Off Grid Electric is focusing mainly on the lower income population from both rural and urban population, Mobisol seems to focus on the middle class in the urban area (while doing some work in the rural area) with panels ranging from 80W - 120W - 200W. Rafiki Power, the Tanzanian version of German E-On on the other hand operates in start up form and offers rural villages micro-grid solar solutions in the form of solar home systems.

*What Off Grid Electric is doing is offering the same service as TANESCO, but without the big initial investment cost. Rather customers pay 15.000 TSH to get registered and between 300 and 1000 TSH for their daily use and service package. They receive a panel with a certain amount of light bulbs (minimum 2) and a box inside their house through which monthly payments are done to get access to the panel.*

### F.2.1 JACOB WINIECKI

- State your name?  
Jacob Winiecki

- From which company are you?  
Off-Grid Electric (M-Power)

- What is your role in the company?  
Director of Innovation

- From which company are you?  
Off-Grid Electric (M-Power)

- How did .... start? (History)  
We started as a company that was going to provide telecom

companies with solar energy through micro grids. When that provide to not be feasible we looked further and moved on to provide rural households electricity and track their payment through mobile paying as this is booming and the mobile phone penetration is high in Tanzania.

- What kind of products do you sell?

Small solar home systems. In partnership with Fosera - a German solar company - (Ashden , 2014) this is home system is created and retailed as M-Power Box. Manufacturing happens in Thailand according to Ahsden (2014).

- To which segment?

Households without access to grid electricity due to the high costs. Mainly in off-grid (rural) areas.

- How do you deliver after sales service?

Through the customer service set in place. Clients can call in with problems and are called to check their payments.

- How do you make sure people pay?

We assess their creditworthiness before we allow them to buy a product from them. Next to that they pay through mobile money, which makes it possible to track payments and check in why they don't pay regularly.

- What kind of business model do you use?

Service based. When agreeing on the contract Off-Grid discusses the level of service that the customer can expect from them. The customer will not own the system but instead pays for the service that is provided with the system. In return the system gets repaired or replaced whenever needed for free (if the service includes this). Minimum payment is one day's use (Ashden, 2014).

- Which activities does .... have in hand?

Designing the system, distribution, customer care and training of agents. The agents are in place to "find customers, install systems and provide ongoing customer support. Use of tailored smartphone apps linked to a complex database allows customer, system and payment information to be integrated. Cloud-based servers keep data secure" (Ashden, 2014 p. 2).

- How do you create awareness / promote your products?

Off Grid finds new areas to work in using the strategy explained in the next question ( *How do you identify new areas to go into?* answered by Jacob Winiecki). According to Ashden (2014)

the company than

1. Sets up a publicity campaign and organizes the installment of demos.

2. Recruits customers, who want to change agents and trains them. The change agents install systems and payment control. The trained change agents recruit customers and perform the tasks that they are responsible for.

- What are the bottlenecks that you encounter?

Affordability - Will it be deemed as affordable enough?

Technology risk - Does the product technology wise do what I said it would do when I sold it. This influences customer perception of the company and returns on the investment in pursuing the technology.

Payment - Getting clients to pay regularly. We already played into this by setting up a mobile payment plan.

- How do you identify new areas to go into?

We assess areas based on the accessibility. Does the area lie close to main road? Can we come there with our supply. Next to that we try to get some data regarding the amount of money spend on energy. In this way we can assess based on data if it would be interesting for us to promote or product and service there.

- What do you think about my concept? Does it fit with what you do?

Interesting, but not something for us as we are focused on solar energy. We did not look into other solar based opportunities yet. Next to that it would be interesting to look at specific applications for this technology and how it could really help.

- What is your final advice to me?

Find out specific applications. Look into what Biolite is doing and how your solution is different. Look into solar heaters and what you can do with that in your concept. Estimate costs, charge time, amount of charcoal that will be used and in how much energy this results (efficiency).

## F2.2 MOSES NGEREZA

Next to interviewing Jacob Winiecki. The researcher also talked to Moses Ngerenza, who is a regional manager at Off Grid Electric. He actually already approached the researcher through LinkedIn during the start of the graduation project when the researcher was still in the Netherlands. As the specific business questions were already submitted to Jacob Winiecki and

found online, the talk with Ngerenza was more experiences on his experience working in the field.

Questions asked were based on what customers told the researcher about their connection with M-Power: they were not because of the fact that the light did not always shine brightly and they did not always have enough energy for their lights. Although the entry system according to [Ashden \(2014\)](#) includes two light bulbs and possibility to charge phones and the next level is six lights with two phone chargers, the customers in the field research all said that they only had power for their 3 or 4 lights bulbs.

Question therefore was how customer expectations are managed? Next to confirming what Jacob Winiecki said about the design: "OGE is designing the systems for worst weather cases". Moses also added that he tries to engage in expectation management about the system and explain how the system works and when it does work well or not. He did add that often it is hard to explain as customers sometimes miss the fundamental knowledge about how a system works (what [Rogers, \(2003\)](#) calls principles knowledge). Customer expectation was therefore hard to keep up. This means that there is a discrepancy between what Winiecki says and what a Ngerenza says.

Ngerenza also added more details, which was not reported before. He states that customers mostly unknowingly are renewing their contracts whenever the solar systems has problems (and thus needed to be replaced, according to Ngerenza. This employee also mentioned that Off Grid Electric is working on trials with ownership business models and that the company is experimenting with a 3rd level system that can handle televisions.

The regional manager was positive about his employment with Off Grid Electric stating that the management is open to suggestions, dynamic

### F.3 MOBISOL

Mobisol targets another segment using another business model using 1,2,3 year plans in which different panel sizes can be paid off in installments starting from a monthly price of 39.000 TSH for the smallest panel of 80W, when paid of in 3 years. The company requires an initial payment of 128.000 TSH for this panel when paid of in 3 years. The initial payment and the monthly fee gets higher when the client chooses or is able to pay of the system in a shorter amount of years. Total cost come down to 1.149.000 TSH, but can range to 2.124.750 TSH for the 200W panel. Mobisol works with a chip in their charge controller, through which it can track payments and close access to the panel when a customer doesn't pay the monthly fee. Through this system the company can also track data of usage. This helps the company foresee on forehand the problems that customers are dealing with, even before they call in. Combined with an antenna and customer number the company deals efficiently with any encountered problems.

#### F.3.1 MATTHEW HANSEN

- State your name?

Matthew Hansen

- What is your role in the company?

Working in the technology department in the assembly office.

- How did .... start? (History)

Founded in 2011, the company started working in off-grid solar. At this time this was still seen as a niche market, according to the German Thomas Gottschalk, Founder and Managing Director of Mobisol ([The Changer, 2015](#)).

- What kind of products do you sell?

Solar Home systems varying in size from 80 to 200W. The systems are bigger than the ones from Off Grid Electric and therefore can power even household appliances such as televisions and music systems.

- To which segment?

The company says to target low income customers, but with the prices that they maintain the middle income customers seem to be attracted more.

- How do you deliver after sales service?

The payment plan includes customer service. We include a sim in the system, which monitors and tracks payment. Through

this we can track if the system is working and detect problems before customers know it.

- How do you make sure people pay?

The sim that is included in the system is a mobile sim. Through this sim, customers pay and when they do not pay the system gets blocked.

- What kind of business model do you use?

Mobisol calls the business model rent-to-own: people rent the system until they own it after paying it off.

- Which activities does .... have in hand?

Engineering, developing and delivering systems. The systems get designed in Germany, produced in China and shipped to Tanzania where it gets assembled by teams in the assembly quarter. This is also where Matthew works.

- How do you create awareness / promote your products?

Through mobile hubs that we set up in the areas we expand to. We train people here [to become change agents]. They then create awareness and do the promotion.

- What are the bottlenecks that you encounter?

The business model does not allow to let us expand to smaller systems. This was too hard to sell, because it becomes too expensive and we do not gain enough from this.

- How do you identify new areas to go into?

I cannot really answer this question. Maybe interesting to get connected with the Customer Care or Business Development department. Unfortunately, this did not happen.

- What do you think about my concept? Does it fit with what you do?

Interesting, but not something we focus on. Our focus is on solar panels. Next to that it would be interesting to look at specific applications and how it would work.

- What is your final advice to me?

Talk to customer a lot and see whether you can find a specific application. Looking into solar boilers and combining this with that might be an interesting direction to look into.

## F.4 RAFIKI POWER

Rafiki Power is the Tanzanian embodiment of the German E-On Off Grid Solutions GmbH (EOGS). The startup offers micro grid solar systems.

### F.3.1 ATHINA KYRIAKOPOULOU

- State your name?

Athina Kyriakopoulou.

- From which company are you?

Rafiki Power.

- What is your role in the company?

Head of Operations.

- How did .... start? (History)

In 2014 with installing the first micro grid system.

- What kind of products do you sell?

Solar micro-grid home systems of 3-9 kW. Up to 80 households can get connected to one system. The systems are part of a container, which gets installed in a community.

- To which segment?

Rural populations in East Africa.

- How do you deliver after sales service?

We keep in touch with our customers. We even help entrepreneurs in the village improve their businesses due to the fact that there is electricity: connecting freezers to cool drink instead of no cooled drinks.

- How do you make sure people pay?

Through working with the payment plans and keeping in mind seasonality of work. Next to that offering mobile payment services aids in making sure that people pay.

- What kind of business model do you use?

The interviewer lacked to ask this question, but synthesizes from the information provided that it is community based and pay per use. Micro-grids are installed and customers can get connected to the system; paying per use.

- Which activities does .... have in hand?

Developing, engineering, financing and operating systems.

- How do you create awareness / promote your products?

Through having community elders in place who are on board with Rafiki Power we create trust. Next to that one person from the community can run the kiosk as a store operator. He is charged only for the use.

- What are the bottlenecks that you encounter?

The payment plan. "One question we had to resolve was: how are people going to pay us? We chose a mobile money solution involving a local partner. Customers make an electronic prepayment using their mobile phone and receive a credit for a certain amount of electricity. They can monitor their consumption and remaining balance at any time and also contact customer service". (Eon, n.d.).

Also feedback from customers was not what we expect: we thought that they would understand things that we regarded as simple, but they didn't. So it is good to be prepared for the fact that they will not always react to things the way you thought they would. Due to lack in education for example. Therefore, it's important to get feedback from them often.

Also feedback from customers was not what we expects: we thought that they would understand things that we regarded as simple, but they didn't. So it is good to be prepared for the fact that they will not always react to things the way you thought they would. Due to lack in education for example. Therefore it's important to get feedback from them often.

- How do you identify new areas to go into?

The interviewer failed to ask this question.

- What do you think about my concept? Does it fit with what you do?

Not directly, but it is an interesting concept that could work and offer the customers some electricity. At this time the researcher knew how she wanted to apply the system, namely during cooking.

- What is your final advice to me?

Think about the fact that clients will have to change their habits and routines. How will you facilitate that? They often cook for hours, does that work for the concept? Won't they use the fuel now to charge the batteries? How to avoid this.

If you want to use sales agents, think about what they are getting back. We noticed that giving bright t-shirt might work. Also

led community elders to the work. If they get on board it will be easier to convince others as they already have the respect in the community.

- think about a pay plan: will they pay little bits in installments or a lot and once and does this coincide with when they receive their money from often (seasonal) work.

- Doing promotion at local market is also a strategy that might work for you.

### F.5 LOCAL ENTREPRENEURS.

Lastly the researcher got the chance to sit in on an interview conducted by Jessie Press-William, a MIT student working for the International Development Innovation Network (IDIN). Her research was about innovations in other parts of the world.

The interview was conducted with the two energy entrepreneurs Frank Kijenge, Liwitico Thompson and their business partner Martin Dewani, who also translated the conversation to English. They tried to improve inverters, work on the development of new incubation systems for eggs and develop new energy generation solutions. Only the relevant parts of the interviewed are included in this appendix.

- State your name  
Frank Kijenge (designer) - Previously worked for Off Grid Electric, designing a system for them.  
Liwitico Thomson (operational partner)  
Martin Dewani (business partner)
- What type of products to you make?  
Egg incubators (we sold 5)  
Inverters (according to the needs of customers)  
Small electricity generating systems for clients.
- How do you learn?  
From friends (asking them to share their expertise) or from the internet.
- What is your motive to be an energy systems entrepreneur?  
I want products to be made in Africa. There is a need here to develop products. Next to that I think we can offer better customer service. We can offer unique products in the sense that they do are not totally made outside the country. We can also make it for a lower price.
- Are you independent or do you have a steady job next

to it?

We operate independently. There are people who hire us to make adjustments to their electronic systems. We also sell our own products or we get hired by companies.

- What are obstacles for you?  
We do not have enough capital to really start. We need to have the cash in hand. Also after completion there are challenges regarding sales. Also we use the internet, but there is not always access to the internet so we have to go to an internet cafe. This also forms a challenge.  
Lastly, people often want consultancy and us to make the new solutions without any payment, meaning that we should invest ourselves. This is not always possible. The material here is often scarce and thus expensive so we have to invest heavily and than see if we maybe get it back.

- How do you come up with new ideas?  
Because of electricity problems that I or other people have. When I know that I start looking for solutions, collect the materials and than make the solution.
- What do you need to make it work?  
- Trust from people and also the government to make it work. Now we do not really get funding.  
- We need time to develop and test our ideas.  
- Having a role model from abroad would be nice as well as they can systematically control our ideas.

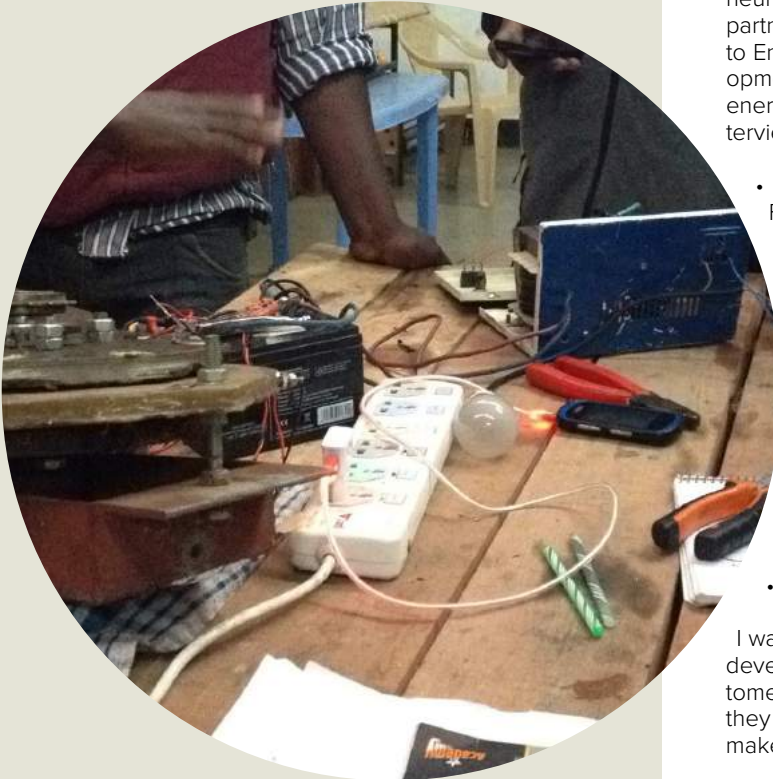


Image F1: A talk with the local entrepreneurs Frank, Liwitico and Martin

## APPENDIX G: THERMOELECTRIC ELEMENTS

As an improvement for the earlier design the use of thermoelectric elements is proposed by the designer. In this appendix a short explanation of what these elements are exactly.

### G1: THERMOELECTRIC ELEMENTS

Thermoelectric elements work with an input voltage that they convert in a temperature difference between the plates of the element. A thermoelectric generator does the exact opposite.

Note that whenever you want a thermoelectric element to work there is thus need for a temperature difference. The material inside this type of element ensures that whenever there is phenomenon occurs a charged element will move from the hot side to the cold side. The temperature difference that is needed to make a thermoelectric element works depends on architecture of the the material.

### G2: THERMOELECTRIC GENERATOR

Thermoelectric elements used to generate energy are called thermoelectric generators. They are often as heat machines, while they actually work with temperature difference. Although they offer an advantage of no moving parts, less conversion steps and take up less space, there is also a trade off: they are often more expensive and also less efficient. Most seen applications are in the form of converting waste heat in energy. This is also what the proposal of LITA is used for.

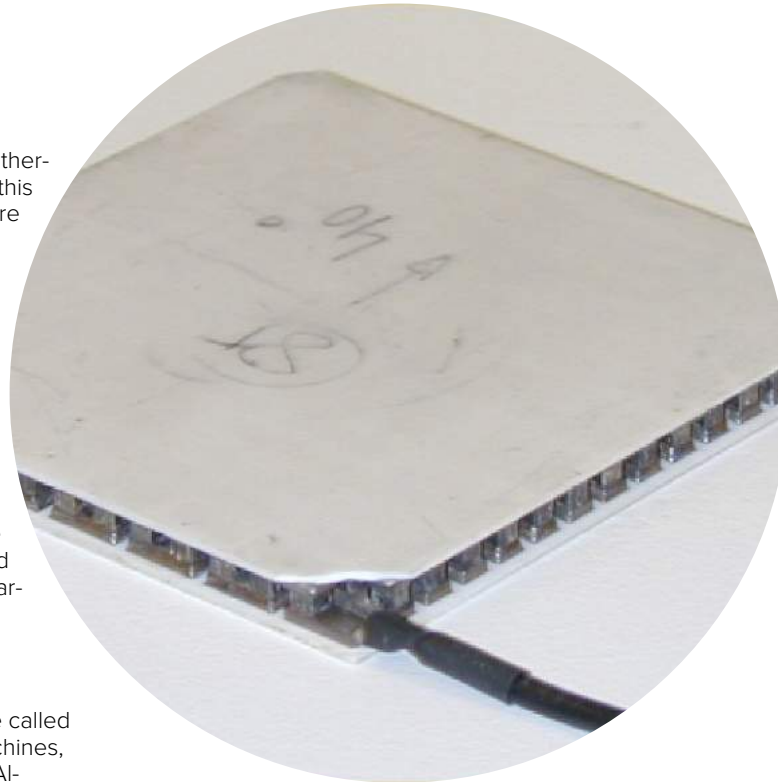


Image G1: Thermoelectric Element . Source Wikimedia.org

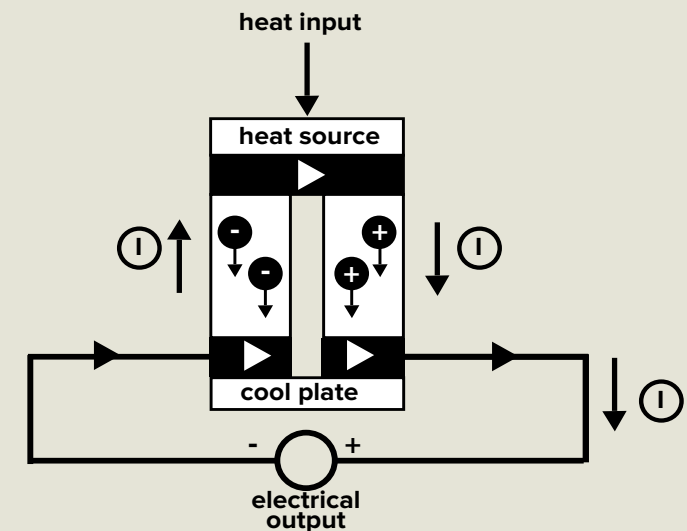


Figure G1: Thermoelectric Element working principle





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## IMAGERY

### IMAGES

All images used in this report are made by the author of this report, Deborah Sumter, with the exclusion of the product images in section 5.2: Current Offerings and the picture on page 89, which was made by the members of Am IADesigner during a visit to the University of Dar Es Salaam, where the prototype of RiziQi resided. The pictures cannot be copied without asking the author permission.

### FIGURES

The illustrations in the report are made by the author as well or adapted based on online imagery from not specifically one source. In case the owner of a certain image does not feel or is not attributed well enough, he/she can contact Deborah Sumter through the contact information stated on page 3. All figures cannot be copied without permission of the author.



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