The Crux of Sustainable Energy Provision

An explorative study of cluster strategies in rural Tanzania

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Executive summary

An energy transition is required in Tanzania. Household energy needs are currently largely met by unsustainable woodfuel resources. 92.4 percent of rural households use firewood for cooking, while 62.2 percent of urban households rely on charcoal. These woodfuel resources are responsible for indoor air pollution, annually resulting in the death of 18,500 people, mostly children under five. Moreover, many households experience energy poverty, that is they aren't able to gain sufficient access to, for example, cooking fuel or lighting for their homes. The traditional strategies to introduce modern energy, mainly connection to the electricity grid, are slow and unable to reach the majority of rural households for the foreseeable future, especially those households in inaccessible and poor areas.

To make an energy transition and to meet the energy demand in Tanzania in a sustainable way three appropriate energy technologies (AETs) were identified based on the study in this master thesis. AETs make use of locally available and renewable energy resources and can be owned and controlled by the local population. In this way these decentralized technologies don't require an elaborate infrastructure, such as the centralized electricity grid, which suits the characteristics of rural Tanzania. The stage of sector development of AETs in Tanzania was studied to assess whether these technologies can be easily disseminated. The solar PV (photovoltaic), improved cook stoves (ICS) and biogas technologies were selected based on the appropriateness characteristics and sector development.

Sustainable energy provision requires a sector of independent enterprises that own the capacity to provide appropriate energy technologies. Such appropriate energy enterprises (AEEs) ensure that a technology doesn't disappear when donor or governmental interventions finish. Cluster strategies promote the development of groups of such resilient AEEs. This master thesis contains the results of 18 months of exploratory studies of cluster promotion for appropriate energy enterprises in rural Tanzania. It was found that in contrast to theory of cluster strategies that designates a coordinating task to local governments, cluster formation of AEE depend on civil society organizations. Representation of the rural energy topic on the local level by district governments and public agencies is virtually absent. Tanzanian organizations on the national level have technological knowledge of AETs available, but their knowledge is seldom shared or commercialized. A conducive factor for developing appropriate energy enterprises is the modest shift to an opportunity driven entrepreneurial attitude in Tanzania. The lack of trust in businesses beyond family ties is an important institutional hurdle for cluster formation. It hinders the necessary formation of enterprise linkages.

No full-grown appropriate energy enterprise cluster was identified during the research, but based on the encountered inceptive clusters five types of cluster promotion are categorized. Firstly, the development organization SNV experiments with an organizational cluster that brings together the main stakeholders in the energy sector to coordinate their activities. This type of cluster promotion is a first step to improve the institutional setting for appropriate energy enterprise clusters. Secondly, Camco, a consultancy firm, shows that customers can be organized to collectively procure an energy technology and create economies of scale. AEEs are potentially linked to these groups of customers to promote enterprise clusters. Thirdly, development organization Instituto Oikos initiated a one stop shop that provides a wide range of energy technologies for a community. This type of cluster promotion comes closest to the theory of cluster strategies because it brings together governments, enterprises and civil society organizations in one location. Fourthly, a number of organization among which TaTEDO, a Tanzanian NGO, started energy platforms, a large energy installation that delivers an energy resource to nearby households, for example via a mini-grid. This type of cluster promotion creates a focal point for all energy related issues in a village, but requires an elaborate strategy to create proper management of the energy platform and promotion of AEEs. Fifthly, the Tanzanian companies Tanga Fresh and Diligent are active in respectively the dairy and Jatropha sector. Clusters of appropriate energy enterprises are promoted through these existing value chains by integrating appropriate energy technologies such as biogas and improved cook stoves to fit the energy needs of their producers.

The goal of sustainable energy provision is to meet household energy needs. The research results point to cluster promotion through existing value chains as currently the most suitable strategy for achieving this goal. In rural Tanzania it makes economic sense to use the limited infrastructure to integrate energy provision and appropriate energy enterprises with the existing business activities, such as diary and Jatropha production. The crux is to create the right institutional setting to develop the mutual benefits of sustainable energy provision for households and enterprises.

The results in this master thesis show that in sub-Saharan Africa lack of trust and inefficient institutions can hinder enterprise development. Development sometimes requires a third party to allow entrepreneurs to initiate investment or carry out a transaction. Successful business relations can create trust and propel the process further. Cluster promotion is a strategy to change the institutions or “rules of the game” in favour of enterprise development and endogenous growth.

Keywords: Appropriate energy, rural energy provision, cluster promotion, economic geography, Tanzania

Preface

Before reporting on the content of this study I feel this is the proper place to explain how I came to write about energy provision in Tanzania. This master thesis is the conclusion of my Master Sustainable Development and six years of academic studies. During these years I have tried to understand how the development of countries has effect on its people. My Bachelor in Political Science taught me to look at the interaction between states and political forces. I was especially interested by the debate between the conflicting positions of Fukuyama, who advocated the dominance of the liberal democracy and Huntington, who saw a world with clashing of civilizations. After these years being trained in Political Science I started to search for practical understanding of development. I visited Uganda and studied microfinance and entrepreneurship. It led me to change from the helicopter view that is international politics to a focus on local strategies for development. Moreover, I became exited by scholars and entrepreneurs that emphasized the potential instead of the poverty of developing countries. Especially Prahalad's ideas on developing the market at the *bottom/base of the pyramid* and Yunus' introduction of *social business* as an alternative business model inspired me. In a similar way did the challenges of climate change trigger my attention for new opportunities. I became involved with a European Union organization, Climate KIC, that tries to stimulate "green" business start-ups and knowledge sharing relating to this topic. Combining these two interests led me to enrol in the International Development track of the Master of Sustainable Development. This programme gave me the wonderful opportunity to do an internship on renewable energy entrepreneurship in Tanzania. The study I report on here contains the research results and experiences gained during that internship and led this year, 2012, to follow up on these results with another research on this topic in Tanzania. A final comment on my personal belief in the possibility to manage poverty and climate change issues into (business) opportunities: there is a real threat that wishful thinking starts to dominate research, reporting and investment. This is illustrated by the hyped-up expectations of biofuels (e.g. Jatropha) and microfinance some years ago and the subsequent reversal of attitude. I belief that there are real opportunities to be exploited, but any reported panacea should be treated with scepticism and proper research.

Acknowledgement

This master thesis comprises the results of studies in 2011 and 2012 and two periods of research in Tanzania during that time. The beginning of the journey towards this report started 18 months ago with a research for the development organization SNV into the Tanzanian biogas sector. I am very grateful for this valuable and enjoyable first period in northern Tanzania. I would like to thank the SNV staff at the office in Arusha, especially Tayeb Noorbhai. I admire your drive for development and thorough understanding of the sector; I enjoyed learning from you. Then I would like to thank Bob Jan, my fellow researcher and friend. Your enthusiasm and passion are contagious. Even at times when I couldn't appreciate, for instance, the tragic comedy of a broken bicycle, you helped to see things from a new angle.

This year's research period in Tanzania built on the experiences and contacts from last year, but was not initiated by one organization. Regardless of these limited credentials, many organizations and people offered me their hospitality. I would especially like to thank TaTEDO, Instituto Oikos, and again SNV that offered me their help, knowledge and facilities. Also the hospitality of Tanzanian families and the support and friendship of fellow students made me enjoy Tanzania and helped me to overcome the trouble on the way.

Overall, I like to thank the respondents that made their time available for me and were willing to share their story. Furthermore, I am thankful to my main supervisor Henk Huisman who helped to make this journey and who I was fortunate to have met during both times in Tanzania. Your instructions, practical advice, and friendliness have been leading throughout this study. Thank you Ilse for your involvement and to be the editor in chief of my very own glossy magazine. I am grateful we had the fortune to share many African experiences, among which the beauty of the research areas we visited. Finally, I would like to thank Mark and Daphne, and mom and dad whose advice I cherish. I am sure you know me best and I thank you for being there for me.

Table of content

List of boxes

Abbreviations

The list below includes all abbreviations mentioned in this master thesis, apart from common and well-known abbreviations.

AET	appropriate energy technologies
AEE	appropriate energy enterprises
BDS	business development services
CDM	clean development mechanism
CPR	common pool resources
D-by-D	Decentralization by Devolution
DED	district executive director
DFID	(United Kingdom) Department for International Development
GIS	Geographic Information System
GHGs	greenhouse gases
GBS	general budget support
IAP	indoor air pollution
ICS	improved cook stoves
IREU	Integrated Rural Energy Utility
LED	local economic development
LGA	local government authority
PPP	purchasing power parity
PSD	private sector development
solar PV	solar photovoltaic
RET	renewable energy technology
SHS	solar home system
SMEs	small and medium enterprises
SSA	Sub Saharan Africa
TEA	total energy access
TZS	Tanzania Shilling
USD	United States Dollar
Wp.	Watt peak

Organizations and projects

ABPP	African Biogas Partnership Programme
BEST RAY	Bringing Energy Services to Tanzanian Rural Area
BRELA	Business Registration and Licensing Agency
CAMARTEC	Centre for Agricultural Mechanisation and Rural Technology
COSTECH	Commission for Science and Technology
DfID	Department for International Development
EAC	East African Community
GIZ	(Deutsche) Gesellschaft für Internationale Zusammenarbeit
GoT	Government of the United Republic of Tanzania
GVEP (DEEP)	Global Village Energy Partnership (Developing Energy Enterprises Project)
IMF	International Monetary Fund
MEM	Ministry of Energy and Minerals
MNRT	Ministry for Natural Resources and Tourism
PfD	Partners for Development
REA	Rural Energy Agency
REEEP	Renewable Energy and Energy Efficiency Partnership
Sida	Swedish International Development Cooperation Agency
SACCOS	savings and credit cooperative society

SIDO	Small Industries Development Organization
SNV	Netherlands Development Organization ("SNV" is not in use as abbreviation)
TANESCO	Tanzania Electric Supply Company
TAREA	Tanzania Renewable Energy Association
TaTEDO	Tanzania Traditional Energy Development Organization
TDBP	Tanzania Domestic Biogas Programme
TRA	Tanzania Revenue Authority
UDSM	University of Dar es Salaam
VETA	Vocational Education Training Authority
VICOBA	village community bank

Conversions

1.000 United States Dollar (USD)	=	1600 Tanzanian Shilling* (TZS)
1.000 Tanzanian Shilling (TZS)	=	$6.250*10^{-4}$ United States Dollar (USD)
1.000 Euro (EUR)	=	2000 Tanzanian Shilling** (TZS)
1.000 Tanzanian Shilling (TZS)	=	$5.000*10^{-4}$ Euro (EUR)

* rounded currency rate for December 2011 (XE, 2012)
**rounded currency rate for May 2011 (XE, 2012)

Introduction

"*Ensuring access to affordable, modern energy is central for sustainable development and poverty reduction...*" (UN, 2012).

Sustainable energy access impacts lives: it allows to study after dark, it supports enterprises and reduces toxic indoor smoke. By 2030 the world can achieve universal access to modern energy services. This year, "2012 the International year of Sustainable Energy for All", is the ideal time to stress the importance of this goal (AGECC, 2010; UN 2012). In this master thesis sustainable energy provision[1] in rural Tanzania[2] is analysed by reporting on 18 months of studies. Firstly, to understand the need for intervention of any kind the broader perspective on development and energy provision is introduced. Secondly, to make energy provision sustainable it requires a number of characteristics. In this introduction the need for contextual information is explored. Furthermore, sustainable energy provision should become independent of external aid. How it can be part of a local economy is discussed here as well. Thirdly, by setting priorities the goal of sustainable energy provision is explained. Finally, in the last two sections of this introduction the objectives and structure of the study are presented to guide the reader through this master thesis.

The development picture I

"*In many places in the world today the poor are getting poorer while the rich are getting richer, and the established processes of foreign aid and development planning appear unable to overcome this tendency. In fact, they often seem to promote it, for it is always easier to help those who can help themselves than to help the helpless*" (Schumacher, 1973: 159).

Scholars and statesmen expected during the 1950s that developing countries would easily find their way to economic growth and development (Leftwich, 2008). The influential work in economic geography of Myrdal showed, however, that the development of one area or region can be dominated by backwash effects. Backwash effects occur when the resources from peripheral areas are used for the growth of the core. To prevent unrestrained inequality, a comprehensive understanding of development is required. Myrdal argued that peripheral areas can develop by promoting egalitarian policies. But areas and countries require enabling institutions to actually benefit from these policies, otherwise countries are vulnerable to the increasing core periphery divide (Cypher and Dietz, 2009; Panico and Olivella Rizza, 2009). Broadly defined, institutions are:

[1] Energy provision is meant in a broad sense to include energy products and services such as fuel supply and the introduction of methods that for example lead to more efficient energy use .
[2] Officially United Republic of Tanzania, hereafter Tanzania

"*...rules, enforcement characteristics of rules, and norms of behavior that structure repeated human interaction.*" (North, 1989: 1321). According to North enabling institutions are created when a society gives the highest pay-off for productive behaviour, if unproductive or inefficient behaviour gives the highest pay inefficient institutions are created (1995; cf. Baumol, 1990).

This master thesis seeks application of the institutional reform proposed by Myrdal and North (1989; 1995) for energy transitions. Myrdal's focus on institutions can assist in understanding why countries are or aren't receptive for development. Asian countries have generally developed better energy provision than African countries, for instance in the adoption of biogas technology. Biogas installations have been successfully introduced and are nowadays integrated in Nepalese and Vietnamese societies, while the dissemination in sub-Saharan Africa in general is more problematic (Kammen, and Kirubi, 2008; Karekezi and Kithyoma, 2003; Parawira, 2009). These biogas adoption problems were noted for Tanzania as well (Marree and Nijboer, 2007; Schoot Uiterkamp, 2011). The lack of enabling institutions has proved valuable in explaining development in sub-Saharan Africa (Hyden, 1985; Nissanke and Sindzingre, 2006; Ribot 2003). In the conclusion the way the case of energy provision in rural Tanzania can contribute to the overarching debate is discussed.

Energy transitions: technology, context and ownership

"*The energy transition in Africa is an incremental process and not a leapfrog process, dependent upon household, national and regional accumulations of technological capabilities*" (Parawira, 2009: 192).

We require energy to live. Energy surrounds us continuously, ranging from heat to the potential energy in organic material. Energy poverty, through scarcity or rising prices is a cross-cutting issue, which negatively affects livelihoods, economic development and service provision (AGECC, 2010; Practical Action, 2012a). In sub-Saharan Africa (hereafter Africa) the main source of energy is biomass. Annually approximately two million people in developing countries die from respiratory illnesses caused by indoor air pollution from the use of firewood or charcoal as cooking fuel (WHO and UNDP, 2009). Also the social impact of collecting large amounts of wood, mainly by women, has a severe impact on livelihoods (ibid.). The Secretary General of the United Nations initiated in 2010 the global goal of achieving universal access to modern energy[3] services by 2030. An energy transition to sustainable energy provision is required. This should result in an increase in energy efficiency and uptake of modern energy technologies (AGECC, 2010; De Vries, 2011).

[3] "*...modern sources of energy include fuels such as natural gas, liquid petroleum gas (LPG), diesel and biofuels such as biodiesel and bioethanol. Technology, such as improved cooking stoves, can also enable cleaner and more efficient delivery of traditional fuels.*" (AGECC, 2010: 7). In this master thesis electricity will also be considered a modern fuel.

The successful uptake of a newly introduced technology depends on contextual factors such as the manifested demand and institutional setting (Baron and Shane, 2008; Baumol, 1990; Cherni et al., 2006; Henao et al., 2012). Just the introduction of the knowhow of a technology is insufficient for its application (Baumol, 1990). For energy provision this firstly, means that energy solutions that worked in developed countries are not a priori appropriate for developing countries. Hence, copying the fossil fuel and grid connection choices of developed countries is not necessarily suitable for developing countries (Practical Action, 2010). Secondly, assuming energy technologies can be rapidly leapfrogged (skipped) needs nuance. It has been proposed that developing countries can easily adopt new technologies without going through intermediary technologies, such as in the case mobile telephony sector in Africa, that largely leapfrogged landline telephony (Moloney, 2007). Studies show that adopting a new technology in developing countries requires social acceptance, public policy and training (Murphy, 2001; Parawira, 2009; Sauter and Watson, 2008; Van Benthem, 2010).

Energy transitions should thus take the underlying context into account in two ways. Firstly, the selection of an energy technology should be appropriate (Cherni et al., 2006; Henao et al., 2012). Secondly, sustainable energy provision includes establishing local skills and proper ownership of the newly introduced technologies (Murphy, 2001; Clancy, 2011; Karekezi and Kithyoma, 2003; Parawira, 2009). Local economic development (LED) is designed to promote economic progress in rural areas. One LED strategy is cluster promotion. Cluster promotion entails that enterprises are stimulated to establish themselves in one locality. A cluster strategy can be designed to stimulate enterprises that independently provide energy (Meijer and Huisman, 2011; Schoot Uiterkamp, 2011).

Setting priorities

"*The main objective of energy projects should be to improve rural people's quality of life, not to disseminate a particular technology or mitigate an environmental problem*" (Murphy, 2001: 175).

Directing interventions to stimulate energy enterprises is a sensible goal for energy provision, because small and medium enterprises (SMEs) are required to meet rural energy demand. A too narrow focus on enterprise development might dilute the goal of reaching end-users. Energy provision cannot be measured in employment or even number of enterprises. Free market and a level playing field will lead to bankruptcies and shifting employment opportunities. Clinging to employment in energy enterprises or one type of enterprise via interventions will distort this process. A healthy and innovative energy sector has a shifting number and types of enterprises that gradually increase efficiency of energy provision. This process will increase the ability to meet the energy demand in a sustainable way. Interventions should thus be loyal to sustainable energy provision to end-users, and can use enterprise development as a means to this end.

The Tanzanian energy context

"*wood for a 3-stone fire is always available; I just have to walk far away to gather it.*" (respondent, cited in GACC, 2012: 45).

To illustrate the Tanzanian energy context a number of trends are key to understand. Firstly, the energy demand in Tanzania is increasing considerably. The primary energy consumption in Tanzania was in 2009 already two times that of 1991, and is expected to double again in 20 years (World Bank, 2012b). This is because the energy consumption per capita is increasing (World Bank, 2012a). Economic growth and technological progress requires energy provision to keep pace with access to new appliances. Population growth also increases the rise in total energy consumption. Tanzania has an estimated annual population growth of 2.8 percent (PRB, 2012)[4]. Combined with increased per capita consumption this means that energy consumption increases in such a fast rate (World Bank, 2012b). Secondly, the social economic and conservational implications of maintaining the status quo are severe. Rising oil prices affect the budget of many Tanzanian households. Furthermore, in Tanzania 85 percent of all energy consumption is sourced from solid biomass, consisting mainly of firewood and charcoal (IEA, 2007). Also this type of consumption is affected by rising demand and leads to scarcity. Erosion and deforestation threaten arable land and biodiversity. Between 1990 and 2010 Tanzania lost 2.4 percent of its forest area. Moreover, in total deforestation in Tanzania accounts for 52 percent of the total East African forest area loss during that period (FAO, 2011).

Objective of the study

This study aims to contribute to sustainable energy provision in rural Tanzania by stimulating debate and further research. As discussed, the need for an energy transition is illustrated by the current energy demand and trends. A new technology needs to be rooted locally to meet this demand. Appropriate energy enterprises (AEEs) are a way to arrange sustainable provision. This master thesis reports on a research in Tanzania that aimed to study cluster strategies for AEEs. The (specific) study objective is to explore to what extent cluster strategies can lead to sustainable energy provision. This objective can be translated in the research question. To answer the research question three subquestions are devised. Firstly, the household energy demand of rural Tanzania needs to be made insightful to understand which energy technologies are appropriate for this research area. Secondly, the institutional setting for cluster formation is assessed to understand the potential of

[4] The doubling time of a population with a growth rate of 2.8 percent is 25 years. The average population growth in Tanzania over the last 50 years is 3.0 percent and thus roughly corresponds with this recent figure (World Bank, 2012b).

clusters. Thirdly, the current state of cluster promotion in Tanzania is assessed by studying (inceptive) clusters and analysing their potential in rural Tanzania.

Research question (RQ): To what extent can cluster promotion stimulate sustainable energy provision in rural Tanzania?

Subquestion 1 (SQ1): Which appropriate energy technologies can meet the household energy demand in rural Tanzania?

Subquestion 2 (SQ2): To what extent is the Tanzanian institutional setting conducive to cluster formation of appropriate energy enterprises?

Subquestion 3 (SQ3): To what extent does cluster promotion in appropriate energy enterprises take place in rural Tanzania?

Structure of the study

Chapter 1 contains the theoretical views that will give a direction for analysing the results. The chapter will provide the theoretical basis to assess the household energy needs in the research area. Subsequently, cluster promotion and a set of conducive conditions for the creation of enterprise clusters are presented. Chapter 2 then provides the contextual information and household energy needs. Chapter 3 presents the conceptual model which depicts the approach to tackle the research questions. Also the methods that were used to conduct the research and the resulting limitations are presented. The next three chapters are used for reporting results and each one correspond with a subquestion. Chapter 4 makes a selection of the appropriate energy technologies (AETs) relevant for cluster formation in rural Tanzania. It reports on the stage of sector development of the AETs based on the research results. In chapter 5 the institutional setting is assessed for cluster formation in AETs in Tanzania. The research results are compared to the conducive conditions for cluster formation introduced in chapter 1. In chapter 6 the (inceptive) clusters that were identified during the research are categorized and compared to the institutional setting. Finally the conclusion contains the results of the study and answers to the research questions. Also the applicability of the conceptual framework is discussed before concluding with recommendations for further research.

Chapter 1 Theoretical views on energy provision

This chapter explores the existing literature and aims to find a direction in answering the research questions. Firstly, before continuing with exploring sustainable energy provision the way energy demand is met needs to be clarified. The concept appropriate energy technologies (AETs) is therefore conceptualized. Secondly, the energy demand is discussed to assess, based on prevailing norms, what energy provision should consist of. Thirdly, besides technological requirements and context specific interventions, sustainable energy provision requires local ownership. Cluster strategies are discussed as a way to stimulate appropriate energy enterprises (AEEs). Based on the way clusters are thought to function a set of conducive factors for cluster promotion are presented.

1.1 Sustainable energy provision

Sustainable energy provision implies that delivering energy is lasting because it is designed to consider social economic needs and environmental needs. Social economic needs are given priority, as described in the influential report "Our Common Future": "*in particular the essential needs of the world's poor, to which overriding priority should be given*" (WCED, 1987 : 41). In the case of energy provision the ultimate objective is meeting household needs. Interventions should have a lasting impact to promote sustainable provision. Short lived energy projects have in the past led to so-called "*islands of development*" (Riddell, 2007: 188). Such projects can be successful in meeting household needs, but often remain superficial. If there is lack of attention for coherence with other projects and the exit of initiators, they can distort future development. Partly because of these considerations donors and partners made agreements on aid effectiveness in Paris in 2005 and subsequently in Accra in 2008. It was determined that local ownership[5] is a key priority in aid effectiveness. Aid should be designed to ensure that development becomes an endogenous process (OECD, 2008). The proper local ownership of energy provision can be stimulated through local economic development (LED). LED will be discussed in relation to cluster promotion strategies in section 1.5. The next section discusses the role of technology in sustainable energy provision.

1.2 Appropriate energy technologies

Renewable energy technologies, such as wind power, solar PV and hydropower can make energy provision environmentally sustainable, because of negligible greenhouse gas (GHG) emissions. But it does not always fit other sustainability dimensions. For example, because the household needs in the research area don't align with the type of technology. This master thesis focuses on the introduction

[5] The Paris Declaration on Aid Effectiveness also includes alignment, harmonisation, results and mutual accountability. The Accra Agenda for Action includes three areas of improvement. Namely, besides ownership there is the area of inclusive partnership and thirdly, delivering results. More recently, in 2011 in Busan, Korea a forum reviewed the implementation of the Paris Declaration (OECD, 2008).

of appropriate energy technologies. What is appropriate depends on the context. Schumacher (1973) introduced appropriate technology as an alternative to technologies that were developed in industrialized countries. Appropriate technologies refer to: *choices and applications that are small-scale, locally controlled and energy efficient. Also they should be centred on people, labour utilization and the environment* (based on the common ground in the definitions from Akubue, 2000; Hazzeltine and Bull, 2003; Schumacher, 1973).

Firstly, energy technologies that are small-scale and locally controlled is essentially decentralized energy. Decentralized energy provision makes use of locally available resources for provision to nearby households. Appropriate energy technologies (AETs) should thus be decentralized. In contrast centralized energy is for example connection to the main electricity grid or provision through oil-based energy resources. Oil-based energy requires extensive logistics to refine and bring to the customer. Similarly grid connection requires high investment to transport electricity to households. A centralized energy value chain is characterized by one utility, and a large number of end-users. The utility has a powerful position because the investment to establish the infrastructure is very high for potential competitors. One or more households in decentralized energy value chain are directly connected to locally available energy resource. Nearby households in villages or towns can share appropriate energy resources via a mini-grid. An indication of the corresponding energy value chains are schematically depicted in figure 1.1. Decentralized energy provision is very relevant for developed countries as well. In box 1 the global importance of decentralized value chains is illustrated. The distinction between centralized and decentralized energy provision can be further categorized. Decentralized chains include stand-alone systems, such systems consist of is used by a single household, e.g. a biogas installations. Slightly bigger decentralized systems supply to a number of connected households, e.g. in a mini-grid powered by micro-hydro installation. Note that the energy source is of essence for determining the category. For example, diesel generators may appear decentralized, but diesel is centralized because it is purchased on a commodity market and requires centralized logistics. Centralized chains thus also include commodity markets that sell products such as batteries, kerosene and charcoal (Practial Action, 2012c).

Box 1 Smart grids and smart development cooperation

Decentralized energy technologies gain momentum in the developing and developed world alike. The increased electricity generation of grid connected end-users leads to the development of so-called smart grids. In smart grids the energy flow is increasingly two-way. Besides utilities, end-users are energy generators through renewable energy technologies such solar PV (photovoltaic) and geothermal heat. Making demand and supply meet is essential for decreasing loses, because storage of energy is difficult. Information about generation and proper incentives can tune the energy use to make supply and demand align. In this way a smart grid increases efficiency. For smart grids the decentralized energy value chain in figure 1.1 can be extended by showing two-way information flows (Rosenfield, 2010). Exchange of knowledge of decentralized energy provision could improve energy provision across continents. There is no a priori reason for assuming that innovations from one place such as smart grids could not be of inspiration for energy provision in developing countries. Vice versa, the introduction and uptake of technologies for decentralized energy provision in a developing context is of interest for developed countries.

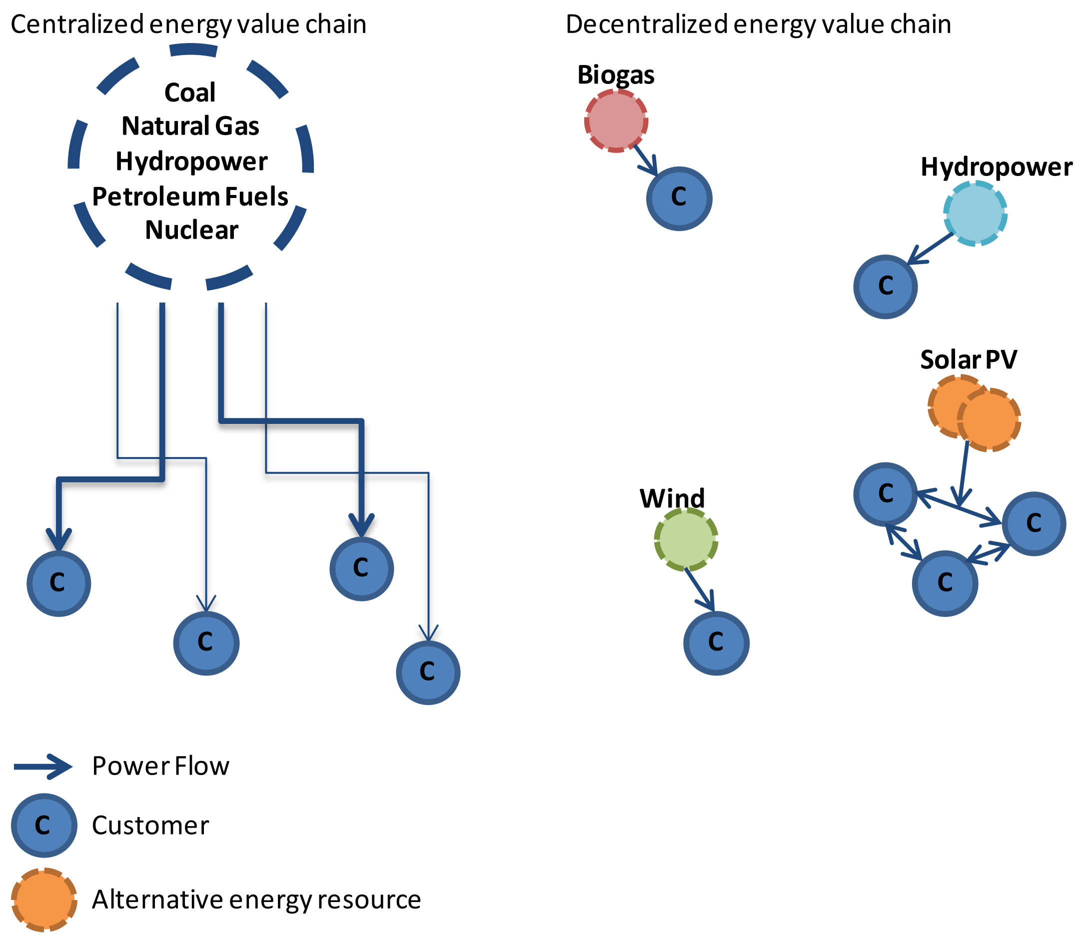
Secondly, appropriate technologies were defined as energy efficient and centred on the environment. As mentioned in the introduction the effects of using biomass are severe for the short term, because natural assets are badly affected. If forests are not able to recuperate from logging, resources are lost and carbon emission contribute to climate change (De Vries, 2011). Moreover loss forest area increases erosion (lose of arable land), desertification and sand storms (ibid.). Energy technologies are considered appropriate when they contribute to conservation of forest area and decrease harmful emissions. In general, renewable energy technologies (RETs) have these characteristics. Commonly cited advantages of RETs include: the low investment costs; the modular character of many RETs, which allows for gradual extension; decreased dependence on imported fossil fuels and volatile prices; and decreased GHG emissions (Ahlborg and Hammar, 2011; Barry et al., 2011; Castro and Castro, 2009; Holm and Arch, 2005; Otiene and Awange, 2006). Finally, some caution is required because energy efficiency does not necessarily refer to a shift to renewable energy. In many instances most direct savings can be realized by increasing the efficiency of current (fossil or biomass) energy use. In the long-run these efficiency gains should be part of an integral shift to renewable energy. This is not necessarily a matter of shifting energy resource. For instance, biomass use can very well be sustainable, depending on forest management and household practices. The risks of high dependence on biomass and the consequences of resource depletion will be further discussed in relation to the rural Tanzanian context in chapter 2.

Finally, labour utilization is of importance because it fits the relative abundance of labour in developing countries (1973: 166). Schumacher argues that many low productive workplaces should be favoured to few high productive workplaces even if the output is lower. The focus on labour utilization is, as argued in the introduction, subordinate to the household energy needs. But local employment and household energy needs can very well align. For example, waste to energy projects in Rwanda, Tanzania and Malawi, such as briquetting husks for cook stoves, have proved a valuable source for creating employment and are capable of fulfilling household energy needs (Barry et al., 2011). Table 1.1 summarizes the consequences of the results so far.

Table 1.1 Overview sustainable energy provision

Appropriate technology requirement (Akubue, 2000; Hazzeltine and Bull, 2003; Schumacher, 1973)	Appropriate energy technologies
Centred on people and labour utilization	Priority is given to household energy needs
Small-scale and locally controlled	Preference for decentralized energy provision
Energy efficient and centred on the environment	Preference for renewable energy technologies

Figure 1.1 Schematic impression of energy value chains



Source: Inspired by Rosenfield, 2010 and Practical action, 2012c.

1.3 Energy needs

Energy demand and the type of energy provision depends on energy needs and preferences. This section discusses how to assess energy needs. Also this master thesis focuses on domestic energy provision. This section explores to what extent a distinction can be made between domestic energy needs and productive energy needs.

1.3.1 Household energy needs

From the household perspective a number factors can drive an energy transition. The Total Energy Access (TEA) model, developed by Practical Aid[6] captures the minimal energy standards of household (2012a). When these standards cannot be met households experience energy poverty and have a latent energy needs or latent demand. Households are unable to meet latent needs due to lack of money, information or other resources. Access to energy services can potentially be fulfilled by for example awareness sessions that clarify the advantages of energy technologies. Also, financing schemes can help to meet latent energy needs. The model presented in table 1.2 aims to structure and create coherence in addressing energy poverty by highlighting the real energy needs. The model used in this master thesis is adopted from the recently revised edition of the Practical Action report (2012a) and functions as a starting point and standard to compare energy provision via AETs with. The second column with type of access is added to illustrate what the consequences can be for the livelihoods of households.

[6] Practical Action is a British NGO founded by the aforementioned scholar E.F. Schumacher. The Practical Action approach and the TEA model are related to the aforementioned conceptualization of appropriate energy technologies (Practical Action, 2012b).

Table 1.2 TEA model

Energy service	Type of access	Minimum standard
Lighting	Access to a conducive work and live space	300 lumen for a minimum of 4 hours per night at household level.
Cooking and water heating	Access to energy resources	1 kg woodfuel or 0.3 kg charcoal or 0.04 kg LPG or 0.2 litres of kerosene or biofuel per person per day, taking less than 30 minutes per household per day to obtain.
	Access to improved cook stoves (ICS)	Minimum efficiency of improved solid fuel stoves to be 40 percent greater than a three-stone fire in terms of fuel use.
	Access to clean air	Annual mean concentrations of particulate matter (PM2.5) < 10 µg/m3 in households, with interim goals of 15 µg/m3, 25 µg/m3 and 35 µg/m3
Space heating	Access to save and comfortable shelter	Minimum daytime indoor air temperature of 18 °C
Cooling	Access save and comfortable nutrition	Households can extend life of perishable products by a minimum of 50 percent over that allowed by ambient storage
	Access to save and comfortable shelter	Maximum apparent indoor air temperature of 30 °C
Information and communication	Access to communication	People can communicate electronic information from their household
	Access to information	People can access electronic media relevant to their lives and livelihoods in their household

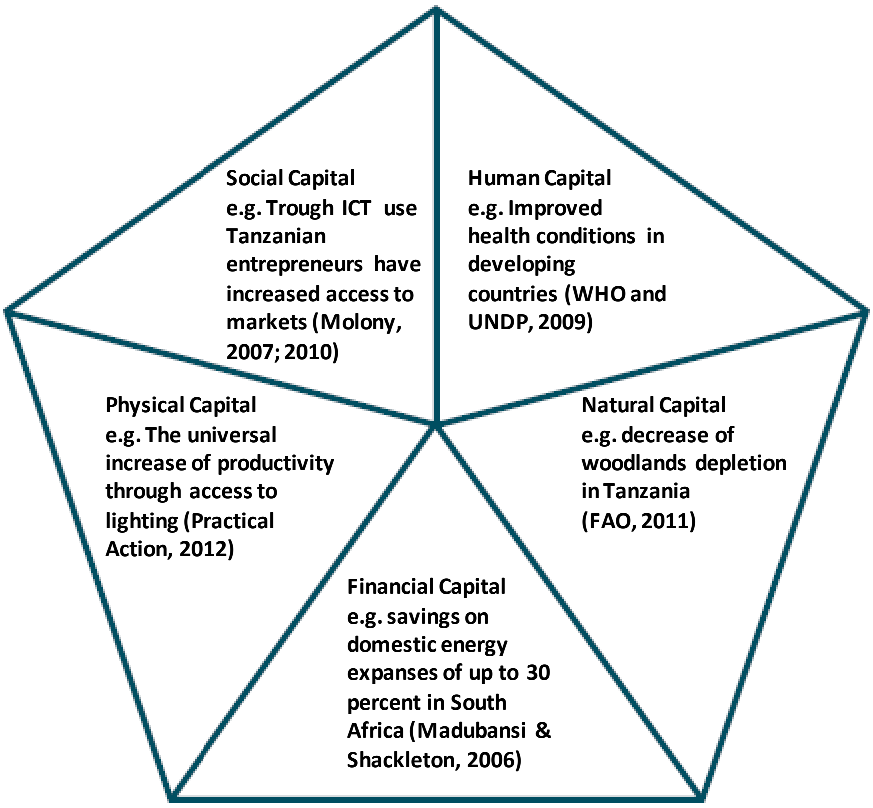
Source: Practical Action, 2012a (apart from "Type of access")

The minimum standards for energy services might appear universally valid. The standards can change according to social and environmental conditions. The climate will influence the need for energy services that provide cooling and heating. Also social norms might determine priority or rejection of some energy services. For example, the perceived need to gain access to communication and information will depend on the lifestyle of communities and their desire to interconnect. This is the reason why this model is coupled with the background of rural Tanzania in chapter 4.

The way these conditions are met, i.e. the type of energy provision, will differ profoundly. Some types of energy provision might be appropriate and sustainable in one context while failing in the other. The importance of the type of energy provision is illustrated by the dependence on wood fuels or biomass in the developing countries. Biomass use without the access to an improved cook stove can have severe health implications for households. An estimated 2 million premature deaths a year, virtually all in developing countries, are caused by smoke from cooking fuels, i.e. indoor air pollution (IAP) (WHO and UNDP, 2009). The number of deaths caused by IAP is higher than for example the number of people that die from malaria. Also, because IAP is related to food preparation, IAP diseases such as bronchitis, are disproportionally manifested among women and young children (ibid.). IAP shows how interconnected energy provision is with the conditions in which people live. The impact of the type of energy provision should thus be understood on the household level. The type of energy provision is related to a sustainable livelihood. To arrive at an answer to SQ1 a reasoned choice for the type of energy provision in rural Tanzania is required. The sustainable livelihoods (SL) framework as used by the UK Department for International Development (DfID, 1999) and can be applied to decide on sustainable energy provision that fits local demand (Cherni et al., 2006; Henao et al., 2012; Kooijman-van Dijk and Clancy, 2003; 2010). The SL framework is particularly human centred, and can be used to align energy provision with the assets of communities (ibid.). Energy poverty has an impact on the five livelihood assets: human capital, social capital, natural capital, physical capital and financial capital[7].

[7] Human capital refers to the ability to work and enjoy good health. Social capital consists of the social resources used to sustain a livelihood, mainly available through relationships and networks. Natural capital consists of the broad spectrum of natural resources, ranging from the atmosphere to firewood. Physical capital consists of all basic goods and infrastructure for productive use and basic needs. Financial capital refers to availability of cash, mainly through savings or regular inflows (DfID, 2009).

Figure 1.2 Livelihood pentagon relating to energy use



Source for livelihood pentagon DfID, 1999

Figure 1.2 includes some of the examples mentioned in this master thesis to illustrate the implications and potential improvements of energy provision for livelihood assets. The IAP example illustrates that improved cook stoves can save lives and improve human capital (WHO and UNDP, 2009). The biomass depletion as mentioned in the introduction shows that firewood and charcoal energy use affect natural assets, but can be stimulated by introducing forest management as well as saving measures (FAO, 2011). In an elaborate study of five South African villages it was found that domestic expenditure for energy can be cut by up to 30 percent through a shift to modern energy, thus impacting financial assets (Madubansi and Shackleton, 2006). Physical assets are closely related to energy provision itself, access to lighting for example can enable schoolchildren to do their homework (Practical action, 2012a). Finally, Moloney demonstrates how Tanzanian entrepreneurs gain access to an increased market by using ICT services, for example by contacting and keeping in touch with wealthy foreign customers (2010). Overall, for the household level increased energy access has a positive impact on livelihoods. Moreover, research by Kooijman-van Dijk and Clancy (2003; 2010) that employs the SL framework to understand the impact of increased energy access shows mainly improvements of the four non-financial livelihood assets. In box 2 an example is provided of the way the SL framework can be put to use by comparing energy technologies to the ideal of fully developed livelihood assets.

Box 2 The SL framework applied in San José de Cavo Norte, Columbia

The rural village of San José de Cavo Norte (SJCN) is situated in the east of Columbia and is inhabited by about 400 inhabitants. The village is not connected to the national electricity grid and extending the grid from the nearest electrified town some 30 km. away seems unfeasible. The community owns a 5 kWh diesel generator that can serve 12 percent of the households for 7 hours a day. The population of SJCN requires an energy technology that can operate 24 hours. The hot weather in the region requires, for example, the health clinic to be powered full-time so that it can cool vaccines. A research by Cherni et al. (2006) applied a baseline study and compared alternatives by using the so-called sustainable rural energy decision support system (SURE DSS). The baseline study defines the optimal improvement of the five assets of the SL framework and then assigns a score for the potential of an energy technology. For example, in the status quo in SJCN physical assets score low (0,1 out of 1), partly because limited electricity is available to power appliances. Similarly the improvements to the five assets were assessed for eight alternative energy technologies: biogas, grid connection, solar PV, micro-hydro and hybrid forms with the diesel generator. The SL framework showed that a combination of the existing diesel generator and a micro-hydro system is most appropriate for SJCN. A similar study was done for a community of 370 people in the Jambaló province in the south-west of Columbia. Again the status quo in energy provision was a diesel generator. In this case the new type of energy provision should lead to a livelihoods improvement of the community to minimally 0.6 out of 1 for all livelihood assets. This design should ensure that not a peak in one of the assets, but an appreciation of all assets forms the basis for a decision for an energy technology. A biomass installation powered by the organic waste from a nearby sugar cane factory was found to suit best the five assets of the community in Jambaló province (Henao et al., 2012). An example of the applied SL pentagon of this case is provided in annex B.

1.3.2 Productive energy needs

At least three parties are involved and can benefit from an energy transition. Namely, households that get (domestic) energy access for direct consumption as discussed in the TEA model. Then there are enterprises benefitting or even starting because of increased energy access, which can result in an increase of their productivity. Finally, there are enterprises that provide energy carriers or related technologies. These energy enterprises can even include modest income activities such as charging services for mobile phones (Maleko, 2005; Murphy, 2001).

The distinction between domestic and productive energy needs is fluid for many small entrepreneurs in the developing world. Household and enterprise energy needs overlap because micro entrepreneurs do their work from their homes. Moreover, in order to sustain their household an enterprise is a central asset and thus enterprise energy needs might be interpreted as a general household need (Maleko, 2005). Surprisingly little academic evidence is available for a direct link between access to modern energy such as electricity and increased productivity (Kooijman-van Dijk and Clancy, 2010). Supplying modern energy is just one factor that needs to be accompanied by a set of enabling factors to be effective. In itself energy access does not necessarily lead to the emergence of small enterprises (Meadows et al, 2003). In general, the correlation between electricity access and wealth creation is intermediated by preconditions. The factors location and the main economic functions of a village are better able to explain the relative wealth of a locality. Moreover, direct financial gains of electricity access are accrued by the already better-off villages and households. Expansion to poor villages is often not a development strategy in itself: "*energy alone is insufficient to stimulate production, but it can under the right conditions.*" (Kooijman-van Dijk and Clancy, 2010: 17). This has to do with lack of capital for luxury goods, while demand for basic goods remains equal. Modern energy can simply replace labour, while the freed-up labour is often not put to use for other productive ends (ibid*)*. Electrification is typically conducive to economic development in economically growing areas. Electricity access is likely to lead to productivity increases in economically vibrant areas, such as roadside and market villages and villages with exploitable resources. Introducing electricity in poor villages does not necessarily lead to economic growth (Kooijman- van Dijk, 2008; Kooijman-van Dijk and Clancy, 2010).

1.4 Entrepreneurship

The first sections discussed the characteristics of AETs and household energy needs. The remainder of the chapter is devoted to energy provision, i.e. how to bring energy technologies to households. AETs requires energy provision to be taken on by local entrepreneurship. This point is stressed by Karekezi and Kithyoma: "*Trained manpower capable of developing and manufacturing renewable energy technologies is a prerequisite for their successful dissemination."* (2003: 18). This point is illustrated by the case of an expat technician in Kenya that developed a low-cost control unit for PV solar systems. On departure of the technician the production simply stopped and the technology was lost (ibid.). Entrepreneurship is defined in this master thesis as: "*Any attempt at new business or new venture creation, such as self-employment, a new business organization, or the expansion of an existing business, by an individual teams of individuals or established business.*" (Reynolds, Hay and Camp, 1999).

Naudé and Havenga (2007) concluded a study of 520 scientific publications on entrepreneurship in Sub-Saharan Africa. It was found that African entrepreneurship is often related to self-employment and seen as a survival tactic or as a back-up to finding a job in the formal sector. Also in Africa growth of micro and small enterprises is problematic, which results in an entrepreneurial missing middle (medium sized enterprises). One explanation could be the entrepreneurial attitude (Naudé and

Havenga, 2007; Olomi, 2007; Ramachandran and Shah, 1999). Firstly, in the case of survivalist entrepreneurship, entrepreneurs have become self-employed because of lack of alternatives and try to escape entrepreneurship, rather than seize opportunities to grow and employ a larger workforce. Lack of understanding of this survivalist perception might result in a mismatch with entrepreneurship interventions by governments and donors who wrongly assume that entrepreneurs will want to grow (Olomi, 2007). A solution in this case would be to make a selection based on opportunity-driven entrepreneurs, before offering business development services (BDS) (Miehlbradt and McVay, 2003; Olomi, 2007). Secondly, a missing entrepreneurial middle can result from high requirements for formalizing a business, such as hefty taxes or an elaborate registration process or even the perception thereof. In such an instance small enterprises are trapped in the informal sector (Reynolds, Hay and Camp, 1999).

Entrepreneurship can be motivated by survivalist motives, but changes in attitude are possible. Opportunity-driven entrepreneurial traits and attitude can develop for every entrepreneur (Baron and Shane, 2002). Baron and Shane offer a process perspective to developing entrepreneurial traits (2002). Firstly, according to the way Schumpeter perceived entrepreneurship, opportunity recognition is the essential first step in entrepreneurship. Secondly, taking a risk, or entrepreneurial activation, is necessary to go beyond the survivalist stage and turning the opportunity in a profitable venture. Thirdly, an entrepreneur has to be able to meet the institutional standards and assemble the necessary resources to launch a business (Baron and Shane, 2008; Nkya, 2003). One can possibly add managing growth to this list as a further requirement of opportunity-driven entrepreneurship (Baron and Shane, 2008). The above process to develop entrepreneurial traits have much to do with the availability of knowledge and the institutional setting. Knowledge availability can be stimulated through education. Studies show that entrepreneurs with a secondary school education or higher have a higher rate of success (Naudé and Havenga, 2007; Ramachandran and Shah, 1999). Knowledge sharing and the institutional setting for enterprise development are discussed in the next section.

1.5 The cluster approach

As discussed entrepreneurship can be stimulated by having a conducive institutional setting. In this section the strategies for stimulating enterprise development are under scrutiny. The section serves as a way to determine the conducive factors.

1.5.1 Local economic development

Local economic development (LED) is a strategy that can be applied to create sector development . LED strategies are directed at increasing economic capacity by creating a multi-stakeholder network. Such a network comprises local government authorities (LGAs), the private sector and civil society organizations (Blakely and Green Leigh, 2010; Goldman, 2005; Swinborn, Goga and Murphy, 2006) and is discussed in section 1.5.2.4. Sustainable local economic development should be designed to foster endogenous economic growth, a process that can sustain itself. In a recent revaluation, LED no longer solely refers to the pursuit of economic growth, but includes an end state with consideration of inclusive and sustainable growth: "*Local economic development is achieved when a community's standard of living can be preserved and increased through a process of human and physical development that is based on principles of equity and sustainability*" (Blakely and Green Leigh, 2010: 75).

In developing studies a further distinction can be made between three kinds of LED strategies (Helmsing, 2003). Firstly, community economic development aims to diversify households economic activities. Diversified economic activities increases livelihoods assets and creates safety nets for households. These safety nets decrease the risk that all income creating activities are destroyed by external shock (ibid). Survivalist entrepreneurship mentioned in the previous section is associated with community economic development. Secondly, enterprise development is directed at specialization of small and medium enterprises (SMEs). In contrast to community economic development, this LED strategy is meant to create products and services that address a market larger than the locality of origin. The enterprises in a local economy that have such an extended service area are the local economic base. Specialization of SMEs is thought to be a growth mechanism and has for long been advocated by classic economic (Ricardian) theory (Cypher and Dietz, 2009). Thirdly, locality development refers to the development of the infrastructure and shared overhead capital for facilitating the local economic base. The development of these jointly used assets can greatly determine economic development. Locality development is a strategy that tries to improve the competiveness of the locality (Helmsing, 2003). The three LED strategies contain the development of infrastructure and a multi-stakeholder network. Together they form the enabling environment. The role of the enabling environment will be elaborated upon in the section dealing with the innovative milieu. Also it should be emphasized that the above three main categories of LED overlap and have spill-over effects. For example, locality development, e.g. improving roads for export, is conducive for enterprise development.

1.5.2 Cluster formation and economies of agglomeration

Enterprises should become opportunity-driven to create a self-sustaining sector (Naudé, 2009), i.e. go beyond the survival entrepreneurship that is associated with the community economic development. Community economic development can be a first stage, but there are other routes to establishing enterprise development.

Enterprise development seeks to establish agglomerations of enterprises, or so-called clusters. Porter, one of the main contributors of the development and popularization of the cluster concept defines clusters as: "*a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities*" (2000: 15).

The relation between agglomeration of enterprises and economic progress is well founded in economic geography. The benefits that enterprises reap when concentrated are referred to as economies of agglomeration (Krugman, 1991; Martin and Sunley, 1996). The beneficial economies of agglomeration result from the processes in clusters. Enterprises concentrated in one locality can form linkages, compete and stand out to attract customers. This leads to the specialization of the enterprises and increases the competiveness of the local economic base. Firstly, specialization thus serves as a growth mechanism (Helmsing, 2003; Porter, 1985; UNIDO, 2008). Secondly, specialization also make start-ups more likely. Specialization increases the knowledge availability, which stimulates the entry of new start-ups that can apply themselves to specific tasks (Naudé, 2009; Naudé and Havenga, 2007). These new enterprises can start off as spin-offs from existing enterprises or by external entry. The knowledge availability seems essential for development of endogenous economic growth (Barr, 2000; Ramachandran and Shah, 1999). Another economies of agglomeration benefit is that entrepreneurs with more and diverse contacts or social capital are more likely to be economically successful (Barr, 2000; 2002). In an area where enterprises are proximate it is easier to develop social capital (ibid.).

Clusters or agglomerations can assume a number of forms. Below four forms of agglomeration strategies as categorized by Helmsing (2003) are introduced. The institutionalizations of the four strategies differs. The strategies are ranked from least institutionalized forms of clusters to most institutionalized. A distinction between cluster strategies can also be made based on the way they come about as described in box 3.

Box 3 Cluster formation, bottom-up promotion and top-down promotion

In this master thesis a distinction is made between cluster formation and cluster promotion. Formation is the actual creation or development of clusters, which can be the result of cluster promotion. Cluster promotion ranges from explicit top-down interventions and implicit bottom-up processes (Fromhold-Eisebith, and Eisebith, 2005; Zeng, 2006). According to Fromhold-Eisebith and Eisebith (2005) the bottom-up strategy is appropriate where the multi-stakeholder network has already developed and infrastructure is in place. Top down interventions are needed when the institutional setting is less conducive, or for example when an entrepreneurial attitude is lacking.

1.5.2.1 Passive agglomeration economies

Passive agglomeration economies (PAE) are concentrations of enterprises. PAE can create agglomeration economies, but lack institutional support. The interventions of non-private actors are in these cases limited to a facilitating basic hard infrastructure and promotional activities for attracting investment in one locality. The standard agglomeration economies include the following four benefits (Blakely and Green Leigh, 2010; Krugman, 1991; Rosenthal and Strange, 2001; Scott, 2002). Firstly, PAE stimulate increased inter firm relations and trade. This is improved when distance decreases and consequently (transactional) costs are brought down (North, 1989). Secondly, knowledge spillover effects can be created, these typically contribute to the innovation and specialization of a cluster. Thirdly, agglomeration economies also include labour pooling benefits, that is the concentration of enterprises attract personnel. This can be especially helpful for enterprises that rely on specialized personnel. Finally, input sharing can make the availability of production goods more likely. Also input sharing can lead to economies of scale and lower costs because the cumulative demand typically has a decreased per unit price (ibid.).

An example of passive agglomeration economies are growth points or growth centres. Often growth points were used as a strategy to develop economically weak performing areas. These strategies were popular after the initial years of independence of most African countries, but have proved insensitive to the context of localities (Manyanhaire et al, 2009). Often growth points had little resources to attract investment, and the spent funds for infrastructural development and promotion were lost. Zimbabwe, for example, pursued the growth points as part of a strategy to change the colonially rooted spatial inequality. Most growth points proved unsuccessful to attract enough economic investment (ibid.). In general, the structural problem with the growth point strategy in Zimbabwe was the top-down approach. Even though the strategy was geographically oriented it was not designed to meet local conditions nor was there enough local support (Chazireni, 2003).

1.5.2.2 Cluster promotion

The PAEs are characterized by facilitating a physical infrastructure for enterprises. But besides developing hard infrastructure, flourishing agglomerations also require institutional provisions (Blakely and Green Leigh, 2010; Helmsing, 2003; Porter, 2000; Scott, 2002). An example of cluster promotion is described in box 4. Cluster promotion is introduced as a means to achieve lasting economies of agglomeration by developing locally and rooted institutions. As mentioned in the introductions institutions are defined as: "*...rules, enforcement characteristics of rules, and norms of behavior that structure repeated human interaction.*" (North, 1989: 1321).

The economies of agglomeration benefits apply to clusters, and indeed there is overlap between PEA and cluster promotion. The benefits of cluster promotion can be structured into the effects of two main dynamics. The first dynamic in clusters is collective efficiency between enterprises. The collective efficiency is institutionalized in clusters. For example, non-tacit externalities such as knowledge spillover effects can be stimulated and formalized by organizing experience sharing meetings. Also input sharing can become organized if entrepreneurs come together to discuss procurement in bulk. Organizing entrepreneurs can be problematic, but can be very cost effective as well (Schmitz and Nadvi, 1999). The same goes for other lucrative collective actions, such as arranging shared advertisement and information access. Institutionalization of an agglomeration consists of what Helmsing conceptualizes as "*active collective efficiency*" (2003: 72). Helmsing mentions two examples. Firstly institutionalization can be realized by regularized specialization. Specialization has been discuss as a spontaneous effect of competition, but can also be based on agreements between enterprises. Regularized specialization assigns specific tasks to enterprises. Secondly, the establishment of local producer associations can increase the ownership of collective action. Collective action vis-à-vis government, for example advocacy for common sector interests, can be realized through such associations (Helmsing, 2003; Sölvell, Lindqvist and Ketels, 2003).

The second main dynamic in clusters is competition between the enterprises (Porter, 1985; 2000). As discussed competition leads to specialization and innovation, which leads up to the competitive advantage and expanding the service area of a cluster. Internal competition also makes sure that prices, quality and services are market driven, i.e. in line with consumers interests. Especially for newly introduced products and services ill-informed customers that have little choice can be easily misled (Velayudhan, 2008).

Box 4 Government-driven clusters in the Brong Ahafo region, Ghana

In a report drafted by UNIDO (2008) on the enabling environment in Africa clustering is mentioned as a strategy to create linkages between enterprises. Also it allows enterprises to successfully compete or stand stronger vis-à-vis a large buyer (Humphrey and Schmitz, 2008). An example of a cluster from Ghana shows how government support can affectively create circumstances for economies of agglomeration (UNIDO, 2008). In the case of the Brong Ahafo region the local conditions were taken into account and management was arranged with public (district councils) and private stakeholder (producer associations). The main strengths of the economic zone is the facilitation of two hard infrastructure and one soft infrastructural provision and includes:

-Access to affordable land. Land issues and high costs make it hard for entrepreneurs to start a business in a suitable location. Especially for graduates obtaining land is big hurdle for starting a company.

-Reliable access to electricity. An important constraint for enterprises is the limited and unreliable access to electricity. This is partly because enterprises are scattered, which makes it hard to handle electricity demand

-An advantageous institutional setting for **business development service (BDS) provision**. (see also section 1.5.4).

Internal competition will most likely lead to the demise of enterprises. But a cluster is not designed to create as much employment or economic activity as possible. Instead it should create a lasting sector by creating external competitiveness. The institutionalization and difference between PEA and cluster promotion is manifested by the coordination between stakeholders to build the capacities of a cluster. Capacities, such as education, are necessary to stimulate innovation and specialization, which are both essential to avoid a race to the bottom (Helmsing, 2003). A race to the bottom occurs when enterprises compete solely for prices of similar services and products. Coordination and investment by the multi-stakeholder network should stimulate building capacities, which is the way out of the fruitless race to the bottom (Helmsing, 2003; Meijer and Huisman, 2011).

1.5.2.3 Group learning

The third type of agglomeration promotion includes another step towards the institutionalization of enterprises in one locality and sector. Group learning refers to achieving common quality standards and norms for products and the production process. Also group learning should enable enterprises comply to these standards (Helmsing, 2003). This level of institutionalization is closely linked to increasing competitiveness by meeting demand side needs and preferences. In global value chains, which are often dominated by powerful buyers or retailers, control and coordination of a spatially dispersed suppliers requires so-called chain governance (Humphrey and Schmitz, 2008). The ability of a cluster to comply with standards gives a pivotal competitive edge. Also it allows a product or service provider to be part of a global value chain and greatly increase the service area (ibid.). In local value chains standardisation can also proof essential to increase market reach and penetration. Clear standardisation, possibly followed by certification makes the quality of a product insightful for customers and distinguishes it from counterfeit and substandard products (Velayudhan, 2008). Reputation damage from such products is also less likely to occur when proper trade is clearly recognizable (ILO, 2009). Stakeholders within and outside the cluster are eligible to initiate and safeguard the standardisation and potential certification. These could for instance be a producer association or a powerful buyer (Helmsing, 2003).

1.5.2.4 Innovative milieu

The final type of agglomeration promotion refers to the local innovative milieu. The innovative milieu is a well functioning multi-stakeholder network and will be discussed here. The enabling environment consists of the multi-stakeholder and infrastructure. Cluster promotion is dependent on the presence and ability of local stakeholders to cooperate (Helmsing, 2003; Maillat, 1998).

Firstly, LGAs tasks in such a network are: (1) service delivery, i.e. provision and maintenance of the physical infrastructure, (2) clear-cut law enforcement, so to prevent conflict, (3) and initiating the multi-stakeholder network and stimulating involvement. LGAs should also strive to enable stakeholders to contribute to the network (Goldman, 2005; Swinborn, Goga and Murphy, 2006). Local governments are better equipped than central governments to support enterprises because this requires direct involvement and tuning interaction of the stakeholders (Helmsing, 2005). Through recent decentralization policies in the Africa, LGAs have gained increased authority to govern public affairs. Often though, there are lacking resources and local capacities to meet the policy decentralisation, resulting in much responsibility but limited capacity to govern. Weakness of LGAs limits the ability in performing the above three tasks and creating an enabling environment (Helmsing, 2005; McEwan, 2003). This could potentially lead to transferring more responsibilities to the other two stakeholder groups.

Secondly, the private sector is central for all LED activities. Entrepreneurs are perceived to spark economic growth in an enabling environment. The role of entrepreneurs themselves differs in cluster formation, depending on the capacity of stakeholders to initiate a cluster. Ideally a cluster is initiated by entrepreneurs themselves. This creates ownership of the cluster and its activities. But the private sector rarely has the organizing power to set up a bottom-up cluster (Fromhold-Eisebith and Eisebith, 2005). In a similar way Zeng (2006) distinguishes between spontaneous agglomeration and government-driven, see also textbox 3 (2006) This is the reason why LGA's are assumed to at least initiate the multi-stakeholder network. Once set up, the innovative milieu makes sure active collective efficiency is created within the private sector, through for example producer associations. Producer associations lobby LGA's. This could help LGAs in recognizing their own value for the private sector and position and also prevent them from rent-seeking behaviour (Lucas, 1997)

The third stakeholder group, civil society organizations (CSOs) is hardest to define. This is also the point where less institutionalized clusters and clusters in an innovative milieu differ (cf. Helmsing, 2003; Porter 2000). In the former conceptualization the civil society, especially via NGOs and donors, take the position of an intermediary between governments and the private sector. Helmsing also includes business development service (BDS) providers in the group of CSOs (2003). For example, a Tanzanian case-study shows that the NGO sector plays a pivotal role in LED through capacity building and advocacy (Hewitt, Wangwe and Wield, 2002). In some cases this type of intermediation of CSOs is not required. In Porter's conceptualization CSOs function as an independent knowledge provider. Mainly universities and research groups spark innovation by brokering the knowledge input (Porter, 2000). In this case CSOs are no longer supportive to the overall multi-stakeholder network as a coordinator, but directly stimulates innovation.

1.5.3 African clusters

Experiences with cluster formation in Africa have been relatively limited and unsuccessful: "*Inter-firm specialization in local clusters is limited. Existing networks of ethnic business communities exclude indigenous African firms.*" (UNIDO, 2008: 18). Barr attributes the relative underperformance of Sub-Saharan African clusters to risk-minimizing behaviour (2000). She argues that basically such behaviour stems from a lack of trust, which to a large extent limits the potential to institutionalize clusters. Trust is essential to move from a low institutionalized agglomeration to a well functioning multi-stakeholder network (innovative milieu). Building trust in trade and other business relations in Africa seems to follow traditional routes. Trust is based on personal relations, rather than formal contracts, resulting in poor contract discipline (Barr, 2002; Moloney, 2007; 2009; Mwasalwba, 2012). Furthermore, lack of trust seems to have to do with enterprise size. Small enterprises are less able to take risks or far-reaching decisions, because of limited access to resources. Also the lack of outsourcing or subcontracting between these enterprises makes development of networks less likely (Barr, 2000; McCormick, 1999).

Dorothy McCormick studied six industrial clusters in Africa with each more than 500 enterprises (up to 8.000), mostly producing for a domestic market (1999). This pinpoints a first difference between the stereotypical Porterian clusters[8] that have expanded their service area to the global market. A second difference between these Porterian clusters and cluster manifestations in Africa is the size.

[8] Typical examples include the electronics industrial cluster in Sillicon Valley, the Norwegian maritime cluster and financial services in the City of London.

Research on cluster formation in Africa show its potential as a local economic development strategy (McCormick, 1999; Meagher, 2007; Murphy, 2002; 2007; Zeng, 2006; 2008).

In this master thesis clusters consist of SMEs, and are part of a local strategy for endogenous economic growth. Achieving a high number of enterprises for a large number of localities seems unrealistic. Rather than trying to have many enterprises in one place, a decentralized strategy for promoting (small) local cluster initiatives is proposed (Meijer and Huisman, 2011). Hence, it is assumed that concentrating enterprises can result in small-scale appropriate energy clusters. Finally, an apparent characteristic of cluster formation in Africa is the strong involvement of governments, for example by providing market information, trainings or accommodations (McCormick, 1999). Again this points to the need for top-down involvement of LGA's in the formation of a multi-stakeholder network.

1.5.4 Business development services

Section 1.5 has elaborated on the functioning of the enabling environment of clusters by describing the multi-stakeholder network. Finally, business development services (BDS) for SMEs as part of the (soft) infrastructure are of vital importance for cluster promotion (Olomi, 2007; Riedijk, 2010). Business development services can be defined as: "*the wide range of services used by entrepreneurs to help them operate efficiently and grow their businesses with the broader purpose of contributing to economic growth, employment generation, and poverty alleviation*" (Miehlbradt and McVay, 2003).

The basic rationale of BDS is rooted in solving market problems. By addressing a broad range of seven categories[9], the services are directed at improving supply, demand, transactions and the market for enterprises (Miehlbradt and McVay, 2003). The broadness of the concept makes it hard to generalize or propose a strategy to have BDS linked to a cluster. Ideally, BDS come about as a result of the free market mechanism (ibid.). For example, the aforementioned producer associations provide advocacy services because it reaps collective benefits for one industry. The same should apply for commercial BDS providers, such as banks. BDS providers require upfront investment, in money as well as commitment from the future BDS beneficiaries. Multi-stakeholder networks can stimulate the establishment of BDS providers. Collective efficiency and proximity of enterprises makes it attractive for BDS providers such as financial institutions to settle (Helmsing, 2003). The commitment and investment needed for attracting and setting up BDS, requires more than just the multi-stakeholder network. Creating the right physical infrastructure is part and parcel of attracting BDS providing, because hard infrastructure greatly affects economies of agglomeration, such as low

[9] Market access, input supply, technology and product development, training and technical assistance, infrastructure, policy/advocacy, and alternative financing mechanisms (Miehlbradt and McVay, 2003).

transactional costs (North, 1989). However, the cooperation between the private sector and LGA's often creates a "catch 22" situation, wherein stakeholders wait on each other to commit for investing in hard infrastructure. Also intermediation is often lacking to solve such issues (Helmsing, 2003).

The above described needs for BDS is contrasted by best practise for external involvement, mostly by donors and NGOs. The discussion surrounding BDS has especially focussed on the commercialization. To make BDS provision a self-sustaining and part of the private sector, enterprises should pay for these services. As long as BDS provision remains a subsidy, the enabling environment is there for the short-term. The ideal role of NGOs, donors or other external parties is to facilitate the creation of BDS and design it to be self-propelling (Miehlbradt and McVay, 2003; Riedijk, 2010).

1.6 Conducive factors for cluster formation

In the second part of this theoretical chapter cluster promotion was presented as a tool for enterprise development. Table 1.3 summarizes the main features of clusters. The table distinguishes between the main strengths or economies of agglomeration advantages; the factors that lead up to these advantages; and the possible conducive factors from the institutional setting. **Increased competitiveness** comprises the benefits that directly relate to the proximity of the enterprises and refers to the main dynamic in clusters as introduced in section 1.5.2.2. **Group learning** is a relating advantage that can stimulate the product and service of a cluster to the advantage of customers as explained in section 1.5.2.3. The **enabling environment** includes the innovative milieu (section 1.5.2.4) and the BDS provision (section 1.5.4). The **endogenous economic growth** refers to factors that create the ability of an agglomeration or cluster to avoid race to the bottom of competing enterprises of a similar trait (see section 1.5.2.2). **Input sharing/ supplier and buyer advantages and labour pooling effects** are economies of agglomeration that can be successfully promoted through institutionalization of clusters and propel the competitiveness of the cluster further.

It would require more research to complete table 1.3 and assess the causal relations between the factors and economies of agglomeration. This is outside the realm of this research. The table below is meant to help identify if an institutional setting is conducive to cluster promotion.

Table 1.3 Cluster formation model

Economies of agglomeration	Requirement	Conducive factor
Increased competitiveness (Krugman, 1991;; Rosenthal and Strange, 2001; Scott, 2002)	Specialization (Cypher and Dietz, 2009; Helmsing, 2003; Porter 1985)	Proximity of enterprises (cf. Krugman, 1991; North, 1989)
	Knowledge availability (Barr, 2000; Naudé, 2009; Naudé and Havenga, 2007; Ramachandran and Shah, 1999)	Social capital/Trust (more and more diverse contacts) (Barr, 2000; Moloney, 2007; 2009; Mwasalwba, 2012)
		Repetitiveness of transactions and exchange (UNIDO, 2011)
		Outsourcing (Barr, 2000; McCormick, 1999)
Group learning (Helmsing, 2003; Humphrey and Schmitz, 2008)		Development of norms and standards (Humphrey and Schmitz, 2008; Velayudhan, 2008)
Enabling environment (Helmsing, 2005; McEwan, 2003).	Well functioning multi-stakeholder network (innovative milieu) (Helmsing, 2003; Goldman, 2005; Maillat, 1998; Swinborn, Goga and Murphy, 2006)	Locally and institutionally rooted (cf. Myrdal, in Cypher and Dietz, 2009)
		Strong LGAs, (1) service delivery (2) law enforcement (3) capability as cluster initiator (Helmsing, 2005; McCormick, 1999; McEwan, 2003)
		Private sector, presence of producer association (Helmsing, 2003)
		Civil society organizations, developed knowledge function (Hewitt, Wangwe and Wield, 2002; Miehlbradt and McVay, 2003; Riedijk, 2010; Porter, 2000)
	Hard infrastructure (Scott, 2002)	LGA's facilitation and promotion of hard infrastructure in one locality (Helmsing, 2005)
	BDSs (soft infrastructure) (Olomi, 2007; Riedijk, 2010)	Availability of intermediaries for commercialized BDS ((Helmsing, 2003; Naudé and Havenga, 2007)
	Entrepreneurial attitude (Baron and Shane, 2008; Nkya, 2003)	Education (Mwasalwba, 2012; Ramachandran and Shah, 1999)
Endogenous economic growth (OECD, 2008)	Internal competition (Porter, 1985; 2000)	Coordination to build innovation capacities (and prevent a race to the bottom) (Helmsing, 2003)
Input sharing/ supplier and buyer advantages and (Krugman, 1991; Rosenthal and Strange, 2001; Schmitz and Nadvi, 1999; Scott, 2002) **labour pooling effects** (Krugman, 1991; Rosenthal and Strange, 2001; Scott, 2002)	Active collective efficiency (Helmsing, 2003; Sölvell, Lindqvist and Ketels, 2003)	Regularized specialization (Helmsing, 2003; Sölvell, Lindqvist and Ketels, 2003).
		Producer association (extent of advocacy capabilities) (Helmsing, 2003; Sölvell, Lindqvist and Ketels, 2003).

1.7 Chapter conclusion

This chapter focussed on the theoretical basis for three aspects of sustainable energy provision. Firstly, AETs were conceptualized to assess whether an energy technology is context specific. Based on the literature AETs are thought to be decentralized and renewable solutions that focus on household energy needs. Secondly, the basis to determine what the energy needs are was introduced with the TEA model. Household energy needs can be met by a number of technologies. The sustainable livelihoods framework gives better understanding which technology fits the local context. In textbox 2 an example of its application was given. Thirdly, to build local ownership of a technology appropriate energy enterprises (AEEs) are required. Cluster promotion can develop these AEEs. Economies of agglomeration are the benefits that result from the proximity of enterprises and the reason for cluster promotion. To make economies of agglomeration work for clusters, among others an enabling environment needs to be institutionalized. In table 1.3 conducive factors were summarized that lead to economies of agglomeration. The next chapter provides contextual information of the research area, to understand the household and energy needs and for the selection of AETs.

Chapter 2 Contextual Information: energy provision in Tanzania

Contextual information is essential to make energy provision appropriate. This chapter provides contextual information for assessing the energy needs in the research area of rural Tanzania. The current energy provision is discussed, which illustrates the need for an energy transition in Tanzania. Moreover, this master thesis studies cluster promotion for appropriate energy enterprises (AEEs) to create local ownership of energy provision. The context that effects the institutional setting for developing AEEs is discussed in this chapter as well. For future reference figure 2.1 depicts a map of Tanzania.

Figure 2.1 Tanzania with basic infrastructure

Source: UN, 2006

2.1 Understanding Tanzania

This first section provides information on four types of characteristics of Tanzania. Though some of the information serves as background, it is important for understanding energy provision in rural areas. For instance, the Ujamaa policy (see section 2.1.3) included an unsuccessful campaign to displace people to improve service provision. Such experiences need to be understood to discuss economic geography concepts as clusters.

2.1.1 Political characteristics

The Tanzanian mainland (Tanganyika) gained independence in 1961 and merged with the Zanzibar archipelago in 1964 to form the United Republic of Tanzania. Tanzanian political culture has been greatly influenced by founding father Julius Nyerere and remnants from pre-colonial rule (Pinkney, 2003). Concerning the latter, former president Benjamin Mkapa explained this approach while discussing Zanzibars aspirations for self-rule: "*... to revert to African traditions and ways of resolving conflicts, under which even before colonialism, our elders when confronted with a major crisis, used to 'sit under the tree', discuss, listen to each side, weigh each argument, without regard to how long it took to reach agreement.*" (cited in Pinkney, 2003: 209).

This deliberative process, also known as the palaver tree tradition, is of course not always put in practice. The national dialogue in Tanzania is limited and Nyerere's party (CCM[10]) has been in power since independence. On the other hand, there has always been interparty competition, for example member of parliament candidates from CCM compete for a seat in parliament. Moreover, multiparty competition has been introduced in 1992, and the main opposition party (CHADEMA[11]) has won by-elections in many economically important districts (Pinkney, 2003; Tripp, 1997). But the CCM remains dominant on the national level. In the most recent presidential elections of 2010, CCM candidate Kikwete took two thirds of the vote and CHADEMA candidate Slaa took 26 percent (Meijer, 2012).

In section 1.5 the multi-stakeholder network was introduced and the role of LGAs in Africa was briefly discussed. Decentralization policies lead to increased responsibility at the district level, but decentralization fails if the capacity to meet these responsibilities doesn't go with it (Helmsing, 2005; McEwan, 2003). Nyerere tried to enable (rural) communities to shape the decisions that affect them. Part of this strategy was a political decentralization policy that commenced as early as 1972. However, this policy did little for the self-rule of communities: "*While central government administrative structures improved through these decentralization initiatives, actual participation by the rural and urban populace in the development process was not realized*" (Massoi and Norman, 2009: 134).

[10] Chama Cha Mapinduzi
[11] Chama cha Demokrasia na Maendeleo

In practice this decentralization policy meant centralization. Bureaucrats were made accountable to the central government, instead of the people in their wards and districts (Tripp, 1997). In 1997 the Decentralization by Devolution (D-by-D) policy aimed at increasing local authority. Unfortunately, the value of the D-by-D policy at the grass-roots level is still deemed "*minimal and ineffective*" (Massoi and Norman, 2009: 139). Local communities are inadequately involved in the policy making process due to the irresponsiveness of district councils. Rather than shaping their own policy, communities were involved in centrally planned policy (ibid.*)*. Also the ideal of increasing equality between regions is badly met by the D-by-D policy. The capacities to fulfil goals set by the central government are not proportional to districts needs. Instead, the funds that districts receive are determined by the existing facilities. Hence, regions that are already better off receive more funding than those that are in need of expanding their facilities. Moreover, the local spending pattern is largely pre-determined by the central government, leaving little space for adjusting spending to locally identified needs (MKUKUTA, 2009). Increasing the available and locally controlled funds can be achieved by increasing efficient taxation. This might be done by shifting the responsibilities from elected officials to the council administration (Fjeldstad, 2001).

Finally, one of the most striking political characteristics is Tanzania's stability. Besides negative economic influences the Ujaama (familyhood) policy did create a stable nation state. In contrast to many other African countries, tribalism or religion did not interfere with a sense of nationhood and peace. It has made Tanzania somewhat of a donor darling, receiving general budget support (GBS) in 2009/2010 of 751 million USD. This figure declined to 531 million USD in 2010/2011, but still represents 6.4 percent of the total governmental budget[12]. Moreover, on top of GBS Tanzania received aid through development projects and grants. In total in 2010/2011 Tanzania received 2 billion USD worth of aid, 8.6 percent of GDP. This makes Tanzania a top aid recipient (Meijer, 2012) The total expected amount of aid for the current year is 2.5 billion USD. The OECD does rate the aid well spent and in line with the Paris declaration (see section 1.1) (The Citizen, 2011). GBS has come with an IMF agenda and led to economic liberalization.

Unfortunately, the political situation is getting more tense. Especially during by-elections in strongly contested districts political demonstrations has led to violence. But the country political situation will most likely remain stable at least until the next presidential elections in 2015 (Meijer, 2012).

[12] GPS is provided by 11 donors: African Development Bank, Canada, Denmark, the European Commission, Finland, Germany, Ireland, Japan, Norway, the Netherlands, Sweden, Switzerland, the United Kingdom, and the World Bank (The Citizen, 2011).

2.1.2 Economical and entrepreneurial characteristics

Tanzania has experienced a turbulent economic development process. After independence the government increased its involvement in the economy implementing a socialist policy, that was motivated by ideals of equality and universal social services provision. In the Arusha declaration of 1967 the nationalization of the major share of the economy was arranged, leading to many parastatal organization taking over formerly private sector activities. In 1976 the government employed 65 percent of all employees in Tanzania, which made the government financially top-heavy. As external crises hit this situation could not be sustained and the economy was in big trouble soon, leading to negative growth of 4.4 percent in 1981. Moreover between 1974 and 1988 the real wages dropped by 65 percent. By 1988 the average monthly income of a worker was only sufficient to feed a household of six members for three days of a month (Handelman, 2000). The economic crisis had especially severe consequences for the agricultural sector, which is of vital importance to the lion share of Tanzanians. The net national export of food products in the 1960s had by 1981 turned into a net import (Tripp, 1997).

Part of Nyerere's socialist policy is the aforementioned Ujamaa philosophy. Ujamaa includes the

> "*graduates who identify themselves as entrepreneurs are still equalled to those who are unemployable, necessity-based traders...*" (Mwasalwiba et al., 2012: 394).

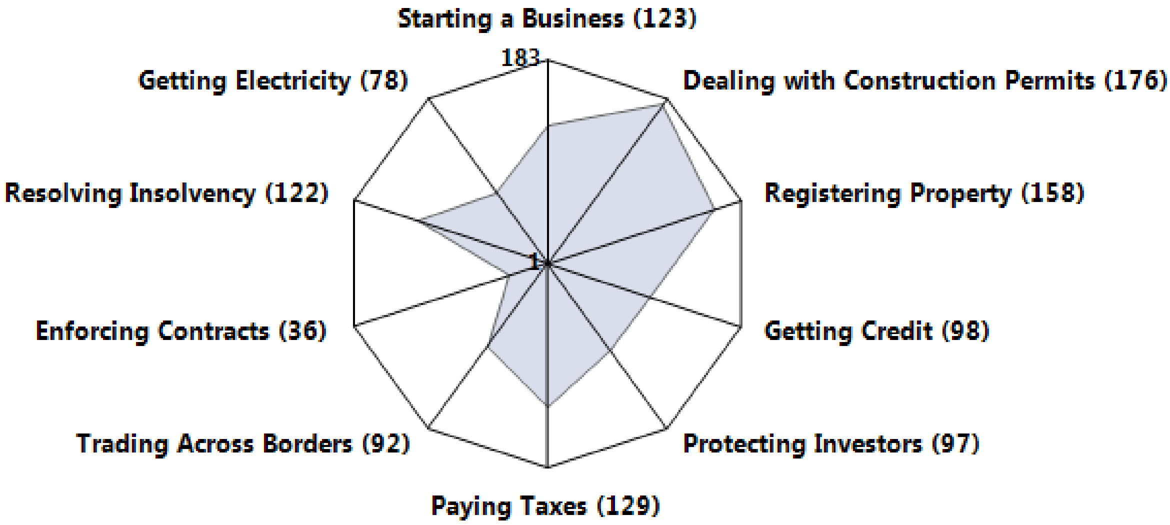
policies outlined in the Arusha declaration, among which nationalization and villagization. Villagization sought to collectivize all rural economic activity and have service provision centralized. Overall, local entrepreneurship was discouraged. Besides setting the conditions for the dire economic situation of the 1980s, Ujamaa affects the relatively low developed entrepreneurial attitude: "*graduates who identify themselves as entrepreneurs are still equaled to those who are unemployable, necessity-based traders...*" (Mwasalwiba et al., 2012: 394). But Tanzania has since the economic crisis turned its economic policy around. The government is pursuing a market led economy (economic liberalization policy) and actively stimulates entrepreneurship. This policy mostly leads to an increase of the most common form of entrepreneurship in Tanzania, i.e. micro and small businesses in cities and towns (Mwasalwiba et al., 2012). As discussed in chapter 1, entrepreneurship can be motivated by survivalist strategies. In Tanzania the origin of these enterprises can be traced to the economic downturn of the early 1980s. To survive the dire situation of extremely low income from formal jobs, many households fled to entrepreneurship. Especially women, who had formerly not worked outside the home, set up small shops, which led to an enormous increase of the informal sector (Handelman, 2000). During the time of Ujamaa and economic recession, much economic activity (as well as social services) were actually not state led but informal. Tripp (1997) describes that the informal sector was born out of necessity to counter the inability of the state. Thus the informal sector challenged the Ujamaa philosophy even before international organizations like the IMF did (ibid).

80 percent of all household budget is earned through self-employment either in agriculture or non-farm activities (Jin and Deiniger, 2008). Becoming an entrepreneur and going beyond the survivalist stage, i.e. opportunity-driven entrepreneurship (see section 1.4), is currently made easier. Especially graduates can build and expand their businesses by relying on their managerial skills. The experiences of a number of graduate entrepreneurs show that political and social climate changed to their advantage. Poor public administration, such as corruption and other rents, is still a hurdle but has been reduced. In general the support of formal institutions for entrepreneurship has improved. (Mwasalwiba et al., 2012). This is further illustrated by studies from the World Bank (*Doing Business)* that compare the formal business regulations in 183 economies. Tanzania ranks 127, which is a bit better than the average of 137 for SSA. The relative costs of starting a business has dropped to one seventh since 2004, amounting to a little over 1500 USD (World Bank, 2012c). Figure 2.2 further shows how doing business in Tanzania is stimulated or frustrated by the formal regulatory framework. The further the grey areas stretch from the centre of the figure and the higher the scores, the worse the business regulations in Tanzania perform vis-à-vis the other 182 economies. Tanzania appears to be relatively strong in enforcing contracts. The main contributor are the courts, that were reported to handle cases relatively swiftly and cheap. The weakness in the business regulatory framework is dealing with construction permits and to a lesser extent registering property. Getting the title deed of a piece of land takes much time and money. Moreover, acquiring the construction permit for a warehouse or other type of business accommodation takes almost a year and the equivalent of 1200 percent of the per capita income[13]. It should be noted that unofficial business regulations, such as bribery, are not part of this World Bank report.

The political shift to economic liberalization has improved the business environment, but there is a lack of entrepreneurship support at lower level of government and institutions, such as banks, tax authorities and training institutions (Mwasalwiba et al., 2012). Other barriers include poor access to technology, corruption and distorting cheap imports from India and China (ibid.). Jin and Deininger focussed on informal non-farm enterprises in Tanzania and mostly suggested financial and infrastructural constraints (2008).

[13] This amounts to 62,000 USD, 16 times the costs for fulfilling the same procedures in 2009.

Figure 2.2 ***Doing Business*** **rankings in Tanzania compared to 182 economies**



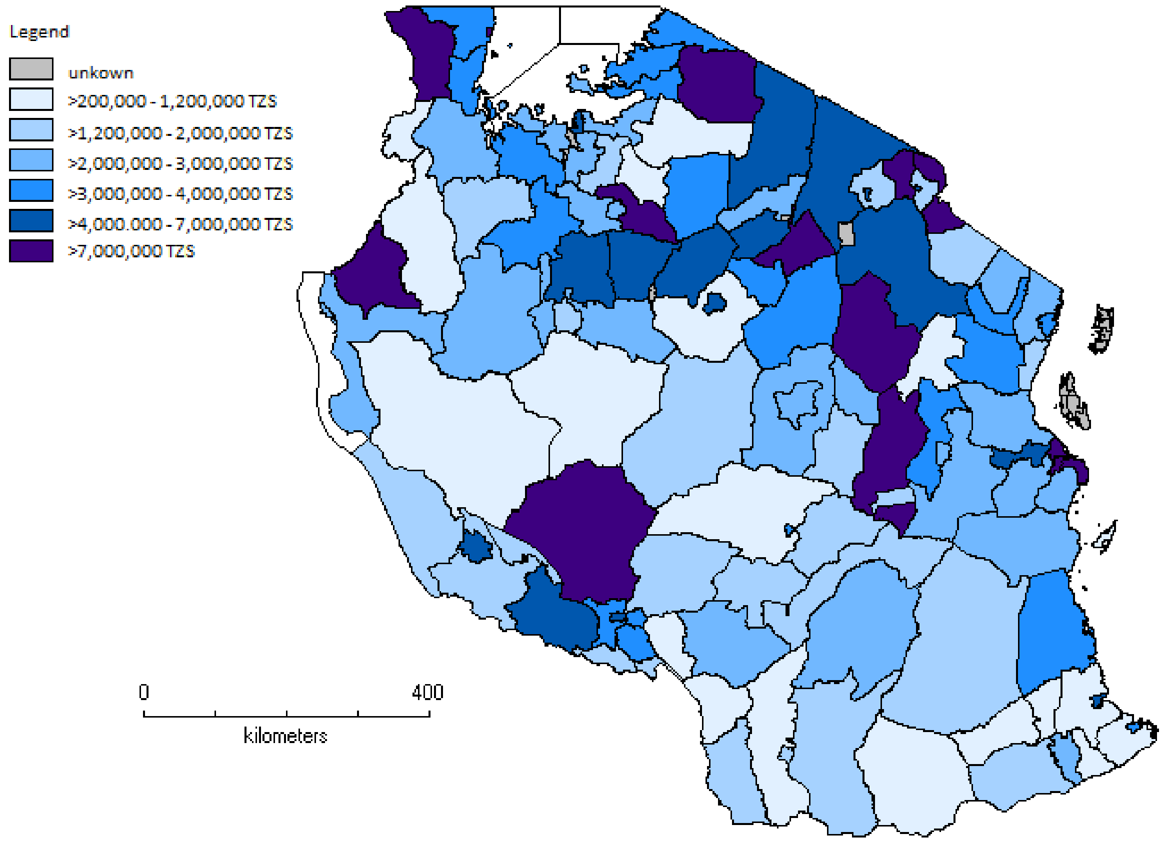
Source: World Bank, 2012c

The experiences of Tanzanian entrepreneurs show that the informal context is of great importance. Chapter 5 elaborates on the research results regarding the institutional setting. Enterprise development depends very much on social capital and relations of trust. Family relations are typically perceived as trustworthy and many Tanzanian businesses rely on these ties. However, as Mwasalwiba et al. (2012) explain, relying on relatives in business can be a sign that businesses need to revert to these ties, because other relations cannot be trusted. And indeed many entrepreneurs in Tanzania claim this is the case: "[At the start] *I used to hire my nieces, my sister's daughters. I was paying them, of course... You know, if you decide to hire other people, they come to work, but not trustful. … But they get tempted to steal. I wanted someone I can trust…*" (entrepreneur cited Mwasalwiba, et al., 2012: 393). As also discussed in the previous chapter, in choosing business partners, employees and suppliers trust and social network (the people one knows) are pivotal. Trustworthy ties largely determine contract discipline and access to resources for start-ups (ibid.).

The economic liberalization measures got the economy going again at the end of the 1990s. Since 2001 Tanzania has experienced annual growth of six percent and more (MKUKUTA, 2009; Meijer, 2012). The most important contributor to Tanzanian economy is the service sector, with 47.8 percent in 2008. Services have increased substantially in share of GDP, while the second sector, agriculture has steadily shrank as a percentage, now standing at 24.0 percent. One of the fasted growing industries is the mining and quarrying industry. Gold represents 36 percent of all export, which is mainly caused by the rising gold price (Meijer, 2012; MKUKUTA, 2009). Imports are dominated by capital goods and petroleum products (ibid).

The household budget survey (HBS) of 2007 shows that most employed people on mainland Tanzania have an occupation in agriculture and fishery, 68 percent overall and 82 percent in rural areas. The importance of agriculture is illustrated by the consequences of the drought in the Horn of Africa and East Africa in 2011. An export ban for grain and sugar was imposed to control mounting prices and prevent shortages (Meijer, 2012). In urban areas many urn an income as shopkeepers and through elementary work, together these two occupations make up roughly half of all urban employment (GoT, 2009). The geographical distribution of the annual household budget averaged per district is shown in figure 2.3. This gives an idea about the distribution of wealth and economic activity in mainland Tanzania. Overall, 88 percent of Tanzanians live off less than 2 USD a day. This is a relatively high percentage of impoverished people, also for African standards[14] (PRB, 2012). On the other hand income inequality is low compared to all neighbouring countries. Over the years of economic growth a slight rise is detectable in urban areas, especially in Dar es Salaam (MKUKUTA, 2009). Finally, inflation has a strong effect on the ability of households to maintain a livelihood. Caused by the droughts and related electricity shortages the inflation rose to almost 20 percent at the end of 2011 and beginning of 2012 (Meijer, 2012).

Figure 2.3 Average annual household budget in TZS per district



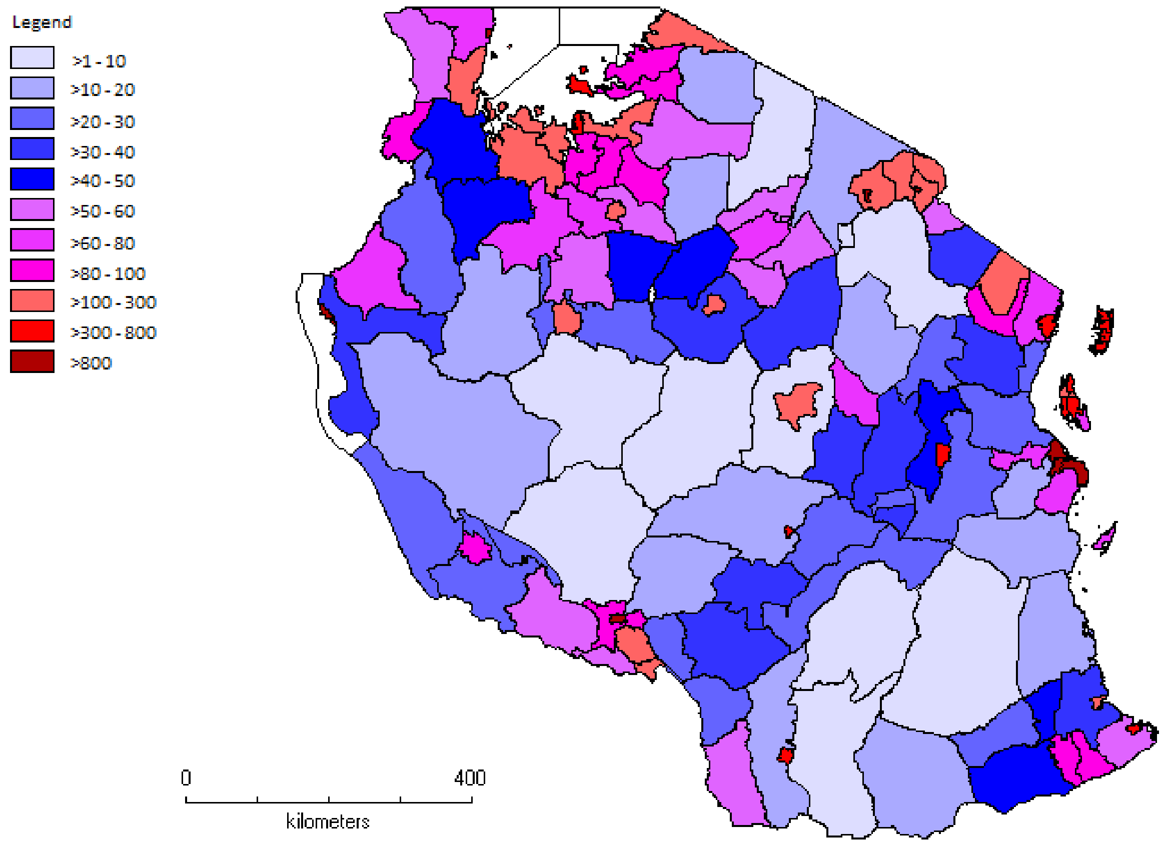
Source: derived from data of the HBS 2007 (NBS, 2009)

[14] 72 percent of the total population of Sub Saharan Africa lives on less than 2 USD (PRB, 2012).

2.1.3 Demographical characteristics

According to the Population Reference Bureau the population of Tanzania has 46.2 million inhabitants, of which 65 percent lives in rural areas. (2012). As already reported in the introduction the population is growing with 2.8 percent a year, which means that it takes about 25 years to double in size (PRB, 2012). This is a slower growth rate than before, because the population has almost tripled since 1975. Despite this fast growing population, population density is still quit low, on average 49 inhabitants per square kilometre. Figure 2.4 gives a geographic impression of the population density per district. Tanzania has a young population, 45 percent is younger than 15 years of age. Life expectancy at birth is 57 years of age, which is just above the African average of 55 years of age (PRB, 2012).

Figure 2.4 Average population density in inhabitants per square kilometre per district



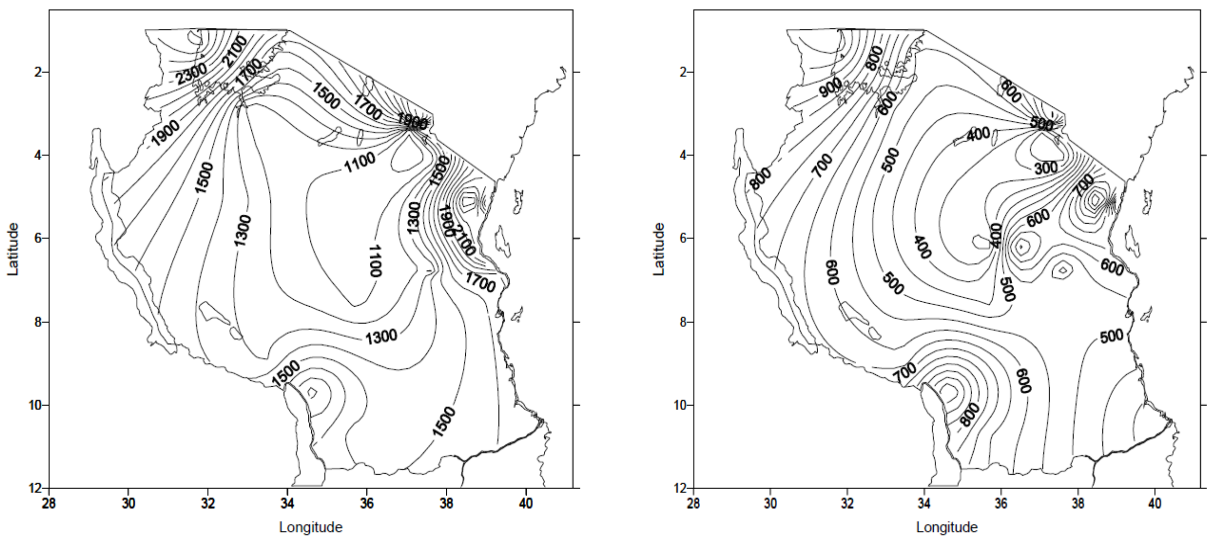
Source: derived from data of the Census 2002, (NBS, 2009)

Of special importance for this master thesis is the way service provision is arranged. Service provision and economic growth is challenging in a thinly populated area. Simply the number of customers in an area makes it hard for service providers and retailers to become profitable. Expanding a service area is also challenging if the hard infrastructure is not adequate. As mentioned before, Ujamaa philosophy tried to solve these issues by centralizing and collectivizing service provision and economic activity in one village (villagization). To succeed, villagization required people to move to Ujamaa villages, and live together around the main services centre. Also farmers had to give up individual farming in favour of working in a cooperative. Overall the policy was designed top-down and was met with distrust and resistance. After three years of unsuccessful coercion the policy was abandoned by 1975 (Ibhawoh and Dibua, 2003). As mentioned at the beginning of this chapter the Ujamaa villages are an important example of spatial interventions. These interventions are motivated by increasing the efficiency of service proficiency. To make service proficiency planned in a cost-effective way it needs to exceed a certain threshold of users. In rural Tanzania this makes the service area of a particular service very large. But instead of trying to centralize users, the Ujamaa village example shows that service provision should be planned to meet the preferences of users.

2.1.5 Physical characteristics

Appropriate energy technologies are designed to fit the characteristics of the context. Besides the needs and preferences of the households this includes physical characteristics. For example, the presence of rivers greatly determines the potential for hydropower. In chapter 4 the appropriateness of energy technologies for rural Tanzania will be determined assisted by this information. In addition for selecting the technologies under scrutiny in this master thesis the level of development of the sector plays an important role.

Figure 2.5 Extreme maximum (left) and minimum (right) annual rainfall in mm.

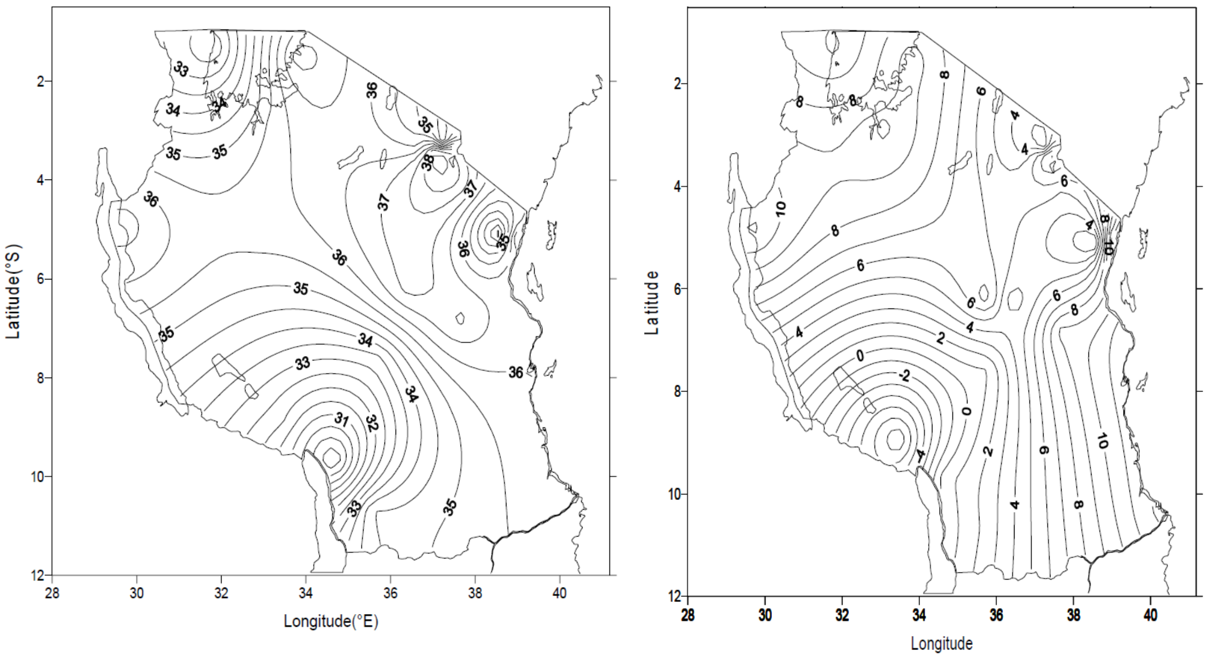


Source: Vice Presidents Office 2007

Tanzania has three dominating climates. Firstly, the tropical coastal areas with high temperatures and humidity and a rainy season in March to May. Secondly, the cooler inland mountainous areas that experience short rains two times a year from November to December and February to May. Thirdly, the plateau areas that are generally drier but instead have considerable changes in temperature. Figure 2.5 shows the extreme maximum and minimum rainfall across the country. Rainfall largely determines the availability of water and fertility of land. Recently the timing and amount of rainfall during the rain seasons has become less predictable. Moreover, there is an overall trend of less rainfall (Vice Presidents Office, 2007). In the summer of 2011 the horn of Afica and East Africa experienced the consequences of drought. The situation in Ethiopia, Kenya and especially Somalia was worse than Tanzania, but the drought impacted livelihoods in Tanzania as well. As mentioned the export of grain and sugar had to be banned in order to control rising prices of these essential food products (Meijer, 2012). Recently, there has been a shift to crops which take a short time to grow, in order to make money in a relatively short time span (Ponte, 2002). This decreases dependence on seasonality, also the resilience of households to shocks is reduced. On the downside, in most cases the money that can be made from so-called fast crops is less than traditional crops, which take longer to fully grow. Ponte contributes this shift to the IMF policies, especially the liberalization of the economy (ibid.). It is unclear whether this shift is partly caused by changes in the climate as well.

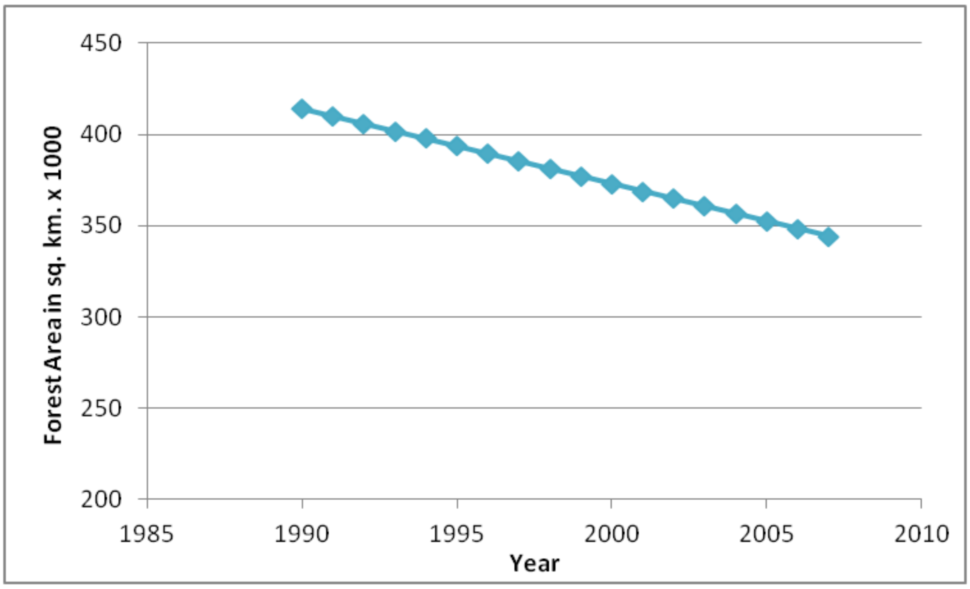
Temperatures in Tanzania differs widely across the three aforementioned climates. With the coastal areas experiencing the highest temperatures, on average 28 degrees Celsius year round, the mountainous areas experience the temperatures with annual averages around 20 degrees Celsius, and occasionally dropping below 15 degrees. Figure 2.6 depicts the extreme maximum and minimum temperature. The average temperature in Tanzania is rising (Vice Presidents Office, 2007). Due to global climate change effects the annual temperatures in Tanzania are thought to rice between 2.1 and 4.0 degrees Celsius. Especially the colder seasons are affected by the rise. The increase in temperature has a direct effect on evaporation rates and thus the ability of soil to retain water.

Figure 2.6 Extreme maximum (left) and minimum (right) temperatures in degrees Celsius



Source Vice Presidents Office 2007

Graph 2.1 Tanzanian Forest Area (1990-2007)



Source: FAO, 2011

As discussed in chapter 1 and depicted in graph 2.1 the biomass base is declining. In a report for the East African Community the biomass fuel scarcity is ranked severe for the majority of regions in Tanzania (2008). The consequences of using biomass don't have to be so detrimental. As long as woodfuels (firewood and charcoal) are properly managed, the fuel can be considered renewable. A forest can become sustainable if the logged amount of wood equals the growth of woody biomass. In theory enough growth is present to meet wood fuel energy demand in Tanzania (Kaale, 2005). Unfortunately biomass resources are unequally distributed across regions. While some regions experience abundance, in other regions households deplete this resource. Moreover, efficiency of production of charcoal and the way the fuel is burned makes the demand much higher than it needs to be. Provided more efficient methods are used biomass can become renewable (Kaale, 2005). In the next section the current energy provision in Tanzania is explored. Also the consequences of reliance on woodfuels are further discussed.

2.2 Energy provision per geographical area

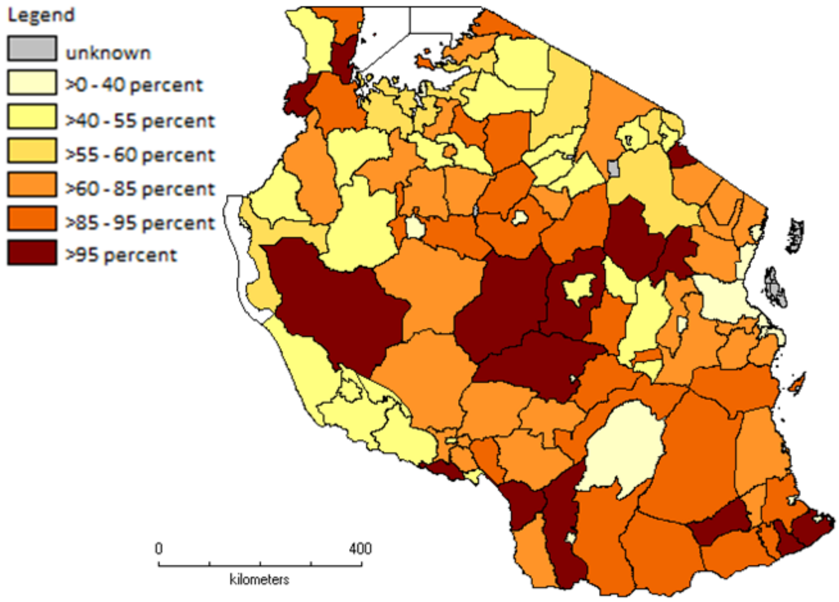
This master thesis focuses on energy provision in rural Tanzania. Besides rural and urban a further classification can be made of geographies: deep rural areas, rural areas, peri-urban and urban areas. These distinctions are made based on accessibility of an area from urban centres (in time) and economic density (in money). Both indicators are equally weighted, which determines the categorization of the area. Low scores indicate deep rural and rural areas, and higher scores peri-urban and urban (EEA, 2011). In this section we use the categorization to make generalizations of the type of energy provision in these areas (see table 2.2).

2.2.1 Biomass

> "*The cost per useful lighting services (dollars per lumen-hour of light) for kerosene lighting is 3000 times higher than for compact fluorescent light.*" (Kammen and Kirubi, 2008: 352).

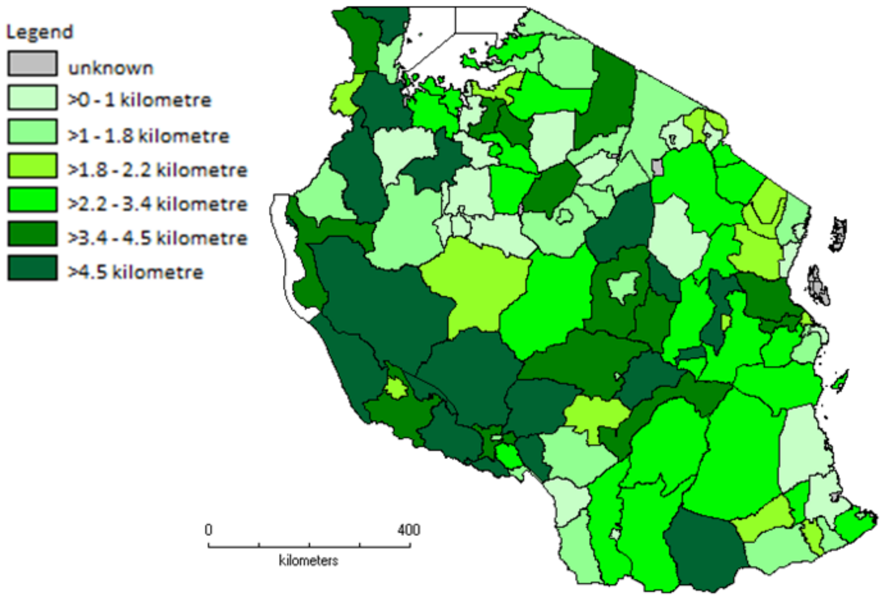
The dependence of the Tanzanian population on biomass is high. 95.6 percent of the population uses wood for cooking, regardless of the use of other cooking fuels (GoT, 2009). In total 78.9 percent of the total population uses this source as primary energy for cooking. In rural areas this is even 92.4 percent of the population (NBS, 2011). Figure 2.7 shows the average percentage of households per district using wood as a primary cooking fuel. The figure show the dependence of rural livelihoods on firewood, but also depicts large differences. It seems likely that this has to do with the availability of wood resources (SNV, 2012). Regardless of whether firewood is bought or collected, in both cases household assets are negatively affected when woodlands are being exhausted. Mounting costs weigh on the household budget and if a household is accustomed to log wood the extra time and labour for collection can be problematic as well. Especially women are equipped with the job of walking great distances for collecting firewood. Often in rural areas women have to walk 5 to 10 kilometre with loads of 30 kilograms of firewood carried on their heads (AGECC, 2010). Figure 2.8 shows the average distance households have to cover to collect firewood. This variable can be considered as an indicator for the scarcity of woodfuels as well. Especially in the Eastern Zone in the regions Rukwa and Mbeya, the access to freely available firewood is limited. These results seem to align with the relative low usage of firewood in those two region as shown in figure 2.7. Because firewood is commercialized in areas where the resource has become scarce the usage typically drops (Wiskerke et al., 2009). Besides thermal energy use, energy for lighting in deep rural and rural areas is mostly paraffin and kerosene (NBS, 2009; 2011). Kerosene is centralized and prices are highly volatile, and thus for many rural households hard to rely on. Also kerone lamps deliver poor lighting, attribute to IAP and is very costly. "*The cost per useful lighting services (dollars per lumen-hour of light) for kerosene lighting is 3000 times higher than for compact fluorescent light.*" (Kammen and Kirubi, 2008: 352). Also the emissions of kerosene lighting are considerable, 100 kilogram of GHGs each year (ibid.).

Figure 2.7 Firewood as primary cooking fuel as a percentage of households per district



Source: derived from data of the HBS 2007 (NBS, 2009)

Figure 2.8 Average distance to collect firewood per district in kilometre



Source: derived from data of the HBS 2007 (NBS, 2009)

These characteristics of the current energy provisions explain the need for energy transition in rural areas, but the primary energy resource in deep rural areas will not change overnight. Many rural households use firewood in combination with a three stone fire, which is costless but thermally inefficient (SNV, 2012). In areas with low accessibility from urban centres, firewood can be the only choice because alternative energy resources are hard to deliver. Also in many cases firewood is collected without financial costs (ibid.). This makes it difficult for alternative energy resources to compete, because any alternative will be regarded expensive (EAC, 2008). In many deep rural areas the main economic activity is subsistence farming, which will generate very little financial assets. Shifting to paid energy resources in these areas can be very problematic even if only small amounts of money are involved (ibid.).

Instead of trying to switch energy resource or technology a first step to an energy transition could be to increase the management of forest areas (Gibson, et al., 2005; Hayes, 2006; Van Laerhoven, 2008). This would require households to purchase their firewood, but might prove an important incentive to increase efficiency by using improved cook stoves (ICS) instead of three stone fires, which can also have social benefits. To commercialize firewood logging needs to be regulated and illegal logging actively combated (ibid.). Alternatively, continuing on the same path will in some cases lead to the depletion of woodlands and in the end firewood will become a commercial commodity just the same. Sustainable energy provision requires that biomass is not depleted (De Vries, 2011). Another, argument for regulation from the household perspective is that commercialized energy provision can reduce the social costs of the exhaustive firewood collection (AGECC, 2010).

Agroforestry is proposed for producing fuelwood (resource for charcoal and firewood). In a study by Wiskerke et al. the potential for management of woodlots in Tanzania is shown (2009). An agroforestry initiative was studied in a rural area of Shinyanga, a region in the north of Tanzania (see figure 2.1) where firewood is commercialized and many households depend on charcoal. When farmers rotate or combine forestry on the plots of their land they can produce fuelwood for a competitive price (ibid.). Unfortunately the costs for obtaining a government license for commercial wood production is too high to make it economically feasible for small holders. A possible remedy for non-commercially feasible projects that clearly show how GHGs are reduced is obtaining funds through clean development mechanisms (CDMs)[15].

> "*Fuel is one of a family's top three household expenses... People struggle daily to afford fuel.*" (GACC, 2012).

Commercialized firewood opens opportunities for a shift to alternative energy technologies and resources. On average households spend 12.5 percent of the household budget on charcoal and even 31.8 percent on kerosene (NBS, 2009). "*Fuel is one of a family's top three household expenses... People struggle daily to afford fuel.*" (GACC, 2012). Increasing efficiency of energy use can make a considerable contribution to the household budget. ICS can greatly increase the energy efficiency of

[15] Funding through CDM can only be obtained if projects are not commercially feasible without CDM support, this a requirement stemming from the so-called additionality criterion (Wiskerke et al., 2009).

cooking and thus reduce the amount of firewood or charcoal required. In chapter 4 the ICS sub-sector is explored.

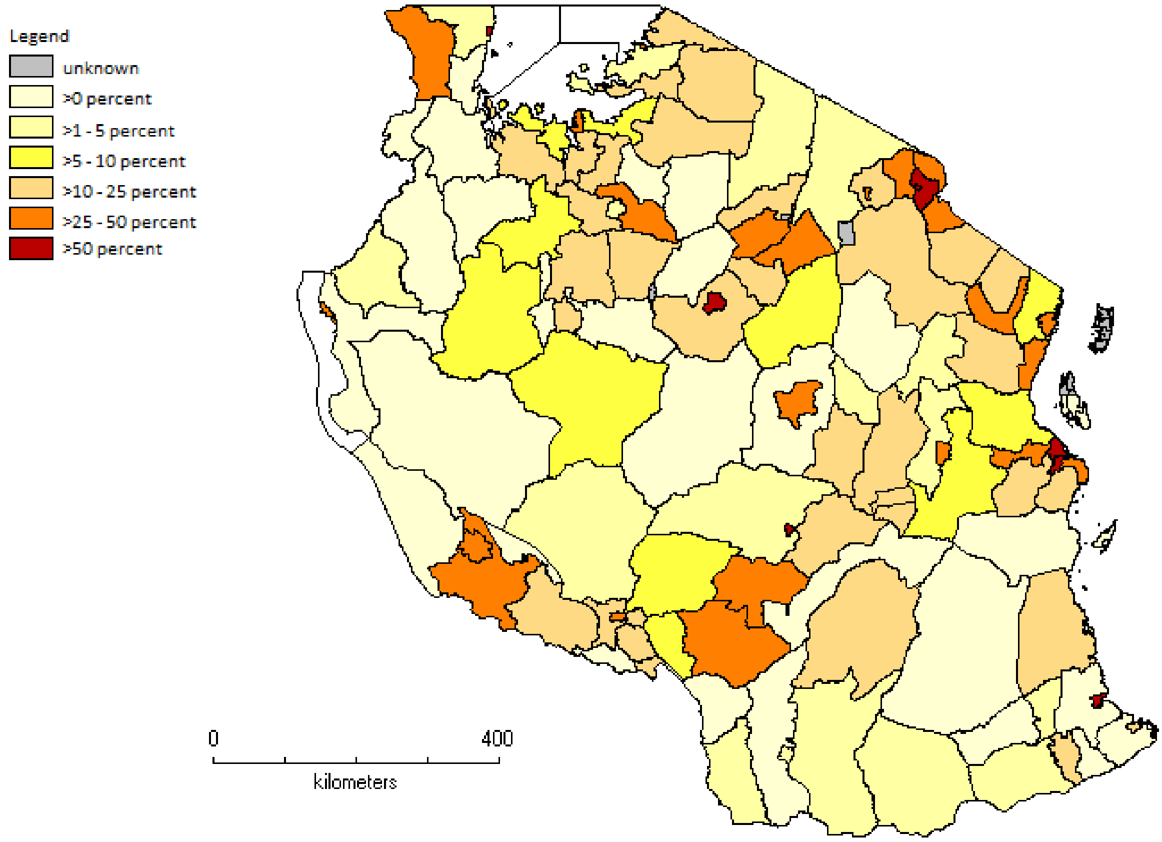
2.2.2 Grid electricity: served and underserved areas

Electricity is of increasing importance to households. For example the wide uptake of mobile telephony increases demand for charging services and requires a powered (wireless) telephone network (GoT, 2010; Moloney, 2007). For the future energy provision and planning of rural areas it is essential to know whether grid connection is likely. Energy provision needs to be arranged in an alternative way if grid connection will remain unlikely. This section explores which areas are electrified and the potential of grid electricity for sustainable energy provision.

According to the Demographic and Health Survey of 2010[16] 14 percent of the population has access to grid electricity, this is a 4 percent increase from 2001 (NBS, 2011). The electrification in 2010 in rural areas stood at a mere 3 percent in rural areas, a 1 percent increase from 2001. By contrast, electrification in urban areas stood at 45 percent of the population (NBS, 2009). The urban bias in grid electricity access is clearly shown in figure 2.9 that depicts the average electrification per household per district. This figure roughly aligns with information of the national grid from TANESCO (Tanzania Electric Supply Company) the network administrator and energy company, which is shown in annex C.

[16] The survey included interviews with 9,623 households (GoT, 2011)

Figure 2.9 Electrification as a percentage of households per district



Source: derived from data of the HBS 2007 (NBS, 2009)

The majority of electricity in Tanzania is generated by hydroelectricity plants, which makes electricity supply dependent on rainfall. Total installed capacity is around 1100 MW, but actual generation fluctuates heavily and is mostly under 800 MW, while demand is closer to 900 MW (Kullingsjö, 2011; Reuters, 2011). As reported by the Ministry of Energy and Minerals (MEM) the yearly electricity demand is increasing with 12 to 15 percent each year while generation increases with 6 percent annually (2011). The droughts in East Africa during the summer of 2011 led to regular blackouts. In July 2011 the electricity was even rationed, with daily 12 hour power cuts (Reuters, 2011). The effects of underperformance of the electricity generation are economically severe. 7000 jobs were lost and 50 businesses had to shut down during the black-outs. The total economic damage is estimated at almost 20 million USD. Moreover, the IMF lowered its expectations of economic growth following the electricity rationing policy (ibid.) The measures to increase installed capacity and reliable electricity generation are described as "*expensive, incoherent and inefficient*" (Meijer, 2012: 2). Electricity connection is only accessible for a fraction of rural households. Future plans for electrification are discussed in the next section. The most prominent alternative for electricity access is solar photovoltaic (PV) installations. The 2007 HBS shows 0.6 percent of all households owns a solar PV installation. The HBS even reports an unexplainable decline from 2001 (NBS, 2009). The development of the solar PV subsector in Tanzania is explored in section 4.2.1

As depicted in figure 2.2 ease of getting electricity is part of the business environment. Tanzania scores well on this indicator. Time and costs required for getting electricity are relatively limited (World Bank, 2012c). For households TANESCO has a number of rates depending on energy use. Households in the domestic low usage tariff have an average consumption pattern of 50 kWh or less are in a favourable position. These users don't pay a service fee and there electricity rate is subsidized and amounts to less than a quarter of that of the general usage tariff (60 TZS per kWh instead of 273 TZS per kWh). The fee to connect to the grid depends on the location and some customer preference which roughly come to 400.000 TZS, which is considerable if compared to the average annual household income (TANESCO, 2012). The general usage tariff saw a 40 percent increase from 2011, partly due to the high costs for increasing the generation potential (TANESCO, 2012). Even before the electricity problems of the summer of 2011 the electricity tariff was rising rapidly. This could explain why the relative share of households with electricity in urban areas has dropped. In 2007 in Dar es Salaam by almost 4 percent from 2001 (NBS, 2009) Moreover, the share of households that made use of electric cooking dropped by almost 80 percent in Dar es Salaam and almost 70 percent in other urban areas from 1992 (ibid.). This urban drop in electricity usage made the use of less efficient alternatives such as charcoal rice (NBS, 2009; World Bank, 2010).

2.2.3 Rural electrification plans

The way the national grid system came about is officially arranged by a number of priorities. Firstly priority is given to electrifying district headquarters. Secondly, electrification of productive centres such as localities with agricultural processing were prioritized. Finally, even productive areas that were distant from the existing grid and could not give an economic return to connection expenses are selected for grid expansion (TANESCO, 2010).

As part of the fieldwork information was collected on future electrification plans. The rural electrification master plan was prepared by REA (Rural Energy Agency) for TANESCO and funded by Sida (Swedish International Development Cooperation Agency) via the World Bank. The plan aims for 700.000 new users of modern energy services in rural areas. 200.000 Off-grid users should be served by 2015 through the construction of small power plants that deliver 300 MW. The remaining 500.000 users should be served by 2015 through new grid-connection. These efforts should contribute to the overall governmental goals: by 2015 15 percent of inhabitants in rural areas should have access to electricity (WHO and UNDP, 2009); 50 percent of the population should be served with modern energy services by 2020 (TANESCO, 2011). The provision of modern energy services is partly funded by a 500 USD subsidy per new connection from main contributor Sida. Though the master plan is not yet ready and could not be obtained during this research, the projects shown in table 2.1 are identified in feasibility studies (TANESCO, 2010). The role of REA and TANESCO in energy provision and the process of electrification is further explained in section 4.1.2

Table 2.1 Electrification projects per 2011

District	Proposed plan	Customers	Costs (million USD)
Bagamoyo	Bagamoyo substation (2x50MVA, 132/33kV)	Economic development zone	20
Geita	Geita substation	26,600 (36 villages)	9
Hai	Extension (90 km of 33 kV line)	1,377	3
Sumbawanga	8MW hydropower project	24,800 (38 villages)	29
Tunduru	6MW hydropower project	18,600 (56 villages)	21
Ngorongoro	1.9MW hydropower project	8600 (17 villages)	13.2
Bukoba and Karagwe	Extension (433 km of 33 kV line)	Unkown	12
Same	Rehabilitation/extension	Unkown	0.86
Bukoba	Rehabilitation/extension	Unkown	1.21
Mufindi	Rehabilitation/extension	Unkown	1.76
Mbeya	Rehabilitation/extension	Unkown	1.57
Njombe, Songea	Extension (1150 km of 132/33 kV line)	8500	Unknown
Shinyanga, Iringa	Extension (667 km of 400 kV line)	Unkown	370
Geita, Kigoma	Extension (500 km of 220 kV line)	Unkown	Unkown

Source: MEM and TANESCO 2005; TANESCO 2010; MEM, 2011

2.3 Chapter conclusion

The contextual information can be used to select AETs and is important in assessing to what extent the institutional setting is conducive to cluster promotion. In relation to enterprise development the contextual information shows a country that goes through rapid changes. Tanzania moved away from socialist Ujamaa policies to IMF inspired market economy, and has shown impressive economic growth over the last 10 years. Moreover, an entrepreneurial attitude is increasingly accepted and promoted. Though a survivalist entrepreneurship attitude still makes employment the desired choice as a source of income. Also trust in business beyond family ties seems an important hurdle for enterprise development.

The current energy provision shows the need for an energy transition. Tanzanian energy provision largely relies on unsustainable biomass resources, while unreliable electricity provision hindered economic growth during the 2011 droughts. Deep rural and rural areas dependent on non-commercialized firewood. Commercialized fuelwood is more prominent in rural, peri-urban and urban areas that experience scarcity of biomass resources. Commercialization is required to be able to introduce alternative energy technologies and resources. Across Tanzania paraffin and kerosene fuels are most commonly used for lighting. The increased electricity prices have decreased the share of household using the resource. Instead of modern energy such as electricity or kerosene, charcoal is increasingly used for cooking in urban areas. The current energy provision is summarized in table 2.2.

Table 2.2 Areas in Tanzania and their energy use

Area	Main resources for energy use	Characteristics
Deep Rural	Cooking: firewood Lighting: paraffin / kerosene	Non-commercialized firewood
Rural	Cooking: firewood and charcoal Lighting: paraffin / kerosene	Commercialized fuelwood
Peri-Urban	Cooking: firewood and charcoal Lighting: paraffin / kerosene, electricity	Centralized energy resources, rising and volatile electricity and kerosene prices
Urban	Cooking: firewood, charcoal, kerosene Lighting: electricity, paraffin / kerosene	Centralized energy resources, rising and volatile electricity and kerosene prices

Source NBS, 2009; 2011.

Chapter 3 Methodology

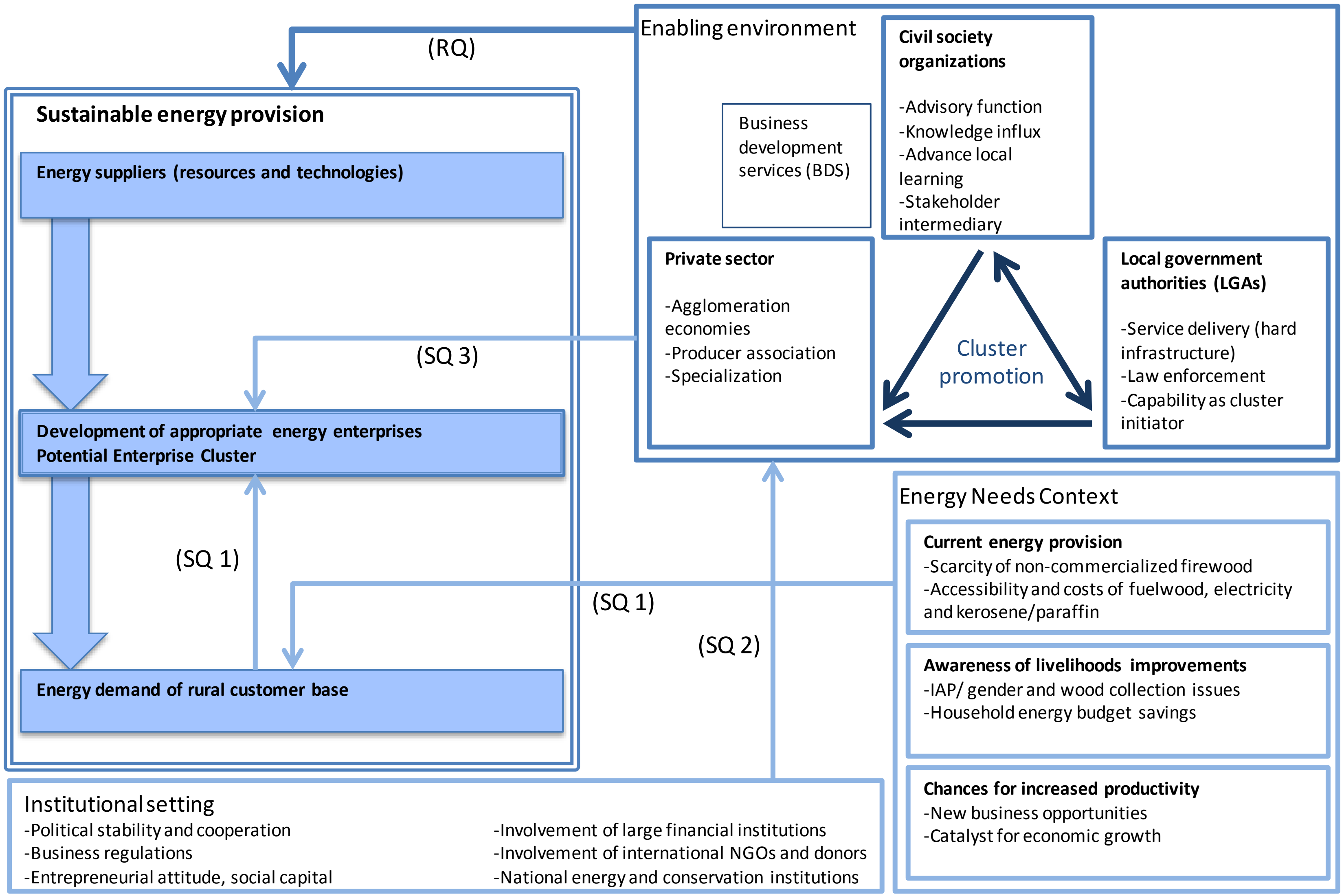
The methods used to obtain the results of the research have to be presented to clarify their validity and reliability, i.e. their strengths and weaknesses. Firstly, the research questions and order of this master thesis implies a certain functioning of sustainable energy provision. The conceptual model represents this functioning in a graphic way and shows which topics are under scrutiny in this study. Secondly, the way the results are presented in chapter 4, 5, and 6 is briefly discussed to explain how the chapters relate to each other. Thirdly, it is explained how the topic of this research corresponds with the type of research and data gathering process. Finally, the choices made during this research result in some limitations.

3.1 Conceptual model

A conceptual model is used as a guide for finding structured answers to the main research question. The conceptual model (see figure 3.1) depicts the way the appropriate energy sector could work and the way it fits in the context of rural Tanzania. The backbone of the conceptual model is formed by the basic energy provision depicted in the energy value chain. On top it includes the energy resource or technology suppliers. In the middle AEEs are depicted, who in turn meet the energy demand of the customer base, depicted at the bottom. Central in this model is the development of AEEs. The enabling environment can promote the clustering of AEEs. The enabling environment includes the multi-stakeholder network and infrastructural provisions. The private sector, shown as part of the multi-stakeholder network is more encompassing than is suggested at first sight. The AEEs that form the cluster are of course part of the private sector, as well as the energy suppliers in the energy value chain. The success of a cluster is depending on the synergy between the stakeholder, but it is also influenced by the external institutional setting. The energy demand consists of the manifest energy needs, which is determined by the energy needs context.

The model is based on the four research questions and the discussion of theoretical views in the first chapter. The linkages shown by arrows depict the research questions. Subquestion 1 refers to the energy demand of the households in rural Tanzania. Based on the theoretical views from chapter 1 a number of factors are brought together in the “energy needs context”. Also the demand of the customer base needs to be manifested to AEEs to have an effect, this is represented by the upwards arrow in the energy value chain from the customer base to AEEs. Subquestion 2 refers to the effect of the institutional setting on cluster formation and is represented by the arrow from this box to the “enabling environment” box. The stakeholder in this box are themselves also part of the institutional setting and are under scrutiny to. (*continued on page 50*)

Figure 3.1 Conceptual model



(*continued from page 48*) Subquestion 3 refers to the effect of cluster promotion on AEE formation and is represented by the arrow from the "enabling environment" box to the AEEs part of the energy value chain. The research question itself refers to the ability of cluster promotion to create a self-propelling sector. Hence the arrow showing the research question is not directed at one specific part of the energy value chain but at its totality.

3.2 Understanding energy provision

A number of key variables lead up to answering the research questions. The Total Energy Access model and cluster formation model have been introduced in chapter 1 that capture these variables. This section is designed to discuss how these models can be applied in this study.

3.2.1 Assessing the energy demand for appropriate energy technologies

In chapter 2 the energy needs context per area was distinguished. An energy transition was deemed necessary. A selection of AEEs needs to be made to offer an alternative to the current energy provision. In chapter 4 the energy demand is explored by assessing the potential of appropriate energy technologies. By comparing, firstly, the characteristics of energy technologies and energy needs and, secondly, the findings from the study of sector development a selection can be made of AEEs for sustainable energy provision in rural Tanzania. The model (see table 3.1) that is used to explore energy demand and the appropriateness of energy technologies is based on the TEA model as introduced in the first chapter. It includes the energy service and minimum standard that household requires to escape from energy poverty. Then the second column captures the current main way energy is provided (based on chapter 2). The third and fourth columns reports an alternative appropriate technology and summarizes drivers and barriers for adopting the technology in a cluster strategy based on the research results.

Table 3.1 Build up of appropriate energy demand analysis

Energy service and minimum standards at domestic level per person	Current rural energy provision	Appropriate energy technology	Drivers and barriers of an energy transition
TEA model	Chapter 2	Chapter 4	Chapter 4

3.2.2 Assessing types of cluster promotion

Chapter 5 is devoted to exploring to what extent the institutional level is conducive to cluster formation in the appropriate energy sector. Firstly, chapter 5 starts by reporting on the research results of the enabling environment for cluster formation in rural Tanzania. Secondly, the cluster formation model as presented in table 1.3 is applied to the institutional setting of the research area. In the final chapter, chapter 6, all cluster initiatives for appropriate enterprise development identified in this research is presented. Finally, the potential of these clusters for AEE development is assessed by determining their internal strengths and weaknesses and the way they fit in the institutional setting. The overall model to assess clusters thus considers the (internal) functioning of clusters and their (external) compatibility with the institutional setting. Table 3.2 shows the model that reports on the compatibility of types of cluster promotion with the institutional setting. The first column names the type of cluster promotion. The three right hand columns are based on the cluster formation model and the results from chapter 5.

Table 3.2 Build up of cluster promotion in the institutional setting

Cluster Promotion	Main institutional conducive factor	Main institutional hurdle	Relating agglomeration advantage
Chapter 6	Cluster formation model and chapter 5	Cluster formation model and chapter 5	Cluster formation model

3.3 Explorative research

Research on the potential of cluster formation is abundant (cf. Porter, 2000; Haughton and Counsell, 2004; Sölvell, 2008), but understanding the applicability of the concept in Africa is limited to urban centres (Barr, 2000; McCormick, 1999; Zeng, 2006; 2008). Cluster formation in the energy sector in rural Tanzania is an almost unexplored terrain (Schoot Uiterkamp, 2011). Beforehand no further research or prominent examples of clusters could be identified. The study is designed to identify signs of cluster formation. Hence the research is explorative.

The value of explorative research has been stressed by Babbie (2007). Though explorative research seldom provides conclusive answers, it is well equipped as a prelude for extensive research. It is an essential first step to indicate the value of the new topic (ibid.). The reasoning for this study is deductive. Because the literature on cluster formation is rich, chapter 1 started by describing the theoretical views on cluster formation, for example the role of the multi-stakeholder network. The (fieldwork) research is designed to explore to what extent the situation in rural Tanzania differs from theory. The type of research method applied in this research is mixed qualitative and quantitative, so-called q-squared. Firstly, opportunistic quantitative data is obtained from existing data sets. Hulme (2007) makes the case for opportunistic data when time and resources are limited. Even though such data-sets are not designed for the research at hand they can still be indicative for new research topics, such as in the case of cluster promotion for sustainable energy provision. When opportunistic quantitative data is obtained before the qualitative data it can contribute to setting hypotheses for the qualitative part of the research. In this way the study is sequenced by starting with a quantitative part and enriching the findings by a qualitative part (ibid.). Secondly, ethnographic qualitative data gives the researcher insight in complex processes and allows to comprehensively understand processes only indicated by quantitative research. Moreover, in-depth data can add to the strength of theories to accurately describe and increase the applicability (Eisenhardt and Graebner, 2007). Overall q-squared data is reliable and rich because it can explain the underlying processes in development studies (Hulme, 2007).

3.4 Data gathering process

This master thesis contains the research results of two periods in Tanzania. The initial research focuses on the biogas subsector and is reported by Schoot Uiterkamp (2011). All results from this research used in this thesis are referenced in this way.

The data gathering process of the second period in Tanzania took place over a period of two and a half months in the spring of 2012. Some interviews were done before departure in the Netherlands as part of the orientation phase of the research. Also, as mentioned in the acknowledgement some of the data used in this master thesis is part of a research done in Tanzania in collaboration with a co-student and development organization SNV in the spring of 2011.

The quantitative data was obtained via the Tanzanian National Bureau for Statistics and includes the 2007 Household Budget Survey (GoT, 2010; NBS, 2009; 2011). In the contextual information chapter the results processed with the help GIS software from this survey have been reported and. Also the data gathering process in Tanzania partly consisted of obtaining grey literature, for example, the information from TANESCO, as introduced section 2.2.3. The qualitative research consisted of semi-structured interviews. In practise this meant that topics and open-ended questions were formulated beforehand, but when interesting topics arose the researcher could stray from the structured interview. Semi-structured interviews provide valuable idiographic explanations. Because the research is exploratory most interviews were done with experts. All respondents were selected by snowball sampling. This technique identifies new potential respondents by making use of the network of earlier respondents. This type of sampling is especially applicable for exploratory research (Babbie, 2007). Three groups of sectors are targeted for these interviews: public sector, private sector and civil society organizations. All respondents were involved in the energy sector, mainly the renewable energy sub-sector, or had intentions to become involved. Table 3.3 shows the number of interviews and their affiliation. A number of interviews were conducted in the same organization and in three instances the same respondent was interviewed twice. Additional time and information was in those cases required to complete a story, sometimes caused by conflicting stories. In total 54 interviews have been conducted. In annex A a complete list is provided of the interviews including the fieldwork shorthand of the results.

Table 3.3 Interviews conducted

Sector	Type of stakeholder	Number of interviews	Number of respondents	Number of organizations	Location
Public sector	Governmental organization	7	7	5	Netherlands, Dar es Salaam, Arusha
Private sector	Company/Enterprise	18	18	13	Netherlands, Dar es Salaam, Arusha, Moshi, Mwanza, Tanga
Civil society organizations	NGO/Social Venture	23	21	15	Netherlands, Dar es Salaam, Arusha, Mwanza, United Kingdom
	Financial institution	2	2	2	Tanga
	Academic organization	2	2	2	The Netherlands, Dar es Salaam
	Sector organization	2	1	1	Dar es Salaam
Total		54	51	38	

3.5 Research limitations

The design of the research is limited at the outset, because exploration allows for limited representativeness of the research results (Babbie, 2007). Also the opportunistic quantitative data is collected with surveys that are not designed specifically for research in sustainable energy provision. Moreover, semi-structured interviews were selected through nonprobability sampling. The sampling is thus biased and there is a possibility that the networks of respondents upon which it relies don't include key respondents. The experts that were interviewed of course have their own interests. Even though the researcher was mostly seeking the point of view of the respondent, the information of one stakeholder doesn't have to correspond with the stakeholder group. Furthermore, practical limitations, such as time and resources constraints greatly influence the number of respondents that could be reached. In total five regions were visited in Tanzania: Dar es Salaam, Arusha, Moshi (Kilimanjaro region), Mwanza and Tanga. These locations are mostly in northern parts of Tanzania and most respondents were located in urban areas. The research thus has an urban bias, despite the rural research area. This, again, has to do with the exploratory character and many expert interviews. Six interviews were conducted in rural areas where energy centres were established. Only in three interviews an interpreter was required. The interpreter with English and Swahili language skills was selected through friendly contacts and did not have a stake in the research or in any way in the energy sector. Mistakes could, however, still be made or subtext could be lost in the translation. It should be noted that some documents were obtained under confidentiality constraints and thus citations and references are restricted. Also cross-checking of this literature might be problematic. Finally, any further research limitations due to non-response or failure to obtain grey literature is reported in the research results chapters that follows hereafter.

3.6 Chapter conclusion

The conceptual model showed how this master thesis tries to unravel the link between the enabling environment cluster promotion for appropriate energy enterprises. The second half of the thesis reports the results of the research. The Total Energy Access (TEA) model can be used to select appropriate energy technologies (chapter 4) and the cluster formation model to assess if the institutional setting is conducive to cluster formation (chapter 5 and 6). This exploratory study uses sequenced q-squared methods, including opportunistic quantitative and (qualitative) ethnographic methods. This topic of this master thesis requires an explorative study. The character of exploration makes it limited in scope, but might be a first step in understanding the value of cluster promotion for sustainable energy provision in Tanzania.

Chapter 4 The demand for appropriate energy technologies

Subquestion 1 (SQ1): Which appropriate energy technologies can meet the household energy demand in rural Tanzania?

A selection of AETs needs to be made to clarify what sustainable energy provision consists of. The ability of AETs to meet household energy needs are important and a universal standard was set via the TEA model. Also, the geography, cultural habits, technological complexity and costs need to be taken into account. Firstly, to clarify the importance of informed choices for AETs, the need for energy provision planning is illustrated by some examples from the research area. Secondly, the market potential and status of the Tanzanian energy sub-sectors are important indicators for the potential of energy technologies and discussed based on the research results. Finally, after summarizing the AET results, the challenging distribution of energy technologies in rural Tanzania is briefly discussed. Current distribution models are researched to discover lessons for energy provision via AEE clusters.

4.1 Energy provision planning

"[Energy provision] *isn't only about meeting essentials, it should also meet some fashion and mainly modern standards. We shouldn't ask households if they need lighting, but what type of light they want*" (UDSM, 8 March 2012).

Energy needs aren't the only factor in sustainable energy provision. One respondent illustrated the importance of energy preferences by a number of subsequent energy transitions a village went through (TaTEDO, 6 March 2012[17]). A prosperous village in the highlands firstly got to know about a solar PV installation for electricity supply. A number of villagers purchased an installation, but soon were disappointed because of the limited power it provided. No television or refrigerators could be powered by the systems. Then secondly, a micro-hydropower system was introduced in the village that could power such appliances. Most solar PV systems became abundant. Thirdly, connection to the electricity grid is most likely more powerful and reliable than the micro-hydropower system. A potential next step could thus be grid connection. In this way newly introduced energy technologies can damage the viability of already installed technologies. This example shows potential loss of investment when energy preferences are not taken into account. Similarly TaTEDO (Tanzania Traditional Energy Development Organization), the main Tanzanian NGO involved with sustainable energy provision, has been working to set up energy systems on village scale that could serve

[17] All results gathered through interviews is referenced with the complete data and organization. Names are not reported. If a number of respondents or general observations can be linked to research results "(fieldwork, 2012)" is used. Results from last year's research are referenced via the reporting of: "(Schoot Uiterkamp, 2011)".

households and enterprises (see section 6.2.2.1). Similarly to the highland village the development of energy provision has changed the manifest energy demand: "*The problem is that two years ago there has been an assessment of the appropriate places for both the MFPs and PUCs* [energy systems]... *the data on which the assessment is based has in some instances become obsolete. That is, some villages have been electrified and thus no longer need it.*" (TaTEDO, 5 March 2012).

False expectations of energy provision, unclear energy preferences or economic progress might change the appropriateness of an energy solution before it can become profitable (fieldwork, 2012). This stresses the importance of long-term planning in sustainable energy provision. By clarifying what is the energy preference of rural communities a roadmap could be drafted which gradually leads to an energy provision goal. Moreover, another reason that might interfere with energy provision planning is lack of transparency of future electrification plans. As mentioned by the respondent from TaTEDO, electrification affects any other energy project. The next subsection tries to capture the process of electrification of rural villages.

4.1.1 Electrification planning

The low accessibility and economic activity often makes electrification of rural areas commercially unfeasible (TANESCO, 13 March 2012). There are two major organizations that arrange rural electrification in Tanzania: TANESCO and REA, which are both public agencies under the ministry. TANESCO is producer and distributer of electricity. In the contact with the agency it became clear that TANESCO gives priority to maintenance and increasing power generation instead of expansion (TANESCO, 13 March 2012). As discussed in chapter 2, generation is indeed lagging behind demand. The other major organization, the Rural Energy Agency (REA), was established by law in 2005 and became operational in 2007. REA facilitates the provision of modern energy to rural areas through financial support for capacity building. The law stipulates that REA should itself have little overhead and it requires REA and the related fund to be involved with local authorities (GoT, 2005). REA is funded through a levy on electricity bills. The levy can go up to five percent, but currently stands at two percent (ibid.). In 2010 REA had a turnover of 100 million USD (TANESCO, 2011). This makes REA in potential a powerful institution that can promote rural energy provision of all sorts locally and nationally.

> "*At TANESCO they think REA stands for Rural Electrification Agency, instead of Rural Energy Agency.*" (SNV, 2 April 2012).

However, the research encountered criticism on the disproportioned focus on electrification and the lack of presence at the local level (fieldwork, 2012). There seems to be a bias towards rural electrification through grid connection and large scale off-grid projects (see table 2.2) instead of energy provision that consist of an appropriate mix. No respondents outside the economic capital of Dar es Salaam were in contact with REA and many openly wondered about REAs position in the sector. As one respondent puts it: "*REA only focuses on the electrification of cities in rural areas, not for domestic energy for rural areas"* (cited in Schoot Uiterkamp, 2011). As mentioned, the mandate of REA is much broader than just electrification, but their focus on electricity could have to do with the reported interplay between REA and TANESCO, which seems to favour TANESCO (SNV, 2 April 2012). REA collects the levy on the electricity bill, but has to transfer it to TANESCO. If REA needs to use to money it has to send a proposal to TANESCO for their approval. If TANESCO approves REA's proposal the next step is the public tender that is allotted by REA. In cases of electrification projects TANESCO is a likely candidate for winning the tender. But even if TANESCO is not the implementing party of these electrification projects they still act as supervisor. Illustratively the informant adds: "*At TANESCO they think REA stands for Rural Electrification Agency, instead of Rural Energy Agency.*" (SNV, 2 April 2012).

TANESCO and REA also arrange rural electrification planning. Access to modern energy has a political priority as mentioned in chapter 2. The Government of Tanzania has the objective to provide modern energy services to 50 percent of the population by 2020. Even though TANESCO has limited generation capacity, rural electrification is seen as a major contributor to this objective. An informant illustrated the way TANESCO decides on grid expansion (SNV, 2 april 2012). Any town or village applying for connection should be able to pay back 7 percent annually of the grid installation costs through the billing of their own consumption. Hence, the grid connection has a financial return of maximally 11 years (disregarding interest and inflation). TANESCO rejects applications of areas that are unlikely to meet these consumption standards. Another informant stated: " [TANESCO] *will only expand the grid to places where it is profitable, that is where the electricity consumption will cover the expansion. Hence, there priority is not rural areas* (MEM, 9 March 2012). However, inhabitants who had their applications rejected can try to overturn TANESCOs decision through applying to a grant of REA. This procedure is not widely known and typically villages that have strong political ties follow it. Also in those cases politicians can use their influence to speed up and stimulate a favourable outcome. Some villages even skip the initial TANESCO application and directly apply at REA (SNV, 2 April 2012). In box 5 the lack of clarity on rural electrification planning is explored based on the research findings.

Box 5 In search of the rural electrification master plan

The political objective to increase modern energy services has resulted in the intention to formulate a master plan for rural electrification. This plan should structure the increasing efforts of organizations that try to achieve electrification in rural areas. The consultancy services to draft the plan were tendered in the beginning of 2011 by REA. According to a number of respondents the plan should have been completed, but TANESCO reported it is not in their possession at this point (TANESCO, 6 March 2012). Other important stakeholder such as MEM and REA seem to be unclear about the availability or existence of such a plan (fieldwork, 2012). As mentioned for the TaTEDO energy systems rural electrification is important for future decisions (5 March 2012). The same may apply for companies that are interested in settling in rural areas. Sector stakeholder even including those indirectly involved with rural electrification, need to be aware of electrification plans.

4.2 Selecting appropriate energy technologies

Three energy technologies and there corresponding sub-sectors in Tanzania are presented here: solar energy (solar PV and solar thermal), biogas, and improved cook stoves (ICS). The selection of these three technologies is based on firstly, their appropriateness, secondly market potential and finally the sector development. These characteristics is explored in the following sub-sections.

Alternative energy technologies and resources are numerous, and some disserve to be assessed here briefly. First of all, LPG (liquefied petrol gas) technology is the most prominent alternative, besides the three aforementioned technologies. Current energy policy in Tanzania is focussed on promotion of LPG for cooking (Banks et al., 2008). The sector has grown across East Africa, especially in Kenya and in urban areas (TAREA, 8 March 2012). Electricity and kerosene are more expensive per cooked meal, charcoal is the cheapest and most commonly used cooking fuel in urban areas, but is inefficient and polluting (see chapter 2). Especially in urban areas, such as Dar es Salaam, LPG can be part of a shift from charcoal, which causes IAP and rapid degradation of forest land (World Bank, 2010). Reliance on charcoal and other biomass will continue for a while, because for many households alternatives are simply too expensive. LPG is not explored further because it seems at this point most appropriate for urban areas and limited in its ability to serve the masses (EAC, 2008). Moreover it relies on a centralized energy resource. Similarly to kerosene it needs to be purchased on a commodity market, which makes it less suitable for inaccessible rural areas. Also it requires an elaborate logistical system and refinery process, which causes much carbon emission and thus has a negative impact on the environment.

Hydropower and wind power have the potential to meet rural energy demand in an appropriate way. For wind power, plans mainly include large scale wind parks in carefully selected locations, for example a project in the Southern Highlands in Iringa region. Such projects are designed to counter electricity grid shortages (Daily News, 2012a). Small scale wind power projects for sustainable energy provision in rural areas are present, but still require considerable investment compared to other small-scale energy technologies. Also small-scale wind projects need to include technical training to ensure proper maintenance, and are therefore thought unsuitable for the household level (Castro and Castro, 2009). Hydropower has proven very important for large scale electricity generation. Small-scale installations[18] again require much technical understanding both from users and technicians as well as involved stakeholders, such as water boards. Also this technology often involves importing large technical equipment (see box 6) (Oikos, 27 March 2012). Two reasons thus stand out to exclude wind and hydro at this time from the research. Firstly, sector development is low. There is limited experience with small installations that provide sustainable energy to rural areas, even though pilots are certainly present. Secondly, both technologies seem best suitable to be installed on the community level or on a larger scale instead of the household level (Castro and Castro, 2009). Furthermore, it is hard to develop enterprises in subsectors that need high upfront investment for entrepreneurs and buyers alike. Wind power and hydropower subsectors will possibly develop in the common years and become indispensable for rural energy provision. For now this master thesis focuses on development of the solar, biogas and ICS subsectors.

Box 6 Locally embedded hydropower

The respondent of Istituto Oikos (an Italian NGO) in Arusha, discussed their experience with hydropower. Oikos had purchased a small hydropower installation (about 4 kW) from Italy to be installed in a village in Arusha region. The respondent expressed: "*I don't like this so much, since the technology should be local*" (Oikos, 28 March 2012). He continued by describing how a master student from UDSM (University of Dar es Salaam) had recently designed its own hydropower installation of a similar capacity. Oikos linked him with a technical college in Arusha to develop the model further. During an unrelated visit of the prime minister it attracted attention and the politician pushed for implementation. Oikos was approached to assist with scaling up. However, the installation had defects and no documentation was available. Oikos could not convince the partners to go back to the drawing board and withdrew from the project: "*I wouldn't like people associating Oikos with such an installation*" (ibid.). Other projects have reportedly run in problems because technical understanding was lacking. Reportedly an hydropower installation (9 kW) project in the Usambara mountains (UNIDO, 2012), in Tanga region, was destroyed after it experienced minor technical problems. An untrained technician set out to repair it, but instead irreversibly damaged the installation (Oikos, 28 March 2012).

[18] Pico-hydropower installations deliver less than 5 kW of electric power (and often much less) and has proven itself mainly in Asia. This scale of hydropower installations requires less technical know-how and could become appropriate in rural areas (De Vries et al., 2011).

4.2.1 Solar

"*You don't need an NGO to explain a solar panel*" (SNV, 2 April 2012).

The growth in the solar PV subsector makes it the most promising of the technologies dealt with in this chapter. GIZ estimates that the size of the total installed capacity per 2008 in Tanzania is 2.5 MWp. (2009). While the total market potential was estimated at 35 MWp. minimally (ibid.) Sector organization TAREA (Tanzania Renewable Energy Association) reports that the total annual sales in 2009 already accounts to almost half of the installed capacity in 2008, 1.16 MWp (2010). Though the GIZ report seems more conservative, the increase is clear since 2005, when 100 kWp was installed. TAREA identified a total of 22 officially registered solar PV importers of solar home systems (SHS). The total amount of dealers is much higher, already 114 are member of TAREA (Schoot Uiterkamp, 2011). Largest import in terms of total capacity are the small solar panels of 14 Wp. and 15 Wp., second are the 80 Wp. and 85 Wp. panels that can power a small television set. Reportedly these panels are most often used in an institutional settings (schools, hospitals, etc.). Regrettably, no figures are available for the past three years because solar PV importers stopped sending data to the affiliated governmental institutions due to a lack of personal communication with the importers (TAREA, 2010).

Solar PV panels are considered environmentally friendly. Solar PV panels[19] converts solar radiation into electricity without emissions. The main material used for producing solar PV panels is silicon, the second most abundant material in the world. Rare earth metals are sometimes used in very small quantities, but in general solar PV production is sustainable, because the embedded energy payback[20] of solar panels is estimated at 18 months, way shorter than their lifespan (Holm and Arch, 2005). In rural settings that don't have access to the electricity grid, batteries are required to have a functioning solar PV system. Batteries can potentially hinder uptake and sustainability of solar PV. The solar PV respondents reported an average lifespan of three to five years largely dependent on over-discharging of the battery (fieldwork 2012). Furthermore, cables need to be bought for connecting the PV equipment and optionally a charge controller can be purchased to extend the lifetime of the battery, but this would require an additional 30,000 to 50,000 TZS. Prices of solar PV panels range in 2008 from about 6200 to 7800 TZS per Wp. for the small 14/15 Wp. panel and about 8750 to 9250 TZS per Wp. for the large 80/85 Wp. panels[21] (TAREA, 2010). In 2009 Zara Solar is the largest importer of solar PV (TAREA, 2010). Their pricelist in 2012 shows a sharp drop from the per Wp. prices in the TAREA report. The 14/15 Wp. panels cost 60,000 TZS and a matching battery (26

[19] Zara Solar reports that amorphous silicon PV is appropriate for small solar PV systems and crystalline modules for the larger installations (Zara Solar, 2007)
[20] The time it takes the PV panel to generate the energy it took to produce the panel.
[21] Note that the other system components such as the battery are not taken into account here.

Ah.) 72,000 TZS. A 85 Wp. panel costs 340,000 TZS[22] and a matching battery (120 Ah.) 310,000 TZS (Zara Solar, 2012). A battery thus accounts to virtually half of the initial investment for a solar PV system. The costs of batteries are even more considerable if the life spans of panels and batteries are taken into account. The life of a panel stands at 25 years, while at least five batteries need to be purchased during that time to keep the system functional. Hence, the most expensive part of solar system is the battery, which negatively impacts the revenue model and environmental friendliness. The battery issue needs to be well understood by potential customers and investors.

In line with the appropriateness requirements solar PV is a decentralized technology, which can be applied by households or in a community/institutional setting. The technology is typically used for lighting and other small domestic appliances. Appliances that already have inbuilt batteries such as mobile phones can be charged directly. Larger equipment such as electric stoves and refrigerators consume significantly more power and often run on AC (alternating current), which in combination with a solar PV panel would require an inverter and causes losses.

Besides the installed panels (mainly 14/15 and 80/85 Wp.) a range of smaller solar PV systems (pico solar PV) are sold in Tanzania. These are portable systems with panels that typically have an output of 1 Wp. to 5 Wp.. The systems often come with a small lamp that has an integrated battery. Also the systems typically provide the possibility to charge mobile phones (Barefoot, 2012; D-light, 2012; Greenlight Planet, 2012). Furthermore, there are a range of products, especially lamps that have an integrated PV panel of less than 1 Wp.. The price of these products stand at about 10,000 TZS (SolarAid, 9 March 2012). Box 7 illustrates the consequences of high competition between companies in pico solar PV that try to serve rural markets.

Despite these small and affordable products the uptake of solar PV among the rural poor was reportedly low. The richest 10 percent of the population own half of all solar PV systems in rural Africa (Kammen and Kirubi, 2008). Moreover, the domestic PV panels of 14/15 Wp. only deliver a tenth of the consumption of average grid-connected rural household in Africa (ibid.). However, the potential of PV systems for rural energy provision is high. One of the main strengths of solar PV is the modularity of the panels. Households can gradually expand their power supply by purchasing new panels. Also the relative ease with which panels can be mounted and demounted make it possible to use it as collateral for loans and also allows for lease constructions. The disadvantage is that the panel might be easily stolen, which will require additional investment to secure an installation, at the same time this development could even be interpreted as a (perverse) sign of sector development (fieldwork, 2012). Another issue that might prove the popularity of the product, but is in itself detrimental, is the strong presence of a black market. Low quality and counterfeit solar PV panels can

[22] The per Wp. prices for both the domestic and institutional panels thus stand at 4,000 TZS.

easily find their way in a young market, when consumers are still unaware of product characteristics (Ensol, 13 March 2012). To root out the problem prices should drop below the counterfeit products, also certification might prove valuable. Furthermore, smart distribution and business models can be conceived (fieldwork 2012). One interesting initiative that is currently being tested by a number of organizations in East Africa is a prepaid system, possibly in combination with a mobile money payments. A solar panel is installed with a chip that can switch on and off the access to the power generation. An interested rural household pays a small down payment for installing the solar system. Once the panel is installed the household pays a monthly amount for the usage rights via a mobile money application[23] or in other systems households would rely on an affiliated dealer to obtain the usage rights. By paying the monthly instalment the household gradually pays off the system in a number of years (e.quinox, May 7 2012). In Tanzania KAKUTE, an Arusha based NGO, is piloting a variety of this system, the so-called Mobisol system. An additional advantage of Mobisol is that the chip can also function as an alarm system and thus protect against theft (TAREA, 2012).

Box 7 The story of d.light and a reputation in Tanzania

The solar PV subsector is the most market driven RET in Tanzania. Suppliers come and go, which can be healthy for a young sector to make it competitive and consumer oriented. One particular company and its role in the sector stood out in this research. Overall respondents involved with solar PV in Tanzania had mixed feelings about d.light. d.light Produces and distributes pico solar PV panels in combination with a lamp or as an integrated product. Reportedly, d.light sold about 150.000 of the small solar PV installations from 2005 untill 2011, when it changed its representation in Tanzania. A number of issues had a severe effect on the reputation of solar PV and the development of the sector. The quality of their product was reportedly inferior. "*At one point a retailer showed me a huge pile of their* [d.lights] *solar lamps. All the batteries were broken*" (2 April 2012, SNV). A former employee of d.light responded to these quality issues: "*Of the first 50.000 we only had 14 returned. This could be due to the distribution model, but mainly bad stories can be greatly exaggerated just based on one instance."* (SolarAid, 9 March 2012). The real problem seems to come forth out of a lack of infrastructure to support any after-sales services. "[d.light's] *Margin was simply too low, which was the reason they did not survive. But in the meantime they made the market a lot worse for other companies to operate... it harmed the confidence of my own dealers. d.light Undercut all their dealers."* (ARTI, 13 March 2012). The confidence of customers and dealers seem to have been damaged. This example shows how competition can cause a race to the bottom that pulls down prices, companies and most importantly the trust of dealers and customers. The current generation d.light systems (S250) which are supplied through SolarAid and via a d.light office in Nairobi are reportedly of good quality.

[23] East Africa has seen a large uptake of money transfers via telephone. At agents of telecom companies money can be charged on mobile phones and received money exchanged for cash.

4.2.1.1 Solar thermal

So far solar PV has been discussed, but solar radiation can also be used for solar thermal energy to dry agricultural products, heat water or even cook. To some extent these products fall outside the realm of this research, since it concerns productive energy provision. For some interviewed research organizations the productivity aspect is reason to continue research in for example solar dryers (CAMARTECH, 26 March 2012; COSTECH, 12 March 2012). "*If you look at the mobile phone and the motorbike, these products have reached rural areas very successfully... because it added value... In renewable energy we look to solar dryers and process equipment to increase income generating activities.*" (COSTECH, 12 March 2012). Some solar PV importers identified in this research also sell solar thermal panels. The heaters look like (tilted) PV panels but have a cylinder on top to collect the water that was heated while it runs upwards through tubes in the panel[24] (an example of a solar thermal panel is shown on the cover page of this master thesis). The appropriateness of these products is somewhat limited because of its size and non-modularity. Moreover, similar to the solar dryers, solar thermal panels seems more appropriate for institutional and productive uses, i.e. users that require large amounts of heated water. For instance, milk processers in Tanga region expressed the need to disinfect the instruments that test the milk with hot water. Currently the only cleaning was done with cold water (Tanga Fresh, 25 April 2012). Finally, solar thermal can function as a source of heat for cooking. Objections have been raised about the appropriateness of these cookers. Mainly, concerning conflicting cooking habits and the characteristics of the cookers, that operate best at noon when the sun is at its brightest. Users typically cook in mornings and evenings and prefer to stay out of the full sun (Castro and Castro, 2009). Regardless of whether these objections hold, no solar cooker producers were identified in this research.

4.2.2 Biogas

"For biogas awareness is a problem, not unawareness. People that are familiar with biogas mostly have a negative image of the technology. It is easier to sell to people that are unaware of the technology." (SimGas, 2 May 2012).

This subsection deals with the biogas technology in Tanzania. The technology basically relies on capturing the biogas produced by waste products. Biogas can be used for a number of applications, but most efficiently for cooking. The gas can also be used for lighting, but solar PV is more efficient in energy use (fieldwork, 2012). The track record of biogas in Tanzania is somewhat troublesome. Despite the introduction that goes back to the 1970s the uptake of biogas is low. In the late 1980s and early 1990s projects tried to stimulate the technology but were limited in their long-term impact

[24] Because the water is heated it naturally runs upwards through tubes or even evaporates and condensates in the cylinder.

because the approach lacked context specificity and a proper exit strategy (Marree and Nijboer, 2007; Schoot Uiterkamp, 2011). Currently TDBP (Tanzania Domestic Biogas Programme), a programme initiated by development organization SNV aims to build a total of 12,000 biogas installations from 2009 to 2013. This is especially significant compared to the estimate of 1900 working biogas installation in whole Tanzania at the beginning of the programme (Ng'wandu et al., 2009). Per 2011 the total number of biogas installations under TDBP were behind schedule. In total in three years the programme managed to build 2571 while it aimed to stand at 3609 at that time (ibid.).

More than with solar installations there are fundamental differences between the design of biogas installations. This is the reason why in the separate section 4.2.3.1 a comprehensive overview is presented of the sector. There are some shared preconditions for proper functioning of biogas installations. Most rural models rely on cow manure, hence interested households need to own zero-grazing cows. Grazing cows make it much harder to collect and process the waste product in the installation. Limited information is present on holders of zero-grassing cattle in Tanzania. Interesting links can be made between milk producers and biogas, which is for example a prominent industry in Tanga region (see section 6.2.3.2) (Tanga Fresh, 25 April 2012). Alternatively biogas digesters can work (partly) on kitchen waste, agricultural waste or even human waste. But these models have not yet been applied on large scale in rural Tanzania. Moreover, besides technical feasibility social acceptance in waste to energy production can greatly determine uptake, especially in processing of human waste. A further precondition is the availability of (fresh) water[25]. This limits uptake in the south-east of the country where fresh water is relatively scarce. Finally, temperature is of importance. Low temperatures can hinder the digestion process, in general temperatures shouldn't drop below 16° Celsius (SimGas, 2 May 2012). As reported in chapter 2 temperatures are thus most favourable in the coastal area and in the north-west of the country. For biogas installations that are submerged below the terrain, temperature is less of an issue because the digestion process cases is less exposed to temperature shifts.

Waste to energy production can be appropriate because it is typically low cost and environmental friendly. Costs issues depend strongly on the currently used cooking fuel. If this is non-commercialized then households will be reluctant to invest in a biogas installation. Also waste might be perceived unused but could actually have a function or become commercialized once the value is understood (SNV, 2 April 2012). For instance cow manure is a good fertilizer and can be used for hut construction and cooking (Castro and Castro, 2009). The former issue is often not a problem because the biogas installations provide bio-slurry, which is an improved fertilizer. But it does require the user

[25] Waste water can be used and is in most instances even conducive to the digestion process.

to handle the feedstock, which can be a taboo issue. In general biogas installations are environmentally friendly, because harmful emissions to the consumers health and the environment are mitigated. The materials of which an installation is made can decrease the environmental friendly character, as is the case for models that use firewood baked bricks. Furthermore, biogas is a decentralized energy technology, which can have a high level of local ownership. More than with solar PV, some installations need to be locally constructed by using locally available material, which increases the ownership. Overall biogas is assessed as an AET.

4.2.2.1 Biogas Sector

The most prominent model (fixed dome model) is disseminated through TDBP and was originally designed by its host organization CAMARTEC[26] (an example of the CAMARTEC installation is shown on the cover page of this master thesis). The CAMARTEC model basically consists of two brick build domes submerged in the ground. The biggest dome serves as a digester for livestock manure, varying in size from 6 m^3 to 13 m^3. The second dome is constructed as an overflow for the slurry and helps to build up pressure to transport the gas to the kitchen. These installations are build by trained masons who are also required to do the plumbing work for transporting to a gas stove. Hence the masons need to own a complete set of skills to build a functioning biogas installation. The largest pitfall in this design is making the digester gastight by applying seven layers of cement. Insufficiently trained or uncommitted masons will likely make mistakes that allow gas to escape and render the installation useless (Schoot Uiterkamp, 2011). In general the sensitivity of any biogas installation to leakages and other quality issues triggered the citation this section started with (see above). The strategy of TDBP is to develop enterprises that can independently provide installations including marketing and after-sales, such as the required quality control. Currently a pool of 118 active masons are grouped to form such enterprises (SNV, 14 March 2012). Even though this is a considerable decrease from the total of 500 trained masons reported last year, there is currently too little demand for all masons to earn a living (Schoot Uiterkamp, 2011; SNV, 14 March 2012). CAMARTEC installations are relatively expensive. Depending on size and location an average biogas installation is roughly one million TZS. The price currently excludes labour costs which is paid by TDBP as a subsidy for households. Arguably the price is still too high to reach the urban poor and middle class or even have enough work for a mason that builds the biogas installations (biogas mason) in a reasonably sized service area (Schoot Uiterkamp, 2011). Overall it raises doubt of the sustainability of the CAMARTEC model after TDBP has disappeared.

[26] CAMARTEC stands for Centre for Agricultural Mechanisation and Rural Technology and is a parastatel organization. Its role in the sector will be further explored in chapter 5.

We tried to partner with TDBP, but it was hard. They only subsidize the CAMARTEC model, not the ARTI one. But that doesn't make sense, these two types could easily co-exist." (EMEDO and Rongead, 10 April 2012).

Two Tanzanian companies disseminate the domestic floating drum design. Another company company has been involved with the research and development of the plastic bag and floating drum design, but is currently not involved with the commercialization of biogas. Finally a fourth company is involved with the plastic bag design for institutional and domestic use (fieldwork, 2012). The floating drum installation is build in both cases from two plastic tanks similar to water tanks that fit inside each other. One of the tanks can move up proportional to the gas pressure. Firstly, ARTI Energy is an African subsidiary of an originally Indian institute that has introduced the floating drum design. The director estimates that 300 of those installations that use agricultural waste or kitchen waste have been build (ARTI, 13 March 2012). This year it plans to build a total of 25 installations as part of a project with a French and a local NGO. These parties, however, reported some problems with realizing the plans. The ARTI model has to be made out of 500 litre water tanks, and supply to the project location in Mwanza proved difficult (EMEDO and Rongead, 10 April 2012). Another issue is that the subsidies that are granted under TDBP for the CAMARTEC installations seem inaccessible for ARTI: "*We tried to partner with TDBP, but it was hard. They only subsidize the CAMARTEC model, not the ARTI one. But that doesn't make sense, these two types could easily co-exist.*" (ibid.). The Shamba Technologies case further illustrates the barriers for entry TDBP creates (see below). The ARTI installation is sold in Mwanza for half of the cost price (300,000 TZS) the remaining half is provided as a loan. The transport costs of 200,000 TZS are covered by the NGO and the limited labour by the community (ibid.).

Secondly, SimGas, a promising new company, produces a floating drum design of custom made tanks. The SimGas design principle is similar to ARTI's: "*The SimGas model is the improved version of the model we* [ARTI] *use... they improved the looks and quality*" (ARTI, 13 March 2012). The urban model was launched in March 2012 and per April 2012 27 were sold (SimGas, 2 May 2012). The price for the 0.55 m^3 installation is 550,000 TZS and would provide one hour of cooking a day, provided sufficient kitchen waste[27] and water is added. Depending on the type of use this can be too little for an average Tanzanian family to fulfil their cooking needs (NBS, 2009). SimGas plans to start selling a specially designed rural model at the end of 2012, which uses cattle manure as feedstock. In contrast to the urban model it is submerged in the terrain to prevent temperature shifts that negatively affect the digestion process. This characteristic should increase the service area. The design is a modular system of 2 m^3 ring shaped tanks that can be attached to each other. A 6 m^3 rural SimGas installation

[27] 3 kg of kitchen waste, i.e. mainly organic material apart from lemons and oranges (Daily News, 2012b)

will be sold for 511,000 TZS. Via carbon credits this price is lowered to be able to serve the rural market (SimGas, 2 May 2012). The advantage of the floating drum models is that it can serve as collateral for a loan, similar to solar PV panels. It is hard to determine the effect of SimGas on the subsector since they recently appeared. Some stakeholders have become cautious about the potential of the SimGas installation after the company experienced delays and could not follow up on the expected product launch (SNV, 14 March, 2012; Tanga Fresh, 25 April 2012).

> "*In total we think we had to add 200.000 to 300.000 on the price* [of a CAMARTEC model] *to make the company profitable, but we would lose any competition with the programme* [TDBP]" (Shamba Technologies, 26 April 2012).

Thirdly, Shamba Technologies has been involved with the development of a number of models among which the SimGas model and a plastic bag model. The latter can be much cheaper than the CAMARTEC model, reportedly a 100 USD (160,000 TZS) installation was designed by Shamba Technologies (26 April 2012). But in general the plastic bag model is sometimes considered to lack robustness (SNV, 14 March, 2012). As the name implies the digester is an inflatable bag covered by weights to create the pressure to transport the gas. Shamba Technologies expressed interest to form a biogas enterprise under TDBP at the outset of the programme. However, it discovered that it was hard to compete with the programme and moreover, the business case with the CAMARTEC model was assessed as commercially unfeasible. The CAMARTEC model is labour and skill intensive, which makes the installations possibly too expensive for commercial dissemination. Also the programme has the advantage of hidden subsidies that are inaccessible for biogas enterprises. TDBP doesn't pay income tax for their masons nor does it have its masons subscribed to the National Social Security Fund (NSSF), which would levy a second tax over the income of masons for social security services. Other benefits implicit in the programme but inaccessible for enterprises are the quality control and additional services TDBP partners provide to masons (Shamba Technologies, 2010; Shamba Technologies, 26 April 2012). The Shamba Technologies respondent explains: "*In total we think we had to add 200.000 to 300.000 on the price* [of a CAMARTEC model] *to make the company profitable, but we would lose any competition with the programme*" (ibid.).

Fourth and finally, the Energy Devices Company (EDC) sells large institutional and domestic plastic bag installations. The company just started with their domestic model. Only one has been sold for one million TZS[28] including stove and lamps. The price is currently this high because the production is very low and thus costs per unit high. Also the entire system is imported from the Netherlands and subject to import taxes (EDC, 20 April 2012).

[28] Literally "*500 euro*"(EDC, 20 April, 2012).

4.2.3 Improved cook stoves

"*When we sell LED lights we can really emphasize the 'snob value.' When you have solar powered lights, your neighbor can see when your house is lit up bright and everyone else's has gone dark. Cookstoves don't have that.*" (ARTI, cited in GACC, 2012)

This subsection deals with improved cook stoves (ICS) and biomass. ICS often make use of a traditional energy resources, typically biomass, but increase efficiency and decrease harmful emissions. This is done by improving combustion and the transfer of heat to the cooking pot. In general, stoves qualify if they save at least 40 percent biomass during a field test, compared to the simple three stone fires (Practical Action 2012a; Riedijk, 2011). To some extent even the savings needs to be context specific. As an informant from TAREA, the sector association explains: "*improved cook stoves need totally different requirements in Arusha and Singida than in Dar es Salaam. In the former location people want spatial heating from a stove as well as an efficient cooker. A strong increase of efficiency for cooking is thus not an improved stove for these families. At the same time in Dar es Salaam this is not an issue.*" (TAREA, 30 April 2012). As has been discussed in chapter 1 cleaner cook stoves are of great importance for a healthy living environment with low levels of IAP. For Tanzania it is reported that annually 18,900 pre-mature deaths can be attributed to IAP through cooking fuel emissions, mostly children under five years of age (WHO and UNDP, 2009). Overall the appropriateness of ICS is stressed by the costs of ICS and lack of alternatives of energy resources for most households in Tanzania. Illustratively the Ministry for Natural Resources and Tourism (MNRT) introduced a ban on the production and consumption of charcoal in 2006. Without alternative that could be adopted easily and quickly the ban was unrealistic and led to widespread protest of charcoal users. Consequently: "*The ban was lifted after only two weeks, with charcoal production, trade and consumption continuing almost unabatedly...*" (World Bank, 2010: iv). In contrast to this policy ICS can be appropriate as long as mentality and continuant use are considered. Stoves are decentralized technologies and environmentally friendly in combination with locally available and manageable resources. In the case of biomass this would require forest management (as discussed in chapter 2). Alternatively so-called pellets and briquettes from organic waste products can be used to replace logging for firewood and charcoal. However, pellets and briquettes are not yet widely available. A Dutch company active in Tanzania, Diligent, which produces Jatropha oil[29] and compresses the waste products in these pellets and briquettes (Diligent, 20 March 2012). In general the briquettes are used to replace firewood and the smaller pellets are designed to substitute charcoal (Diligent, 20 March

[29] Jatropha (officially Jatropha Curcas) is a nut that contains an oil that can replace fossil fuels. For long the nut was considered very beneficial since it would grow on dry land and provide a extra income, however, competition with food crops and disappointing investments have largely turned the initial hype around (Messemaker, 2008).

2012). Diligent tries to set up a synergetic system where its producers sell Jatropha seeds and buy back the briquettes and pellets for cooking (see section 6.2.3.1). Regrettably, as long as matching stoves need to be purchased separately and can only be used in combination with pellets or briquettes, it seems likely that uptake will be limited (fieldwork, 2012) (an example of the matching stoves for Jatropha pellets are shown on the cover page of this master thesis). Also the system might potentially only be suitable for areas where a well functioning distribution network can be established (ARTI, 13 March 2012), see section 4.3. Moreover some user training is required since briquettes and pellets can reach much higher temperatures than when a similar amount of biomass is used (SNV, 2 April 2012).

Estimates of current uptake of ICS are hard to obtain and diverse (Riedijk, 2011). Firstly, as discussed in chapter 2 the lion share of the population, 95.6 percent rely on solid fuels for cooking (mainly charcoal and firewood). In rural areas this percentage even stands at 99.6 percent (GoT, 2009; WHO and UNDP, 2009). Currently ICS uptake seems mainly concentrated in urban areas. Reportedly, 40 percent of charcoal users in Dar es Salaam have access to ICS and 20 percent of all biomass users in urban areas have access to ICS (EAC, 2008). This is contrasted by the national low uptake of ICS as reported by the WHO and UNDP: of the population that rely on biomass fuels for cooking, 0.72 percent have access to ICS in 2004 (2009). Moreover, the ICS market is very divers, with a variety of ICS ranging in price from 2 USD to 100 USD. This has mostly to do with the size of the stove and the durability of the materials used. Riedijk's estimate of 4 million stoves produced over the past 10 years gives limited inside in the market penetration, because of the widely varying quality and life spans (2011). The potential market in rural areas is roughly estimated at 3,000,000 households (over half of all households in rural areas).

> ...a simple piece of aluminium foil of 1 USD (1600 TZS) can function as insulation, saving up to 20 percent on fuel expenses (Shamba Technologies, 26 April 2012).

In general the ICS uptake seems to be partly an issue of mentality and partly an issue of the ability to continue use of an superior cooking technology. In terms of mentality, attention to the savings in cooking fuel are often lacking. For instance, a simple piece of aluminium foil of 1 USD (1600 TZS) can function as insulation, saving up to 20 percent on fuel expenses (Shamba Technologies, 26 April 2012). Similar techniques are proposed to be used in combination with the SimGas installation to extend cooking time (SimGas, 2 May 2012). Such savings are an issue of behaviour rather than technology. But a cook stove is not perceived as a status symbol and is therefore unlikely to be invested in (GACC, 2012). Also in areas with non-commercialized cooking fuels it is difficult to even introduce the concept of savings in relation to stoves. To be affective households need to perceive the need to save fuel and time or money and reduce health risks (fieldwork, 2012). Furthermore, proper uptake of ICS has to do with the combination in which ICS is used because: "*only 3 to 4 percent of ICS owners* [in Lake Zone] *use it exclusively. This drastically decreases the imagined revenue or even prevents the stoves from having a financial return.*" (SNV, 2 April 2012). Additionally, Tanzanians: "*purchase new cookstoves but this doesn't mean they're always used. Daily challenges and circumstances often cause them to revert to inferior technologies.*" (GACC, 2012: 38). The Global Alliance for Clean Cook Stoves makes this issue in the ICS sector in Tanzania insightful (2012). Just as discussed in section 4.1, most household prefer superior stoves to three stone fires, but not every household can afford to continue to use commercialized fuels and may have to revert to inferior resources and stoves when the household budget is strained.

Important stakeholders in the sector include the NGO TaTEDO, its subsidiary company (SEECO), the parastatal CAMARTEC, and recently SNV and GVEP have become more active in the subsector. Other mostly informal enterprises that produce ICS are present in the subsector, but are urbanely concentrated: "*Tanzanian urban markets are dominated by cheap cookstoves of both the metal and claylined variety*" (GACC, 2012: 32). Despite the huge market the organizations that were traditionally involved have had limited success. Furthermore, subsidies on ICS have had a short-lived effect and are not a sustainable approach for sector development (Riedijk, 2011). The involved NGO's often have a strategy of training women and artisans groups to become able to produce ICS. This strategy seems to have its limitations, because the trainings are uncoordinated (SNV, 2012). This leads to inefficiencies, for example a number of organizations can be present in one locality at the same time or shortly after each other without each others' knowing, thus providing training where it is not required. Moreover, large-scale trainings seem to make a taught skill decrease in value for the trainee. When stove production is a commonly acquired skill it is no longer a specialised trade which provides a source of income to artisans (SNV, 2 April 2012). The role of NGO's and potentially sector associations is proposed to be focussed more on coordination of sector activities and facilitation of stove entrepreneurs by intermediating commercial business development services (BDS).

4.2.4 Appropriate energy demand analysis

Table 4.1 structures and summarizes the results of section 4.2 in a table. The first column contains information from the TEA model. The lighting and ICT energy services of this model have been brought together, because they can be supplied through one AET: solar PV. Also, the cooling and space heating energy services have been largely left blank, because the research showed it currently is a non-issue in rural energy provision (fieldwork, 2012). The current rural energy provision is based on chapter 2, see table 2.2. In the third column the AET is presented and further categorized in the most potential varieties. The fourth column summarizes the drivers and barriers that followed out of the exploration of the three AETs. The selection of technologies and drivers and barriers are indicative and have their limitations because it is largely based on explorative research (see section 3.4 and 3.5).

Table 4.1 Appropriate energy demand analysis

Energy service and minimum standards at domestic level per person	Current main rural energy provision	Appropriate energy technology	Drivers and barriers of an energy transition
Lighting and information and communication -300 lumen for a minimum of 4 hours per night at household level. -Communication and information relevant to livelihood assets	-Kerosene and paraffin -Access to a small entrepreneur that provide charging services for a mobile phone (through car batteries or solar PV)	**Solar PV** -pico solar Allows to work as an intermediary for an SHS, provides the ability to independently charge a mobile phone -SHS Allows to work as a modular system including saving plans for modular expansion and batteries. Potentially in combination with lease constructions	**Driver** -Market driven -Decrease of Wp. price -Decentral and modular **Barrier** -Battery replacement reducing cost and environmental benefits -Counterfeit/low quality products
Cooking and water heating -1 kg woodfuel, 0.3 kg charcoal or the equivalent in pellets/briquettes or 0.08 l biogas[30] -Access to an 40 percent energy saving ICS	*deep rural and rural* Non-commercialized firewood and stoves	**Improved cook stoves** -Certified stoves Allows for the commercialization of a range of quality stoves in combination with sustainable forest management and charcoal production -Stoves that can work on briquettes pellets, and other (biomass) resources Allows for shifting from energy resource when budget or requirements changes.	**Driver** -Using traditional fuels or using a (abundant) waste to energy solution -Potential link with conservational issues -Solving IAP issues **Barrier** -Hard to commercialize (a three stone stove is free) -Informal markets (e.g. no quality control) -Behavioural change and the ability to continue using one type of fuel
	rural and semi-urban Charcoal and a variety of stoves	**Biogas and ICS** -Combination of biogas and ICS Allows to shift resources if demand exceeds biogas production -Fixed dome model (CAMARTEC model) Most developed technology which allows for local ownership if trustworthy and properly trained technicians are present -Floating drum model Allows to be used as collateral (not yet strongly developed)	(biogas) **Driver** -Variety of models (product development) -Waste to energy solution -Local ownership (biogas) **Barrier** -Costs -Quality and reputation issues -Availability and willingness to handle feedstock -Too little gas production -Water and temperature requirements
Cooling **Space heating**	-Non besides heat from fires/stoves	Part of a context specific ICS strategy	

[30] The per person per day minimum gas availability in case of biogas installation is derived from the LPG as reported by Practical Action (2012a).

4.3 Distribution models

The main issue in the development of subsectors in a challenging geographical situation seems to be to effectively arrange distribution. In the most market-driven subsector, solar PV, three general distribution models were identified during this research. To a large extent these models are also applied in the other subsectors. Of course, this distribution depends on the shipping characteristics and local requirements for installation and maintenance (fieldwork, 2012).

4.3.1 The dealer network

One of the most common ways to distribute a newly introduced and scalable product is to set up a dealer network. The importer or producer establishes contact with local dealers or retailers that can sell their product to the end-users (or even to micro dealers). The retailer typically sells a range of related products for the wholesale price plus a margin, which is used to run the business and in some cases to arrange after-sales. Establishing and controlling the dealer network is a tricky business. As mentioned for the d.light case (box 7): "*I worked with dealerships for d.light for over 6 years, and I established a large network. But I never earned one Shilling with this type of distribution.*" (SolarAid, 9 March 2012). Energy products would most easily be sold via technicians such as electricians, masons or plumbers, and via hardware shops. The main issue is firstly to establish an informed network and secondly control the network. If the supplier doesn't control its network the margin that are charged can be disproportionate and damage sales and reputation. Also dealers can be uninformed or unwilling to handle installation and after-sales (fieldwork, 2012).

An informant summarized three alternative ways of setting up a dealership network (Dutch Ministry of Foreign Affairs, 24 February 2012). Firstly, an easily established and controlled dealer network would be to make use of the network of a large company with a lasting presence in rural Tanzania. Examples include soft drink and beer companies or agricultural wholesalers. Ideally arrangements can be made centrally and the control mechanisms of the network would be relatively developed. However, these networks typically prove inaccessible, especially for relatively small companies with unrelated products (Baron and Shane, 2008). And to the extent that these companies see an advantage in becoming involved with RETs they will try to become a supplier themselves. A somewhat dated proposal is the solar PV refrigerators which was to be implemented by Coca Cola and Pepsi. The refrigerator was designed to increase turnover in off-grid areas by providing cooling and light (Hifab/TaTEDO, 1998). Secondly, companies and organizations in RETs seem often more successful by setting up a dealership with small financial institutions such as SACCOS (savings and credit cooperative societies) and VICOBAs (village community banks). The main advantage of a dealership of financial institutions is that a loan product can be devised to make it easier to meet the upfront investment of an RET. In general SACCOS and VICOBAs are weakly institutionalized and often politicized because MP (members of parliament) use them the gain influence: "*SACCOS are too political... At first SACCOS will appear very interested. But once they need to deliver, there is zero output. There is the assumption that it can all be aid.*" (Ensol, 13 March 2012). Thirdly, companies can try to make use of (other) cooperatives, such as farmer cooperatives. As is true for the other methods, the added value to engage in a dealership has to be clear: "*This strategy will only work when it is clear that the cooperatives are offered something in return, preferably close to their core activity.*" (Dutch Ministry of Foreign Affairs, 24 February 2012).

The distribution model for ICS that work on pellets or briquettes is hard to organize but vital, because functioning stoves depend on transport. In combination with Jatropha production and transport a distribution model is conceivable in combination with existing collection centres of the Jatropha processer (Diligent, 20 March 2012; Partners for Development 23 March 2012). This model is elaborated in chapter 6.2.3.1.

4.3.2 The road show

An alternative or addition to dealerships is to arrange road shows that promote and sell products. It seems that this is currently the preferred solution of the majority of solar PV suppliers interviewed (fieldwork, 2012). Supplier have more control over the sales and after-sales of a product. Road shows would presumably reach more customers than a dealer network can. Dealers are typically located in main regional or district cities and towns and rely on customers to come to them. Typically farmers come to these regional centres once or twice a year to sell their harvest and buy essential goods. A road show is probably better equipped to introduce new products, inform and activate customers (L's Solutions, 19 April 2012). If road shows are not combined with a dealer network, the supplier has to centralize all services and distribution. This option seems challenging in a vast country as Tanzania. However, SolarAid works with this model. It has a team that constantly travels the country to do promotion and explanation of how the product works to a group of headmasters from nearby schools that decide on a purchase for their school. Because it focuses on these institutional customers it can deal with a relative small customer base from its office in Dar es Salaam (SolarAid, 9 March 2012). Alternatively solar PV companies can work with companies that specialize in road shows (Ensol, 13 March 2012).

4.3.3 Cut out the middle man

Establishing and controlling a dealership takes effort. An alternative is to simply supply from one location, indiscriminate of wholesale or retail prices. As explained by a respond from the solar PV sector: "[w]*e worked with dealers before and had signed contracts... We wanted to sell quality, they just wanted a cheap price. In the end they banned my products. I'm not happy with them. Last year I dropped the dealers price and just kept a very competitive retailers price. This makes me the cheapest* *and I have increased my sales significantly. In the end now I sell to everyone for one price."* (ZaraSolar, 12 April 2012). In the case of ZaraSolar the shop is already quit well known to customers and doesn't necessarily need a dealership network to establish a local presence that can represent his brand. Also finding reliable technicians that install or maintain has become less of an issue, in some cases stimulated by NGO presence, because: "*they* [GVEP] *trained so many technicians that I can help customers to easily find someone that helps them install or repair a system"* (ZaraSolar, 12 April 2012).

Biogas and the ICS subsector are not yet as developed as the solar PV sector. For the ICS sector it might be possibly to have a very simple value chain from a supplier or producer directly to a customer or an uncontrolled dealer network. Little explanation of the product or after-sales services are needed. In the case of the biogas subsector this might be more of a problem. Companies need technicians to build or install the installations locally and give customer training.

4.4 Chapter conclusion

This chapter discussed the relation between AETs and energy demand. Energy planning for AETs is necessary to make the smartest investment that suits the context and domestic energy demand. Transparent rural electrification planning is necessary to make this happen. To answer SQ1 three AETs were selected that can meet domestic energy demand in rural Tanzania: solar PV, biogas and ICS. The appropriateness of these technologies was positively assessed by taking demand into account and determining the decentralized character, energy efficiency and environmental friendliness. Based on the research results the status of the subsector, the market potential and the relevant actors were discussed. This information helps to explore the potential of cluster promotion in chapter 6. Finally three simple distribution models were distinguished. These models illustrated the need to establish and control distribution in order to meet quality and price expectations of end-users. Currently this is an issue in the solar PV sector, but lessons from this subsector are of importance for other technologies and AEE clusters.

Chapter 5 The institutional setting for appropriate energy enterprises in Tanzania

Subquestion 2 (SQ2): To what extent is the Tanzanian institutional setting conducive to cluster formation of appropriate energy enterprises?

Development of rural areas is dependent on institutions. Institutions are necessary to voice interest and to have the capacity to implement change (Leftwich, 2008). This chapter reports on the institutional factors that are conducive to cluster formation in the energy sector. The enabling environment is an important part of the institutional setting. Firstly an assessment of the three actor groups in the multi-stakeholder network, the public sector, private sector and civil society organizations is provided to explore their capabilities in cluster promotion. The assessment contains the results of the research, which was designed to include the multi-stakeholder network. Secondly the business development service providers and the hard infrastructure for AEEs is briefly assessed. Then thirdly, to understand the institutional setting for AEE clusters the results need to be compared with the theoretical views on cluster formation. The conducive factors as introduced in the cluster formation model in table 1.3 are compared to the institutional setting and the identified conducive factors and main hurdles for AEE clusters are reported.

5.1 The enabling environment

5.1.1 Public sector

"*Energy was forgotten on district level. Even in the current policy.*" (TaTEDO, 6 March 2012).

This section gives an overview of the extent to which the government is conducive to cluster formation. This particularly involves local government authorities (LGAs), but the functioning of national public organizations can be of importance as well. The role of two important national organizations for rural energy provision, REA and TANESCO have been discussed in section 4.1.1. Especially REA can have a powerful position in the sector, but is not represented at the local level, Even though REA should be involved with local authorities, i.e. district authorities (GoT, 2005), a REA representative stated that: "*we don't support* [a permanent representation at district level] *because we are only involved with operational costs... We can train officers locally but we cannot have our own specialized officers there*" (REA, 9 March 2012). Furthermore, on the national level the role of the Ministry of Energy and Minerals (MEM) is important. The existing policy focuses on traditional centralized energy technologies and strategies, namely electrification through gird connection and oil and gas explorations (MEM, 2003). No goals or strategies related to RETs are included in the 2003 energy policy. As stated in a research on the status of the energy policy the main weaknesses of the current policy include: "*lack of laws to guide RE* [renewable energy] *and lack of specific policy for RE"*

*(*Mnzava, 2011: 36). Moreover, the policy is considered outdated by over 95 percent of the respondents of the aforementioned research, and all respondents agree the policy needs to be reviewed (ibid.). According to MEM the review process will start December of this year (9 March 2012). Criticism on the type of attention the ministry gives to energy provision was expressed during last year's research and this research: "*the ministry is still thinking in MWs and not in terms of small supply to households*." (UDSM, 8 March 2012). Also, the two parastatal organizations COSTECH and CAMARTEC have a role in the energy sector on the national level. The role of COSTECH is to facilitate research and technological development in cooperation with involved companies. For research in Tanzania COSTECH is a accommodating coordinator, but COSTECH has little linkages with the private sector and no cooperating companies were identified in this research (COSTECH, 12 March 2012). CAMARTEC has been mentioned in section 4.2.2 as an important player in the biogas subsector. CAMARTEC has been involved with the development of a range of agriculture related products, from tractors to cook stoves and gas lamps (sold in combination with the biogas installation). In both parastatal organizations commercialization seems troublesome. Expertise and the developed products tend to remain on the grounds of CAMARTEC (CAMARTEC, 26 March, 2012). As mentioned by a COSTECH employee: "*the technologies that are being developed should be more demand driven*" (COSTECH, 12 March 2012). Demand driven refers to the involvement of the customer base in the development of energy technologies. The technological development mission of the parastatals would lead to better dissemination if the technologies are demand driven and geared towards commercialization.

> "*the ministry is still thinking in MWs and not in terms of small supply to households*."
> (UDSM, 8 March 2012).

Currently in most district offices energy is a cross-cutting issue. No particular officer is appointed the energy agenda. This leads to a situation in which non-specialized personnel with lacking knowledge and time are delegated to handle the issue, ranging from agricultural officers to medical officers. Leaving the topic to non-specialists could result in bad procurement and political decisions. For example, having solar PV installed at places that don't require such installations, such as schools that only teach during day (fieldwork, 2012). MEM explains that they try to stimulate involvement from regional councils but there are currently very few energy officer at this level, also the regional level has little power over districts (MEM, 9 March 2012) (see section 2.1.1). Three respondents from NGO's expressed their views on energy policy on the district level. Firstly, the influential NGO TaTEDO is successfully working with district governments on setting up energy committees. These committees consist of all officers that have to do with the topic, typically the agricultural, environmental and business development officers as well as the district executive director (DED). In contrast to the current situation a committee would be able to increase the amount of attention and experience available for energy (TaTEDO, 6 March 2012). Secondly, the sector association TAREA opposed the idea of a committee for the reason that it is too ad hoc and once a project has stopped the committee will disintegrate. Moreover, the committee members are still not specialists and thus lack knowledge and potentially motivation. Instead an energy desk is proposed that forms a permanent office with a trained energy specialist. The energy desk is harder to establish, because it requires a mandate from the ministry (TAREA, 8 March 2012). Thirdly, an informant expressed doubts about setting up energy committees or desks at the district level (SNV, 2 April 2012). According to the informant placing any policy topic outside the existing structure in a committee will actually harm the involvement and responsiveness of the district: "*no district official will feel responsible for the topic. It will only function as a way to garner allowances, and secure money. If this is not the case no official will show up for a meeting.*" (ibid.). Reportedly, in the case of an energy desk or energy officer the topic is again placed outside the existing power structure. Indeed as explained in section 2.1.1, funding of districts is proportional to the existing facilities and is difficult to increase for a new office. Hence, allocating means to a newly created energy desk will most likely be difficult and vulnerable during budget cuts. The respondent proposes involvement of the district representatives in a consortium on request of the private sector and civil society organizations (see section 6.1.2).

The research showed that it appeared hard to have districts actively involved even though most enterprises paid courtesy calls before becoming active in a district (fieldwork, 2012). Due to the Decentralization by Devolution policy districts seem to have extended responsibilities and even though they might have an extended staff the responsibility is still concentrated at the initial core of officers. As one company describes its experience: "*...getting the government to do something for you by going top-down takes a lot of time. It is much easier to arrange something directly with the person responsible...*" (Diligent, 20 March 2012). Moreover, the cooperation between the district council that has increasing opposition representation, and the presidentially appointed DED is often contentious. Hence, the implementation of national policy will also be badly affected by these issues (see section 2.1.1).

5.1.2 Civil society organizations

"*...many NGOs are protective of what they do. There is limited communication in the sector. Even in our own programme organizations have their own way of working and don't have the tendency to adapt or to be very clear about their approach.*" (Partners for Development, 23 March 2012).

The role of civil society organizations (CSOs) was conceptualized as knowledge provider and as an intermediary between LGAs (districts) and the private sector (see section 1.5.2). Part of the civil society are the NGOs. As discussed in chapter 2 non-governmental organizations are overrepresented in Tanzania. In an enabling environment the involvement of donors should be directed at making itself abundant. The intermediary function is meant to assure that LGAs and private sector can function independently. But the presence of CSOs as knowledge providers will always be required in a cluster, for example the universities and training institutions.

A number of civil society organizations are explicitly involved as knowledge provider by developing energy technology products. As mentioned before, the local NGO TaTEDO assumes an important role in the sector. TaTEDO tries to develop and increase uptake of wide range of appropriate energy technologies. TaTEDO has been successful in developing new technologies for domestic energy provision, but the track record in disseminating these technologies seems poor. These two sides of TaTEDO explains their mixed reputation. On the one side TaTEDO is recognized to give technologies a head start and to function as a steady factor in the sector; on the other there is general disappointment with its effectiveness in sustainable energy provision. For instance in the ICS sector TaTEDO has received much donor money and done much work, but achieved little dissemination of the technology (Riedijk, 2011; SNV, 3 May 2012). These issues have been recognized before. In 2009 and 2010 two consultancies were involved with training TaTEDO staff and set up a business facilitation unit. However, private sector development seems not internalized (Schoot Uiterkamp, 2011). Namely, two of the three employed and trained business development officers have left the organization. Also a respondent affiliated with TaTEDO reports: "[w]*e* [the business facilitation unit] *train entrepreneurs. However, there is not always enough work in this type of activity. Sometimes our activities are directed to the end-user not so much to the entrepreneur.*"(TaTEDO, 7 March 2012). The way TaTEDO is active energy provision is discussed in section 6.2.2.1. Other organizations are also involved with the development of energy technologies. ARTI Energy is involved with the development of energy technologies and uses the experiences of her Indian main branch. In Tanzania ARTI specialized in briquetting (especially of charcoal) (ARTI, 13 March 2012). Just like ARTI, Shamba Technologies has been mentioned in relation to the biogas subsector. Reportedly Shamba Technologies is also working on a solar PV product (Shamba Technologies, 26 April 2012). Finally, the University of Dar es Salaam (UDSM) and other universities and colleges are knowledge providers and can help to develop energy technologies. Box 6 illustrates how they can fulfil this role. However, similar to the aforementioned parastatals in terms of technology dissemination these institutions are not so much demand driven. A professor at UDSM stresses the importance of business incubators linked to universities to abate this (UDSM, 8 March 2012).

> “*Currently the rural demand is not vocal. The mission of NGOs is to make the demand more vocal. Hence, it is a matter of knowledge and awareness*” (UDSM, 8 March 2012).

Civil society organizations can also function as knowledge providers by stimulating awareness among households. An organization can of course combine the two types of knowledge provision. Moreover, if a market is not aware of an issue or technology, developing market driven products is difficult. The importance for civil society organizations to provide awareness is stressed by a respondent from UDSM: “*Currently the rural demand is not vocal. The mission of NGOs is to make the demand more vocal. Hence, it is a matter of knowledge and awareness*” (UDSM, 8 March 2012). The CSOs involved with awareness raising often have strong ties with communities. This group includes many Tanzanian and international NGOs. One example is Instituto Oikos that has for many years been involved with communities around mount Meru in Arusha region, among which the Maasai[31]. By building up a relation with the communities a range of technologies including water harvesting, ICT and RETs can be demonstrated and gradually introduced. Especially, in the case of traditional tribes, awareness raising is shown to be an important but long process. Adopting a technology is not merely a case of energy demand and financial means but imply a change of live as well.

Besides knowledge provision CSOs work as a broker or intermediary between public and private sector. In general the intermediary role can also be extended to intermediation between other stakeholders in the sector, including the customer base. NGOs, social enterprises or even consultancies can assumes this role. SNV is a Dutch development organization that is active in the energy sector, mainly in domestic biogas (see section 4.2.2). Their role in the biogas subsector has been directed at developing capacities of the national biogas programme (TDBP) and its partners. SNV tries to bring together stakeholders and provides information on status of the sector and possible activities for sector development. For instance, a status report of the ICS subsector initiated a meeting and coordination of stakeholders in the ICS subsector (SNV, 3 May 2012). Also, as is discussed in section 6.1.2, SNV initiated a consortium that brings together energy stakeholders at the regional level. Camco is an international consultancy in energy services and products. One of its roles in the sector includes an advisory function for the collective procurement campaigns for solar PV. In this capacity it needs to be in good contact with the customer base, financial institutions, suppliers and technicians (Camco, 3 May 2012). In section 6.1.3 the role of Camco is explored in relation to cluster promotion.

Besides the knowledge provision and intermediary functions of CSOs, other functions are sometimes fulfilled in the sector by these organizations. CSOs have to be careful not to oppress the

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[31] The Maasai are a tribe of nomadic pastoralists that live mainly in the North of Tanzania and border area with Kenya. The tribe has maintained a traditional lifestyle with many colourful ceremonies.

development of private sector and public sector involvement. For example, NGOs are sometimes themselves involved with training and disseminating of technology. An example of training activities is provided by the developing energy enterprises project (DEEP) implemented by development organization GVEP. DEEP focuses on training of 600 energy entrepreneurs and support of small energy enterprises (GVEP, 4 April 2012). The case of GVEP is discussed in section 5.1.4 on BDS. No organizations were identified during this research that simply provided energy products for free, but many do provide energy technologies for a subsidized price (e.g. EMEDO and Rongead, 10 April 2012). Also, as is the case for TDBP hidden subsidies can make the situation unfavourable for private sector development (see section 4.2.2). Ideally disseminating of energy products is left to the private sector that can sustain a presence, in contrast to donors. Also consumers' expectations of the price can become unrealistic, and make the customer base unwilling to pay market conform prices. The entrance or survival of private sector actors can be hindered by such subsidies.

5.1.3 Private sector

"*Entrepreneurial attitude forms the largest barrier, not lack of finances; if you want to succeed as entrepreneur you will succeed"* (L's Solutions cited in Schoot Uiterkamp, 2011).

The private sector is the main point of attention in the enabling environment. This section concentrates on the institutions that are directly involved with business regulations and facilities for AEEs in Tanzania. It partly builds on the results from the contextual information in section 2.1.2.

TAREA (Tanzania Renewable Energy Association) is the sector association that represents its members in policy issues, provides information and serves as an independent consultation point for outsiders (Schoot Uiterkamp, 2011). TAREA was founded as solar energy association (TASEA) in 2001, in collaboration with TaTEDO. With the growing importance of biogas, biofuels, ICS, hydropower and wind power the association broadened its focus in 2010 to promote all RETs in Tanzania. One of the main achievements of the association is the realization of the tax exemption on solar PV. It achieved similar exemptions on small wind power installations[32] (ibid.). Moreover, in many instances companies in AET expressed the value of standardization and certification for sector development. Imposing standards together with the Tanzania Bureau of Standards (TBS) would counteract low quality and counterfeit products. Consequently customers are served by quality products, while companies that fulfil the standards are boosted (fieldwork, 2012). TAREA has linkages with important stakeholder in the sector, partly represented in its board of advisors. Also ties with foreign organizations (mainly German) help to build TAREA's capacity. The operational strength is somewhat limited because it functions with two employees and two interns in its headquarters in Dar es Salaam

[32] Smaller than 25 kWp.

and with two other interns and a part-time chairman in its branch in Mwanza. The Mwanza office of TAREA is currently located at Zara Solar, one of the main solar PV supplier in Tanzania. For a sector association this is undesirable, because it limits the (at least perceived) impartiality of the organization (ibid.). These limitations of the organization are largely due to the limited funding. As a membership organizations it receives fees[33], but a number of members expressed during the research that the member fees are probably too low to generate sufficient funding. TAREA doesn't intend to raise the fees, because it feels that it is too much of a limitation for small companies to become a member: "[w]*hen we collect the small fee we charge for membership it feels like chasing our members*" (TAREA, 30 April 2012). Also charging a fee proportional to a member's profit seems difficult because accounting of Tanzanian companies is hard to rely on (ibid.). Instead TAREA is doing paid consultancy work. Currently in this consultancy work TAREA doesn't compete with its members, and should also prevent this because a conflict of interests would arise.

Business regulations were discussed in section 2.1.2 and showed main hurdles in dealing with construction permits and registering property. This report is however limited in that it doesn't include the unofficial hurdles, such as information provision to entrepreneurs and the cooperation of civil servants. Qualitative research can add much depth to such analyses. The results of last year's qualitative research show difficulties in registering a company. All business development officers at the district level directed entrepreneurs for registration to BRELA (Business Registration and Licensing Agency), which has an office in the commercial capital of Dar es Salaam. Only after an interview with the CEO of BRELA did it become clear that enterprises only active on the district level don't have to register at the BRELA office. The trip to Dar es Salaam is thus abundant for many entrepreneurs, instead entrepreneurs have to obtain a business license of 100.000 TZS at the district government (Schoot Uiterkamp, 2011). Another important institution for business regulations is the Tanzania Revenue Authority (TRA). At the TRA a required tax identification number can be arranged free of charge. Also a separate process exists for informal (unregistered) companies that earn less than 20 million TZS annually (ibid.). The TRA number (TIN) and the registration are required to open a bank account, a valuable asset for enterprises.

Vocational and industry development organizations can be categorized as CSOs. These organizations are explored in this section because they are closely linked to the private sector. The Small Industries Development Organization (SIDO) was established in 1973 as a parastatal organization and is active in seven locations in Tanzania. SIDO is involved with trainings, among others it trained the 500 TDBP masons and in Mwanza it is involved with the GVEP DEEP entrepreneurs. It especially focuses on accessible income generating activities, but also provides

[33] 300.000 TSh. from an organization and 50.000 TSh. from a private person

facilities for more complex business activities. Important in this respect is the housing of start-up enterprises in the workshops of the organization. For instance, an ICS entrepreneur produced stoves from a workshop at the Arusha SIDO branch provided for free. Most SIDO enterprises are informal, and can have access to loans from SIDO (Schoot Uiterkamp, 2011). Another organization active in direct support of the private sector is the Vocational Education Authority (VETA). VETA, again a parastatal organization, provides training for over 20 occupations in every region in the country. VETA mostly trains young students that moved on from secondary schools. VETA also provides entrepreneurship trainings. According to a respondent the entrepreneurial attitude is not always favourable, mostly due to the Ujamaa policy (Schoot Uiterkamp, 2011). But, as also described in section 2.1.2 entrepreneurship increasingly has a good connotation. The annual fee for following a yearlong VETA programme is 400.000 TZS. VETA and the ministry developed a curriculum for technicians in solar PV (ibid, 2011). SIDO and VETA support entrepreneurs, however, these organizations are not specifically specialized in the training of business skills (even though an entrepreneurship course exist at VETA).

5.1.4 Business development services

"*In Tanzania, informal groups (20-30 people) are everywhere. They are based on gender, family, wealth, business, etc. This is an excellent mean to promote BDS and sustainable energy technologies.*" (Riedijk, 2010: 49).

BDS providers are important for the development of enterprises, because they help to smoothen out market failures. For instance, by making transactions easier (see section 1.5.4). In section 5.1.3 a number of BDS providers have already been mentioned, such as TAREA, SIDO and VETA. This final section on the enabling environment focuses on research results concerning the way BDS are provided to AEEs.

> "[the business trainings] *are free. They need this training, but they don't know this. That is why we can't ask money for it."* (TaTEDO, 7 March 2012).

In chapter 1 the case was made for commercialized BDS providers. Especially in relation to trainings this seems a difficult task. To make energy provision lasting and locally owned, NGOs such as GVEP via the DEEP program, provide free trainings to technicians (Macharia, 2011). In other instances NGOs even pay a "sitting fee" to attend a training, this practise was not reported during the research. What is true in any development intervention, is true for trainings. A beneficiary's perception of the value of a service or product will be low as long as no money is charged. However, charging money seems difficult as long as participants expects it to be free and don't really see the need of the trainings. As a trainer at VETA puts it: "*Most Tanzanians don't think they need entrepreneurship training to start-up a business and certainly don't want to pay for it. They always know someone who managed to set-up a business without taking a course in it."* (cited in Schoot Uiterkamp, 2011). Also TaTEDO provides business trainings without payment: "[the business trainings] *are free. They need this training, but they don't know this. That is why we can't ask money for it."* (TaTEDO, 7 March 2012). It should also be noted that trainings do require some investment by the participant (are not "free") even though no direct payment is required, transport needs to be paid, time needs to be freed up and successfully participating requires commitment.

> "*banks have very limited experience with energy entrepreneurs, and excepting new proposals would require some experience.*" (SNV, 2 April 2012).

Financial services are regarded essential for enterprise development. "*At some stage during the development period, enterprises need financing to move to a higher level, and in many cases the amount of finance required for expansion exceeds what is being generated from transactional cash*" (Macharia, 2011). The financial system in rural areas which is accessible to small entrepreneurs is often reported as a barrier to enterprise development (Schoot Uiterkamp, 2011; Riedijk, 2010). Small financial institutions such as the aforementioned VICOBAs and SACCOS provide loans to households. SACCOS are groups of savers and loaners, typically formed around one profession, such as teacher or farmer SACCOS. For accessing a loan, SACCOS require a one-off membership fee of about 100.000 TZS, a payback period of 6 to 8 months and collateral. Also interest rates for the mentioned period stand at over 20 percent, which is paid back by monthly instalments. VICOBAs are less institutionalized but often have similar payback periods, payback rates and interest rates. For starting entrepreneurs the requirements of these institutions don't align with their investments. In case of existing entrepreneurs it can help them to expand stock or purchase productive goods (GVEP, 4 April 2012). Also for the AEE's customer base it can assist uptake. Special loans or arrangements for RETs products have been devised as is the case for Farm Friends (located in Tanga region) and Usawa SACCOS (located in Kilimanjaro and Arusha regions) (Farm Friends, 25 April 2012; Schoot Uiterkamp, 2011). Regular banks seem hard to access by AEEs. As an informant put: "*banks have very limited experience with energy entrepreneurs, and excepting new proposals would require some experience.*" (SNV, 2 April 2012). A typical "catch 22" situation thus exists wherein two parties are locked in a unfavourable position because both need the other to move first. Also GVEP rapports that new or misunderstood energy technologies make financing of AEE problematic. Moreover, the size of the enterprises and relating transaction costs makes acquiring a loan difficult (Macharia, 2011). GVEP found a way around this problem (the "catch 22") by providing guarantees to the banks and SACCOS on the loans DEEP entrepreneurs applied for. "*We provide the SACCOS with a guarantee that the loan is paid back, but the entrepreneurs don't know this. Otherwise, they might easily default on their loan. They also have to provide the SACCOS with a simple business plan and collateral for the loan. The loans are between 0.5 and 5 million TZS.*" (GVEP, 4 April 2012). The disadvantage is that the business plan and the quality of the enterprise is no longer of importance to the financial institution, because any risk is covered by a large, financially strong organization. Hence, this particular BDS is not provided in a commercial way, which reduces the market driven character of the sector.

Besides financial services and vocational (technical) training other BDS such as marketing and infrastructural provisions are certainly of importance. Riedijk (2010) also encourages to consider root causes for lacking BDS. In many cases simple adjustments in doing business, such as keeping track of income and expenses are a first step in enterprise development. Training is thus important and hands-on advice is given in the citation at the beginning of this section to increase demand for BDS provision (ibid.).

5.1.5 Hard infrastructure

"*In some areas transportation costs almost double the price of input materials for bio-digesters.*" (Technician active in the biogas sector cited in Schoot Uiterkamp, 2011).

Tanzania is a vast country with challenging terrains for arranging transport. According to the World Bank only about 7 percent of all roads in Tanzania are paved (2012b). Especially during the rainy season road conditions increase the time needed to reach customers or suppliers or even make transport impossible. Also accidents or damage to vehicles become more likely because roads become unreliable. As part of development interventions hard infrastructure receives a lot of attention (MKUKUTA, 2009). The agency TANROADS and many donors are involved in improving road conditions. The conditions of the primary roads have been greatly improved over the past 10 years, data from 2007 shows that 48 percent of the roads are in good condition, from 14 percent in the year 2000 (ibid.). The condition of the roads that fall under district jurisdiction is generally in worse condition than the primary roads: 45 percent is poor condition compared to 15 percent of the primary roads. The Poverty and Human Development report calls for more attention for improving the roads under the responsibility of the district authorities (ibid.). For the development of AEEs transport is important, as also established in section 4.3 on distribution. Transport can determine price of energy technologies, especially in rural areas. Last year this was established through interviews with biogas masons (Schoot Uiterkamp, 2011). Illustratively building materials, especially cement and gas pipes for the CAMARTEC installations are locally available, but prices vary strongly per location. In rural areas stores stock much smaller quantities and per unit price in these areas are thus much higher. In one instance it was observed that masons can purchase locally in the district capital but travel to the regional capital because the transport costs offset the price difference (ibid.).

Telecommunication infrastructure has greatly improved with the introduction of mobile phones. The number of mobile phone customers stood in 2009 at over 17 million, from almost 2 million in 2004 (GoT, 2010). Reportedly in 2011 the figure had already rose to 25.6 million customers (Reuters, 2012). The mobile phone market is dominated by seven highly competing companies. Fixed line communication is in comparison negligible, with 173.000 customers it stands at less than 1 percent of the number of mobile phone customers in 2009 (GoT, 2010). Many new opportunities also arise with related applications such as mobile money. In section 4.2.1 on solar PV an example is provided how telecommunication can assist in sustainable energy provision.

Finally, energy provision is important for the internal operations of AEEs as well. For instance the production of ironlined ICS requires drilling and welding, which relies on (three phase) electricity. This limits the production of these companies to electrified workshops (Partners for Development, 23 March 2012). In section 2.2.2 an overview is provided of the current energy provision infrastructure. As discussed in section 1.3.2 on productive energy needs, electricity can catalyse economic growth. It would be advisable if a utility (TANESCO) can increase its involvement with enterprises, for instance by assisting in raising the financing for enterprises to become electrified (Kooijman-van Dijk and Clancy, 2010).

5.2 Enabling cluster formation

In chapter 1 (section 1.5 and 1.6) 15 interlinked conducive factors were identified that are thought to contribute to agglomeration advantages. In this section the agglomeration advantages are considered and which factors in the Tanzanian institutional setting are conducive and unconducive (a hurdle). Many of these factors relate to the enabling environment as discussed above. Also information from chapter 2 and 4 is considered to complete the analysis. The results are summarized in table 5.1.

> "*In Africa farmers are generally less trusting* [than in Asia] *because when they decide to invest in a product they see higher chances of failure but also act less tough on a technician when any harm is caused.*" (SNV cited in Schoot Uiterkamp, 2011).

Increased competitiveness of the AETs can result from the development of the subsectors and specialization and proximity of AEEs. The highest proximity of AEEs seems to be realized in the informal ICS subsector, for instances in regional urban centres (TaTEDO, 6 March 2012). Especially on market places a number of small producers sell the ironlined and claylined cook stoves. Also solar PV is increasingly represented in the energy sector (see section 4.2.1). Another conducive factor for increased competitiveness is high trust and social capital. As discussed in chapter 2 (section 2.1.2) trust in business is mainly based on family (and ethnic) ties. This was illustrated by a respondent: "*In Africa farmers are generally less trusting* [than in Asia] *because when they decide to invest in a product they see higher chances of failure but also act less tough on a technician when any harm is caused.*" (SNV cited in Schoot Uiterkamp, 2011). Two other factors, "repetitiveness of transactions and exchange" and "outsourcing" were deemed conducive to increase competitiveness, these factors can be promoted by business regulations. In general the formal business regulations in Tanzania were assessed favourable for enforcing contracts and thus for these two factors (see section 2.1.2). In AETs the CAMARTEC installation requires a range of specialized activities, such as masonry, plumbing and user training (Schoot Uiterkamp, 2011). Increasing the specialization in manufacturing these brick build biogas installations can make the biogas subsector more efficient. **Group learning** within AEEs can be stimulated by the development of norms and standards. Currently the sector association is involved with stimulating this process for AETs. As mentioned much technological knowhow is available at parastatals and NGOs but needs to be disseminated to stimulate knowledge availability. Furthermore VETA and SIDO are important actors that can assist in this process, though there could be more emphasis on business skills. It is currently hard to have these business development services provided in a commercialized way. The **enabling environment** was discussed above. In short, the civil society organizations are conducive in AETs because of their ability to support entrepreneurship, initiate clusters and provide knowledge. LGAs need to be more involved with enterprise development and energy issues to fulfil a role in cluster initiatives. Also on the national level the ability to assist in energy planning is poor, as illustrated by the way REA and TANESCO function (see section 4.1) Furthermore even though CSOs can fulfil a coordinating role, communication between the organizations themselves could improve (see section 5.1.2). The telecommunication hard infrastructure is conducive, while district roads make clustering hard. Also enterprises can benefit from more experience with AETs at financial institutions. A number of factors are conducive to **endogenous economic growth** in AETs. As mentioned in chapter 4, solar PV is a market driven AET and can propel sector development. Again the knowledge on AETs is available and can be conducive provided organizations strive to share and commercialize. Overall the sustained growth of the Tanzanian economy seems conducive. Though, this growth of the economy is (partly) dependent on foreign aid. **Input sharing/ supplier and buyer advantages and labour pooling effects** as reported in table 1.3 refer to the active collective efficiency, that is the ability to create mutually shared benefits for the enterprises in a cluster. The institutional setting is conducive through the availability of intermediaries that can coordinate or take the lead in setting up such actions, such as TAREA and other civil society organizations. In general the attitude towards entrepreneurship is improving, but can still hinder AEEs as strictly as long as survivalist entrepreneurship dominates. Also lack of trust beyond family ties as mentioned before seems hurdle.

Table 5.1 Institutional setting for an AEE cluster

Conducive factors	Main hurdles	Relating agglomeration advantage
-Proximity in informal ICS sector -High growth and market driven character of solar PV sector -Trust in business based on family ties -Formal business regulations on enforcing contracts	-Trust in business beyond family ties	**Increased competitiveness**
-Presence of a sector association (TAREA) -Technological knowledge in AETs available at parastatals and NGOs -Presence of decentralized training institutions (SIDO and VETA)	-Dissemination (sharing and commercialization) of technical knowledge -Commercialization of BDS providers -Entrepreneurship and business skills courses	**Group learning**
-Much involvement CSOs -Presence of a sector association (TAREA) -Available supporting organizations for entrepreneurship (NGOs, business competitions, SIDO) -Telecommunication	- Assistance at the local level for setting up a business -Representation of energy issues at the local level -Communication between CSOs -Experience with AETs at financial institutions -Transparency of energy planning at the national level - AETs included in energy policy -Roads under district mandate	**Enabling environment**
-High growth and market driven character of solar PV sector -Technological knowledge in AETs available at parastatals and NGOs -Sustained economic growth (>6%) last ten years	-Dissemination (sharing and commercialization) of technical knowledge -Domination of development aid	**Endogenous economic growth**
-CSOs or private sector can take leading role in coordination -Presence of decentralized training institutions (SIDO and VETA)	-Attitude towards opportunity driven entrepreneurship	**Active collective efficiency leading to: Labour pooling effects and Input sharing/ supplier and buyer advantages**
-Presence of a sector association (TAREA) -Coordination of CSOs	-Trust in business beyond family ties	

5.3 Chapter conclusion

This chapter discussed the institutional setting for cluster initiatives. The three stakeholder groups were currently found not to be equally involved. Especially district governments lack in specialism and attention to energy provision. Theoretical views on cluster formation assign an important role to the public sector, however, in the institutional setting for AEEs in Tanzania the cluster initiator role seems more likely to be assumed by civil society organizations. Furthermore, civil society organizations are important knowledge and BDS providers, but NGOs and parastatals should understand the need for demand and commercially driven interventions. The main hurdle for private sector development seems to be issues of attitude and trust, but there are improvements in infrastructure by BDS provision and telecommunication sector that stimulate entrepreneurship. The issue of trust also relates to the main institutional hurdles for cluster formation of AEEs. The agglomeration advantages "active collective efficiency" and "increased competitiveness" are hard to develop if linkages between enterprises remain absent due to a lack of trust.

Chapter 6 Towards cluster promotion in rural Tanzania

Subquestion 3 (SQ3): To what extent does cluster promotion in appropriate energy enterprises take place in rural Tanzania?

To explore what cluster strategies can mean for enterprise development this chapter reports on the identified inceptive clusters in AETs. Two categorizations are applied to distinguish between the inceptive clusters. The first section introduces clusters that consist of different groups. The second section distinguishes between three types of AEE clusters. In total five types of inceptive clusters can be considered as a means to promote clusters of AEEs. To understand their potential these five types are analysed. The strengths and weaknesses are reported based on the examples from the research. Also the way the types correspond to the institutional setting is explored.

6.1 Types of clusters

In chapter 1 a cluster was defined as: "*a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities*" (Porter, 2000: 15). Clustering can also mean that other actors are brought together.

6.1.1 Enterprise clusters

First of all, central in this master thesis is a cluster of enterprises. Within the conceptualization a cluster can take a number of forms. REEEP (Renewable Energy and Energy Efficiency Partnership), an international organization promoting clean energy uptake in developing countries, has studied a cluster model to improve energy provision, among others in Tanzania. REEEP has proposed integrated rural energy utilities (IREUs) that function as clusters of enterprises and arrange (clean) energy provision to rural areas. (Banks, et al., 2008). Integrated energy refers to promotion of awareness and provision of a range of energy technologies. Instead of focussing on a particular energy resource, integrated energy provision refers to an energy mix, including electrical and thermal service delivery (Aitken, 2009a).

The initial area where the IREU were tested was in South Africa, in the region of northern KwaZulu Natan in a public private partnership. The IREU was initiated by a local energy company and a Dutch utility (together revered to as NuRa) and supported through involvement of governments and donors. From 2001 to 2009 NuRa established 8 energy shops in an area of approximately 45.000 km² with 200.000 rural households. In total 15.000 households are currently served by the 8 shops that provide solar home systems, LPG, ethanol gel fuel and related products (Aitken, et al., 2009). A discussion on the type and integration of energy technologies provided by the shops in the case of northern KwaZulu Natan is provided in box 8.

An assessment of the Tanzanian context by Banks et al. shows no regulatory barriers for establishing an IREU (2009). According to the study the regional and national goals for disseminating modern energy even provide a favourable framework for implementing integrated energy (ibid.). No IREU that is based on the REEEP conceptualization is currently present in Tanzania. Below the inceptive enterprise clusters in Tanzania are further explored.

Box 8 Energy integration in northern KwaZulu Natan, South Africa

Initially the Integrated Rural Energy Utility (IREU) in South Africa, in the region of Northern KwaZulu Natan, aimed at installing 25.000 solar home systems by 2005. But in 2006 it had only sold 11.000 SHS, this was largely due to subsidies that had been withdrew by the government. The business model became unfeasible early on in the programme. Without the subsidy diversification became one of the ways to survive. The management of the IREU successfully decided on selling LPG and related products. The managing director of the IREU at the time explained: "[t]*he small installed* [SHS] *base is not viable; this is a numbers game. NuRa's survival is a result of its LPG sales.*" (cited in Aitken et al., 2009a: 8). Integrating these two main energy technologies in the basic infrastructure lies at the hard of collective efficiency and cluster theory. The operational costs of the IREU are now covered by two energy technologies. Increasing diversification can potential increase benefits further, as is reported in REEEP's guidelines for IREUs: "[w]*hat is interesting here, and it supports the general thesis that integration is beneficial from a financial point of view, is the dramatically lower marginal costs of bringing LPG sales online when compared to SHSs.* (Aitken et al., 2009b: 12). Moreover, it is proposed to further integrate the energy provision by including other energy services, such as pico solar, ICS and productive goods (Aitken et al., 2009a). LPG is currently not included as an appropriate energy technology in this master thesis (see section 4.2).

6.1.2 Cluster promotion via organizational clusters

Collaboration of the multi-stakeholder network on the local level can be promoted through increasing collaboration between the three stakeholder groups on a meso/macro level. In the energy sector companies that have an important role as a supplier, BDS providers and regulators can form organizational clusters. These clusters can be regarded as a prelude to enterprise clusters on a lower level. It would take the commitment of these stakeholders, that are typically concentrated in urban areas to create the right conditions for promotion of AEE clusters.

During the research one example of an organizational cluster for Mwanza and surrounding regions (Lake Zone) was identified. SNV is currently testing this organizational cluster through the so-called Energy Hub pilot based on the aforementioned REEEP reports. But even though the IREU is used as inspiration for this format, this type of cluster functions as a consortium or deliberative body, rather than a cluster that directly promotes energy technologies for households via shops (SNV, 2012). The Energy Hub pilot is currently in its first phase of performing a market intelligence study, which should provide better understanding of the regional drivers and barriers in the energy sector (SNV, 2 April 2012). Similar to this master thesis, but based on a more in depth and self-contained research (i.e. firsthand data is obtained), an analysis of the household demand, appropriate energy technologies and enabling environment are mapped out to explore energy provision. A second phase of the pilot is designed to develop the market via the Energy Hub, financial services and household budgeting. The household energy budget partly determines whether an energy technology is appropriate for a household. The third phase is to make actors in the energy sector more vocal and increase internal and external interaction, for example vis-à-vis the ministry (SNV, 2012). A critical point for a well-functioning organizational cluster is of course the participation of the stakeholders in the region. Currently the consortium includes most important regional stakeholders of the sector, including the local branch of TAREA, a solar supplier, five NGOs/BDS providers (including SNV) and a church (involved with ICS and biogas). Typically these organizations have training contact or dealerships with small and micro enterprises. Even though this pilot is young, it seems that coordination is beneficial for the sector. Duplication by two or more BDS providers in case of trainings and trainings for trainers is a real issue in Lake Zone. As described in section 4.2.3 trainings can become abundant and abundance can become harmful to the sector (GVEP, 4 April 2012; SNV, 2 April 2012). The cluster thus initially focus on the relational aspects between stakeholder. Aligning service provision is prioritized, once existing organizations have clearly positioned themselves the need for other interventions is clearer. "*In first instance we should concentrate on training the service factor and create the links between the existing partners. Later on we can introduce new players and suppliers to the field.*" (SNV, 2 April 2012).

One of the potential risks of the Energy Hub and organizational clusters is that the participants in the organizational clusters are exclusive and enjoy too many privileges. At some point internal division of donor money, collective policy advocacy and price arrangements might make the organizational cluster relatively invulnerable to competition, at the expense of new enterprises and the consumer. New organizations should be allowed access to organizational clusters and privileges should be kept at a minimum. The efforts of the consortium should be directed at increasing the collective efficiency of the energy sector as a whole. A related issue can be considered a hurdle for the Energy Hub in specific and organizational clusters in general. The involved parties are likely to differ in size and power position. For a diverse organizational cluster it is hard to keep all the interests represented, because small and big enterprises have different requirements, just like NGO's. For instance in Lake Zone, a small NGO like EMEDO has installed six biogas installations last year, while an international NGO like GVEP reaches numerous households trough there 250 trained technicians. These two have little shared experience or overlapping interests. The formation of such diverse consortia is especially troublesome in cases where NGOs tend to keep their approach to themselves or show no willingness to change their way of work (see quotation at the beginning of section 5.1.2).

6.1.3 Cluster promotion via customer clusters

Recently cluster approaches have been applied also to customers in order to generate economies of scale and increase efficient procurement and installation. Especially in the solar PV subsector where small discounts on the price can make the difference in profitability, organizing or clustering customers to collectively procure in one batch makes economic sense. There are a number of examples from developed countries where collective procurement of solar PV has proved to work (e.g. Stichting Wijwillenzon, 2012).

In Tanzania the consultancy Camco is involved with communities to arrange collective procurement and instalment. Together with Rex Ltd., a solar PV supplier, Camco will arrange the purchase of solar PV installations in the Southern Highlands and in Kigoma region in the north-west of the country (see figure 2.1). Rex is the supplier and installer of the solar PV installations, whereas Camco is involved with the selection and organization of communities and the procurement process. The project receives some subsidy to cover the costs of organizing the customer clusters. The collective procurement is done via a number of SACCOS and farmer groups with a minimum of 1000 members. As mentioned SACCOS can be instable or politically influenced and need to be carefully selected (see section 4.3.1). Camco demands that participating SACCOS fulfil a number of criteria[34] that can indicate the ability of the SACCOS to sustain a revolving fund (Camco, 3 May 2012). The revolving fund with a value of 1000 USD needs to become self-sustained, by loaners that pay instalments so that other members are able to make use of the fund. In the Southern Highlands Camco now manages 40 SACCOS. Camco has been active in the Southern Highlands from 2010, but has recently become involved with a subsidiary of USAID that provided 4.7 million USD for an increase of Camco's activities (ibid.). Up till now Camco brokered 60 SHS but this figure should rice in the coming months to 700 to 800 SHS. The prices for the systems range from 200,000 TZS to 400,000 TZS (Camco, 3 May 2012).

A customer cluster is especially interesting for large companies to create economies of scale. Basically this approach is an extended version of the dealership model that makes use of financial institutions as described in section 4.3.1. As a form of promotion for clusters of AEEs it might be too much focussed on a single company and product. An appropriate energy cluster would need a comprehensive approach that targets the local enterprise development.

[34] Five criteria are used by Camco: the ability to collect instalments, a growing member base, considerable existing capital, the stability of the SACCOS, and the potential of customer base regarding solar home systems (Camco, 3 May 2012).

6.2 AEE cluster strategies

Below three types of interventions and examples of the corresponding inceptive clusters are presented based on the research. It should be noted that there is an overlap in the types of clusters.

6.2.1 Cluster promotion via one stop shops

In section 6.1.1 the (enterprise) cluster was presented via the integrated rural energy utility (IREU), which serves a rural area via a number of shops that provide energy services via a selection of technologies. In this section these shops are referred to as "one stop shops", because they offer integrated energy services. Firstly, one stop shops sell energy technologies through the affiliated entrepreneurs that form the cluster. Secondly, providing energy services implies more than just the introduction of technology (see introduction), and it goes beyond the direct commercial function of enterprises. The shops have a communal functions by raising awareness and becoming a focal point for energy related issues. Thirdly, these shops, as is true for clusters in general, are an ideal location for BDS provision. Hence, the three stakeholder groups are involved in the one stop shop and many of their cluster functions can be concentrated at the shop. In this section one case of an inceptive cluster is presented that can be categorized as a one stop shop. In textbox 9 a Tanzanian case is provided of an energy shop that couldn't be included in the research, but might also prove an interesting example of decentralized energy provision.

6.2.1.1 Oikos' CERCs

> "*we had a framework that relied on community initiatives. We let them free to decide what to do with the centre. In a way we now hide and watch*" (Oikos, 19 March 2012).

The one stop shops, "Community Energy Resource Centres" (CERCs) were implemented by Instituto Oikos (Oikos) via an European Union funded project called BEST RAY (Bringing Energy Services to Tanzania Rural Area). The project lasted from April 2008 to June 2011 and among other activities established two CERCs in the villages of Oldonyo Sambu and Ngarenanyuki (Arusha region). At the start of the project the energy needs were mapped out and energy committees were set up that could determine how the community could benefit from the centres. Also these committees run the cooperatives that have the affiliated entrepreneurs as members. In this way the CERCs should become community driven. The centres provide solar PV and related products, Jatropha soaps made by women groups, ICS, and biogas masons use the centre as an office that assists in arranging promotion, sales and administration. Last year at the end of the project the committees took over the management of the centres. This is similar to the South African IREU example where the shops are owned and operated by community cooperatives (Banks et al., 2008). Currently Oikos is still present in the area, but not directly involved with the centres: "*we had a framework that relied on community initiatives. We let them free to decide what to do with the centre. In a way we now hide and watch*" (Oikos, 19 March 2012). Already when Oikos was still around, the focus on community driven CERCs let to an extension of its serves. ICT services were provided, mobile phones could be charged, a restaurant was started and more recently a loan group was established (CERC, 22 March 2012).

The committees that run the centres were recruited from the village government. Unfortunately committee members were not necessarily selected based on their capabilities. The statutes of the committee demanded one female member, which resulted in daughters or wives of members being appointed. Also the jobs were used as excuse to get rid of incapable members of the village government (Oikos, 19 March 2012). Also at the Ngarenanyuki centre solar PV panels were stolen. Presumably people from inside of the centre were involved. A judicial case on the issue is still pending the court's decision. Similar problems arose at the shops of the IREU in South Africa. One initial shop had to be closed down in 2004 due to allegations of corruption by local managers (Banks et al., 2008). Overall the functioning of this Ngarenanyuki centre was poor and disintegrated (Oikos, 19 March 2012). Solar PV technicians and biogas masons started to operate without involvement of the centre. In the 12 months after Oikos left only 10 solar PV installations were sold, while the other centre managed to sell 78 installations. Oldonyo Sambu also had three break-ins but it managed to stay afloat. Besides, managerial issues, the difference between the two centres is apparent in location. The Oldonyo Sambu centre is located next to a large covered market place, and situated next to the important Arusha-Nairobi highway. Comparably transport to the Ngarenanyuki centre is troublesome and expensive: "*For example if we buy something from town* [Arusha]*... a motorbike transport to here is 15.000 TZS.*" (CERC, 26 March 2012).

> "*The centre needs to grow up. The centre is my brand.*" (CERC, 22 March 2012).

Two CERCs were visited during the fieldwork. The way the centres function is via the affiliated enterprises and artisans. Ideally customers will buy an energy technology or contract an artisan via the centre. The centre will keep a small commission to run the centre and provide promotional and administrative functions for the enterprises. In practise customers sometimes bypassed the shop to avoid paying the centre's top-up (Oikos, 19 March 2012). The problem is similar to a collective action problem (Ostrom, 2003). Namely, a one stop shop raises awareness and gives additional information, benefitting customers and entrepreneurs. But if payment for the services is avoided the shop is likely to disappear, making everyone worse off. Increasing the stake of customers and entrepreneurs in the centre can increase the share of transactions via one stop shops (ibid.). One solar technician illustrated such involvement with the CERC: "*The centre needs to grow up. The centre is my brand.*" (CERC, 22 March 2012). Also customers are "tied" to the centre by the (in kind) loan that the centre provides. Customers can pay their energy product in instalments with a 30 percent down payment. One such loan is present in Oldonyo Sambu that had stopped due to lacking instalments, but recently restarted (ibid.). In the case of the affiliated biogas mason at the CERC in Oldonyo Sambu, 7.5 percent (30,000 TZS) of his total pay is kept by the centre. However, after Oikos left, the extra subsidy the organization provided disappeared and at the time of the interview the mason had not build any new installations since the beginning of the year. A similar situation is present at the other CERC. The biogas masons no longer earn a living with the installations but have reverted to solely the construction of houses. Moreover, last year the masons from the two centres tried to work together and register as a company even though they're far apart. In general the masons or solar PV technicians don't seem to compete with one another (CERC, 22 March 2012; 26 March 2012; Schoot Uiterkamp 2011). The case of solar technicians is somewhat different since the installations are directly sold through the centre. For the installation of a solar home system of 500,000 TZS the technician will receive 30,000 TZS and 20,000 TZS is paid to the centre. The ties of the mason with the centre thus appear stronger. Moreover, at Oldonyo Sambo the technician rented its own space to store equipment and customers came to the centre with electrical appliances such as radios and phones to get them repaired (ibid.). No ICS technicians were available for interviews.

It should be noted that this type of energy centre require much financial investment to set up and much involvement from CSOs to ensure continuity. Overall the outreach compared to required investment is very limited. Hence, this type of shop relies on the investment and involvement of external parties and is suitable as a local energy provision strategy. The total project costs of BEST RAY (more encompassing than just the CERCs) amounts to 1.5 million EUR of which most money comes from co-financing from the EU (ACP-EU, 2011a). Moreover, Oikos is involved with conservational issues and is trying to find a balance between the ecological state of national parks and reserves and the livelihoods of inhabitants. Thus Oikos' involvement is focussed locally and at direct impact on the community. Also, as mentioned in section 5.1.2 Oikos is involved with the traditional Maasai pastoralist communities. Raising awareness and potentially bringing about behavioural change in energy use is challenging, especially in such a (semi) nomadic tribe. Overall, the approach of Oikos focuses on awareness and the introduction of new technologies, not necessarily market driven energy provision.

Box 9 EGG-energy, battery swap shops in Tanzania

Late in the research a one stop shop formula was identified, currently active in Dar es Salaam region and Iringa region. The formula is based on providing batteries to off-grid households. Households need to subscribe to the company, EGG-energy, and can in return rent batteries that provide electricity for about five nights of average household consumption. The subscription entails that the households is provided with applications such as lights and mobile phone chargers, and the installation that connects with the battery. Once the battery is depleted it can be exchanged for a charged one at a charging station or via a dealer network. The charging station can be connected to the grid or have its own off-grid power supply, like a solar PV installation. EGG-energy's formula is based on the notion that many people live relatively close to the electricity grid, but lack access to it (EGG-energy, 2012). Currently EGG-energy has two charging stations that are connected to the electricity grid. Also it is testing an off-grid solar PV charging station and starting with a franchise model where entrepreneurs can set up charging stations (National Geographic, 2012). Unfortunately no interviews could be conducted with EGG-energy. Installing the appliances and wiring for rural households seems to be quite costly for households. Overall the formula seems scalable and can be applied in combination with one stop shops and platforms (see 6.2.2).

6.2.2 Cluster promotion via energy platforms

Below four examples of inceptive clusters are presented that can be categorized as energy platforms. Energy platforms are small and decentralized utilities that provide energy to rural households or enterprises. In contrast to one stop shops that typically provide energy technologies and related services, platforms provide an energy carrier via for example generators or solar PV panels. But many of the functions of a one stop shop can potentially be fulfilled by a platform as well. However, the functions of a one stop shop, such as the Oikos and IREU model appear the result of a long process of integration with the community. The platforms below seem more market driven.

6.2.2.1 TaTEDO's MFPs and PUCs

Basically the energy platforms are generators, with a number of variations on this theme. The diesel generator is the best known form and widely used in Tanzania in non-electrified areas and as back-up systems in electrified areas (fieldwork, 2012). Moreover, many informal power sellers use a diesel generator to supply electricity to a small grid, typically in (non electrified) towns. Households pay the owner of the generator per electrical appliance in their home (Banks et al, 2008; SNV, 2 April 2012). These types of generators can't be considered an appropriate technology because of the centralized nature of diesel and its environmental damage (see chapter 1). TaTEDO is involved with the dissemination of two types of energy platforms: multifunctional platforms (MFPs) and productive use containers (PUCs). The MFP consists of a generator that works on Jatropha oil, a blend with diesel, or diesel completely. The generator can supply electricity via an alternator, and potentially deliver electricity to nearby households via a mini-grid. Also the generator can be used to directly power appliances without converting energy to electricity and associated efficiency losses. In this way the MFP is used for milling, dehusking, and seed pressing (Farioli and Ippolito, 2012). The envisioned synergy of a MFP is that seed oils, in this case Jatropha, can be used to run the generator and press oil for future generation. In this way energy generation is self-sustained using a local product. Secondly, productive use containers (PUCs) are a bit more straightforward. The containers can accommodate any small or medium enterprise (SME) that require electricity to operate. The container has a solar PV installation on its roof that generates and supplies electricity to the SMEs. The container makes it easy to install in rural areas and the PUC is properly equipped for installing the solar PV systems. This prevents badly mounted panels or bad quality wiring if solar PV is installed on existing houses (TaTEDO, 5 March 2012). Also the PUC and MFP can be relocated if arrangements are not met.

TaTEDO has installed 3 MFPs in the field, but has been working on a much larger project since 2008. 75 MFPs and 75 PUCs should have been procured and installed in 11 districts in 6 regions in Tanzania by 2011 (ACP-EU Energy Facility, 2011b; TaTEDO, 5 March 2012). Reportedly the delays have to do with the procurement process, wherein one of the three essential suppliers hasn't delivered. As mentioned in section 4.1 this has considerable consequences for the planning of the project. The platforms (MFPs and CUPs) should be owned by an entrepreneur that can gradually pay back the container through the earnings from households and enterprises that use the platform. Besides the understandable impatience of the affiliated entrepreneur and village beneficiaries, the energy provision situation at the planned location can be considerably changed making the platforms possibly less appropriate. In 2010 an assessment was done to find suitable location for installing the platforms. The assessment was based on three criteria: the first criterion is the ability of the target village to get a financial return on the platform, this means that the entrepreneur who commits itself to the programme is able to pay back 80 percent of the value of the platform; the second criterion is that the energy needs of the village should be in proportion to the installation of a platform; the third criteria is that the geography should be suitable for the transport, installation and functioning of the units (TaTEDO, 5 March 2012). Especially in the case of MFPs that can function on Jatropha this is of essence, otherwise the platform will likely become dependent on diesel and lose its appropriateness (TaTEDO, 5 March 2012). The project is being executed in collaboration with the Dutch development organization Hivos at a total cost of over 3 million EUR largely funded through co-financing from the EU (ACP-EU Energy Facility, 2011b).

> *"You have to think twice with the MFP before you decide where to install it... you need diesel as well. In essence this a better fuel than Jatropha oil. When starting up and before shutting down it is best to use diesel. Otherwise the generator can get blocked and break down*" (TaTEDO, 5 March 2012).

> "*If one installs a piece of equipment* [MFP] *like this in a village, it is an utopia to assume that everyone is going to hold hands and cooperate to justly provide electricity.*" (SNV, 2 April 2012).

Reportedly the experiences with the already installed MFPs are mixed. After initial success in Mali three MFP pilots are held by TaTEDO since 2006 in Leguruki, Engaruka and Ngarinairobi, three villages in three separate districts of Arusha region (Farioli and Ippolito, 2012). The functioning of the Leguruki MFP that is designed to serve over 100 households and 22 SMEs was studied and assessed in a DFID study (Broadhurst, 2011). The MFP was indeed found to strengthen energy provision and income generation. Main weaknesses were found in the management and proper functioning of the MFP. As mentioned for sustainable functioning the platform requires Jatropha. It was found that many farmers did not deliver to the village but for outgrower schemes. Due to shortages of Jatropha the MFP now often runs on diesel (ibid.). TaTEDO recognizes this issue and even shows the dependency of the technology on diesel: *"You have to think twice with the MFP before you decide where to install it... you need diesel as well. In essence this a better fuel than Jatropha oil. When starting up and before shutting down it is best to use diesel. Otherwise the generator can get blocked and break down*" (TaTEDO, 5 March 2012). Furthermore, customers were dissatisfied with the costs and reliability of the MFP. Also more attention should have been given to land right and sustainable land use issues (Broadhurst, 2011). In line with this report, during the fieldwork the main pitfall in the functioning of MFPs were found to derive from its management. A village energy team and a private operator should be responsible for the management and setting the prices (Banks et al., 2008), but it is typically the private operator that decides on price: "*the problem with this model is that it can be controlled to easily by one person.*" (Diligent, 20 March 2012). A single MFP owner or even small group has a lot of power. There is typically no competition in electricity supply in the benefitting villages thus exploitation can become a real danger: "*If one installs a piece of equipment* [MFP] *like this in a village, it is an utopia to assume that everyone is going to hold hands and cooperate to justly provide electricity.*" (SNV, 2 April 2012). The management of a platform is briefly discussed using the example of an electricity cooperative in box 10. Finally, little is known of the functioning of PUCs, because they have not been field tested. Similar solar PV cases are discussed below (see section 6.2.2.2).

It is clear that not a large number of AEEs are required to run the MFPs and PUCs. However, it can function as an inceptive cluster because a number of energy enterprises can spring from this activity. To install and maintain the technology people are required. And just like the one stop shops the platforms should function as a focal point for energy in rural communities (TaTEDO, 5 March 2012). The combination of Jatropha and energy provision through clusters is further explored in section 6.2.3 in the Diligent case.

Box 10 An electricity cooperative in Tabora region, Tanzania

The management of a platform can be managed via an electricity cooperative. In Urambo in Tabora region (see figure 2.1) an electricity cooperative is present since 1993 that operates and maintains three diesel generators and supplied to 241 consumers in 2002, from 67 in 1994. Diesel generators are not appropriate technologies, but in this case a electricity cooperative successfully managed the platform, which can be a challenge (see the TaTEDO example). The literature points to the importance of technical support, assistance in recruiting staff and managing the cooperative (Banks et al., 2008; Ilskog et al., 2005). Moreover, the use of electricity meters is of great importance to get pricing and supply right. As mentioned some informal electricity providers that own a diesel generator charge a household per appliance. Actual use can fluctuate much, overcharge the generator and cause power cuts (ibid.).

6.2.2.2 Solar platforms Nice International and e.quinox

Two examples of solar PV platforms were identified. The first inceptive cluster consists of the Nice International solar powered ICT centres, in Tanzania implemented by ViAfrica. The second example is the e.quinox solar kiosk installed for a small Canadian NGO called project Tujifunze.

Nice International started in Gambia with a franchise concept consisting of centres that are powered by a large solar PV installation. The centres provide value added services, mainly ICT and cinema functions[35]. ViAfrica is the local implementing partner in Kilimanjaro region. The organization has experience with working with ICT by selling used computers from the Netherlands to schools (ViAfrica, 28 March 2012). During the summer of 2012 four solar powered centres will be build, which function as showcases for entrepreneurs that want to start a Nice International franchise. In first instance, the centres will be located near urban centres and in electrified areas[36]. According to ViAfrica this is the “low hanging fruit” were the business case can become most profitable (ibid.). After penetrating in these easily serviced areas ViAfrica and Nice intend to expand. The centre will be

[35] A similar organization established by the Dutch utility Nuon, FRES (Foundation Rural Energy Services), is involved in African countries (not in Tanzania). It provides SHS and solar PV mini-grids via 5 franchise companies. (see http://www.fres.nl) (FRES, 8 December 2011)

[36] Solar PV installations are thought (ViAfrica, 28 March 2012) to be competitive with grid connection because of the many blackouts and soaring electricity prices (see chapter 2). No further evidence was found for this claim during the research.

able to power 20 computers (maximal 35), a television screen, refrigerator and a printer. In contrast to TaTEDO's PUC the Nice centres are real estate buildings. Also it should be noted that the relation between the initiator and manager is different. In the case of Nice a franchise contract is signed and the building and land remains property of Nice and ViAfrica, whereas the owner of the PUC has more freedom in deciding what to do with the small workshops in the container. Similarly to TaTEDO's PUC these centres can have a cluster function because it can extent its services to accommodating AEEs and providing households with energy technologies.

e.quinox has a number of projects in Rwanda established by engineering students from Imperial College in London. Also there is one solar kiosk installed by e.quinox for an NGO, project Tujifunze, involved with operating a local primary school near Mwanza. The solar kiosk is basically two stacked containers with solar PV installations on top. The solar kiosk generates power for the nearby school and related accommodations. Furthermore, and very similar to a one stop shop, the kiosk provides charging services for phones and lamps that are sold at the kiosk (project Tujifunze, 14 April 2012). Recently the project ran in trouble due to a conflict about the land that is used by the school and solar kiosk. The school and kiosk had to be shut down by court order until the case is resolved. Besides lack of sales, the lamps can no longer be charged by the kiosk, while alternative shops will charge more than two times the price of the kiosk (ibid.). Similar projects are present in Tanzania that try to make extended use of solar PV installations at institutions (mostly schools) by adding commercial services, such as charging mobile phones (ARTI, 13 March 2012).

These solar kiosks provide some extra income to earn back part of the solar PV installation. As a focal point for energy provision they can also be the start of a cluster of AEEs. Especially as a modest first step to sustainable energy provision in inaccessible areas this seems more viable than the high investment of one stop shops. However, small and isolated project are vulnerable, as demonstrated by the project Tujifunze case above.

6.2.2.3 OMASI

The final example of an inceptive cluster is an energy platform that provides electricity via a large generator that runs on Jatropha oil and biogas. The platform is part of the Orkonerei Maasai Social Initiative (OMASI). It is an interesting inceptive cluster because of the way it came about and its importance as an enterprise development model.

OMASI is an umbrella organization of 14 companies that aim to generate economic activities for Maasai communities. OMASI's business activities include, among others, milk and agricultural production and processing. The products are meant to address markets outside the community. It also includes companies that arrange services for the entire umbrella. The Energy & Water Social Investment Company (EWC) was born out of a need for water and energy at the rural OMASI sites, which lack centralized services. Besides energy and water services, EWC provides commercialized trainings to the companies. The companies involved need to budget for the services that are provided by EWC. In first instance, OMASI worked with diesel generators to power the companies on the site, but changed the fuel to a blend of Jatropha oil and diesel[37] for sustainability reasons. Also OMASI uses the Jatropha cake (among other types of wastes), the waste product after refining the oil, for biogas production in a biogas installations (OMASI, 21 April 2012). A 500 m^3 plastic bag biogas installation has been installed in Terrat (Manyara region) at the beginning of this year by the aforementioned Energy Devices Company (see section 4,2,2,1) (EDC, 20 April 2012). The generator at Terrat runs on Jatropha oil and the biogas digested from the cake (see for more information Kerkhof, 2008). The generator supplies in excess of the electricity for the companies, making the surplus available via a mini-grid to 75 households that live near the factory (OMASI, 21 April 2012). The households pay 250 TZS per kWh., which is comparable to the unsubsidized fee of TANESCO (see section 2.2.2). Also it is very competitive compared to electric power supply from diesel generators (Ilskog et al., 2005).

A number of producing companies in OMASI are concentrated at the Terrat site. This site contains a farm with companies in milk processing, an abattoir and a charcoal company. The charcoal company produces charcoal in an efficient way by using improved kilns. Concentrating the companies has to do with the expenses of decentralized service provision in rural areas. Also the companies are able to make easy linkages between each other, because of their proximity (see chapter 1). EWC and EDC are the main energy companies involved with OMASI. In this sense OMASI can't be referred to as an AEE cluster. OMASI could develop into an AEE cluster if rural energy provision is stimulated through small energy enterprises, as is the case for the Terrat charcoal company. The OMASI umbrella is funded through loans and grants by the Dutch financier Stichting Het Groene Woudt (SHGW) that aims to promote social enterprises in rural areas. The organizations in and supporting OMASI seem to form a self-supporting network, but somewhat isolated from other organizations or companies in the sector. Even though it can take care of business on its own, OMASI and sector development can benefit from its integration in the energy sector. Furthermore, this is the second organization that is involved with the Maasai community. The nomadic pastoralist way of live is vulnerable to depletion of arable land by overgrazing and land conflicts and alternative income generating activities are thus important for the Maasai (Oikos, 19 March 2012; OMASI, 21 April 2012). The visible lifestyle and problems can explain the attention of NGOs.

[37] 40 percent is Jatropha oil and 60 percent is diesel

6.2.3 Cluster promotion in existing value chains

Similar to distribution of AETs (see section 4.3.1), cluster formation can be promoted by making use of existing value chains. Setting up AEE clusters is indeed a way to set up distribution as well. Below three cases of cluster promotion through existing value chains are presented, which were identified during the research.

6.2.3.1 Diligent and Partners for Development

The Dutch company Diligent processes Jatropha via an outgrower scheme that covers a large share of the northern Tanzania. In such schemes smallholder keep ownership of the land, and in the case of Diligent a small section of the land, namely the hedges, is used for growing Jatropa. In this way the biofuel crop doesn't limit growth of other crops. Diligent has a network of 100.000 smallholders and owns 200 collection centres that collect up to 31 tons (Mg) and transport the Jatropha nuts to Arusha were the processing factory is located. The company that was started in 2004 seems to be expanding after a period of stagnation. It addresses more smallholders and increases its production by a tenfold from four years before, aiming for 1000 to 1200 tons a year (Diligent, 20 March 2012). The waste product after pressing the nut is a cake that, as mentioned, can be used for biogas production and as a solid cooking fuel by pressing the cake in briquettes or pellets (see section 4.2.3). Diligent prefers to use the oil and cake locally. Transport to foreign countries for blending with fossil fuels[38] would increase the carbon footprint and raises questions about sustainability (ibid.). The challenging part of using the pressed Jatropha cake (mainly pellets) locally is the transport to users. As mentioned, Diligent in cooperation with Partners for Development (PfD) sells the pellets in combination with a matching stove. The smallholders receive a discount on the Jatropha pellets when they bring Jatropha nuts to the collection centre (PfD, 23 March 2012). Diligent wants to arrange the transport of the pellets by combining collection of the nuts from the 200 collection centres with the delivery of this Jatropha fuel. Currently this is logistically still a bit hard, but according to Diligent, once volumes increase it will be easier. The market should be fully developed by 2014 (Diligent, 20 March 2012). Also the possibility of a franchise formula was suggested, wherein the collection centre would be used as the location for an entrepreneur that can sell a range of energy products, similar to the one stop shop concept (PfD, 23 March 2012).

The sizeable network of collection centres makes this case interesting for cluster promotion. Moreover, the involvement of PfD, an American NGO active with a number of AETs, makes it one of the most potential forms of inceptive clusters identified during the research. PfD is currently involved

[38] The Dutch government has set itself the goal that fossil fuels should contain at least 4.5 percent biofuel h.a. and 5.5 percent in 2014 leading up to the European Union goal of 10 percent renewable energy in transport by 2020. Discussion has arisen about the sustainability of these goals, especially in regard to source of the biofuel (Rijksoverheid, 2011).

with delivering solar PV, the Jatropha pellets and pellet stoves to 42.000 smallholders via the collection centres in Diligent's network. PfD provides small solar installations (up to 15 Wp.) and seeks to expand the energy technologies it can offer through the distribution network. Furthermore, this organization developed the pellet stove which can be classified as an improved cook stove (Rajabu, 2011). It set up a company in Arusha that produces the ICS. The ICS is produced for 45,000 TZS, but sold for 30,000 TZS. Once production increases the cost price can drop and in combination with carbon credits[39] the stove is thought to become profitable at the same price. The stove is limited to pellets, though the raw material of the solid fuel can be extended or mixed with other waste materials, such as sawdust and shells of Jatropha nuts. The difficulty remains that the stoves are interdependent with the pellets, i.e. it can exclusively be fuelled by pellets. Tanzanian households typically don't rely on one resource exclusively, which decreases the usability of the stove (GACC, 2012) Moreover, the pellets producer should thus always be able to meet demand, otherwise the reputation of the technology and the household's investment is at stake. Similarly, to some extent the interdependence of resource management (in this case Jatropha pellets) and energy provision is true for other ICS projects as well. To make ICS appropriate the technology should be combined with forest management that prevents depletion (see section 2.1.5; PfD, 23 March 2012). In the 6 months leading up to March 2012 (time of the interview) 60 to 70 tons Jatropha pellets were sold. The production of the pellets in Arusha requires expensive machinery that runs on three-phase electric power, the production is thus limited to electrified areas. The current two machines can produce four tons a day, whereas the more expensive newly acquired machines can produce five times more (PfD, 23 and 27 March 2012).

Combining energy provision with Jatropha value chain makes it dependent on the performance of this particular sector. The Jatropha sector has seen large shifts in its popularity and companies can possibly outcompete each other in a price war for the Jatropha, for instance with the aforementioned organization OMASI that is also active in the sector (Diligent, 20 March). Moreover, TaTEDO's MFP example shows that farmers are hard to tie to one processer (Broadhurst, 2011). Also PfD is phasing out per June 2012. This can hinder the uptake of the ICS and formation of the network. However, making use of an existing network of collection centres that ties thousands of potential rural customers is a promising promotion strategy for setting up a AEE cluster.

6.2.3.2 The Tanga Basket

Tanga Fresh is the largest dairy producer in Tanzania and key stakeholder in a regional network of dairy farmers. Last year's research identified the Tanga Basket that consists of: Tanga Fresh, the milk

[39] Carbon credits are based on the Clean Development Mechanism (CDM) as formulated in the Kyoto protocol. Western companies can offset carbon emissions by funding companies and projects in developing countries that mitigate carbon emissions (UNEP, 2012).

processer and distributor; Farm Friends, a micro-finance institution; Holland Dairy Farm, a breeding company for cross-breed cattle; and the dairy farmers organized in the Tanga Dairy Cooperative Union (TDCU)[40]. These four stakeholder work in a synergy. Tanga Fresh works with 5000 dairy farmers organized in TDCU, who bring their milk to collection centres two times a day. The farmers receive a guaranteed price for all their milk as long as it is up to standards, which is tested at the centre. To increase production and income farmers can apply for a loan to buy a cross-breed cow[41]. The cow that is supplied by Holland Dairy Farm is directly paid for by Farm Friends. The loan that the farmer received (in kind) is subsequently paid back via the milk sales. TDCU collects these instalments and pays Farm Friends. In this way all involved parties benefit of the increased business activities. In 2010 farmers in the village of Pingoni expressed wishes not to increase the number of cross-breed cows, but to have better energy services. Consequently, after exploring the need for alternative energy Tanga Fresh, TDCU and Farm Friends decided to establish a biogas loan (fieldwork 2012; Schoot Uiterkamp, 2011). 30 CAMARTEC installations were build. In December 2011 Tanga Fresh contracted Shamba Technologies to address the market of 5000 dairy farmers. Currently without implementation, because the Simgas model could not yet be delivered (see section 4.2.2.1) (Shamba Technologies, 26 April 2012). Furthermore, Tanga Fresh is considering to equip the collection centres with solar thermal installations for cleaning instruments with hot water (Tanga Fresh, 25 April 2012).

Tanga Fresh has an elaborate infrastructure. Milk requires multiple tests and requires cooling before a factory can even start processing. Tanga Fresh has a network of 35 collection centres some 300 km from the factory near Tanga town. Recently the network was extended to Morogoro region, which is 400 km away (Tanga Fresh, 25 April 2012). TDCU is increasingly becoming more independent from Tanga Fresh. Before many collection centres were branches of Tanga Fresh. Many centres have recently organized themselves as cooperative within TDCU. In total 20 out of 35 collection centres are cooperatives under TDCU that own the centre, though maintenance is still performed by Tanga Fresh. Partly these cooperatives are also meant to link dairy farmers to Tanga Fresh, instead of selling to informal buyers, that over unprocessed milk (Primary Cooperative Pongwe, 25 April 2012) .

> "*Farm Friends was visited by representatives from a solar PV company that wanted to sell via Farm Friends. However, I sent them to the members themselves. The demand has to come from them.*" (Farm Friends, 25 April 2012).

Preferably the loan of Farmer Friends should relate to milk production. Loans have thus been extended to vaccination, pasture development and improved cattle sheds. Also biogas installations

[40] TDCU is also a 20 percent shareholder of Tanga Fresh and thus partly decides on Tanga Fresh its strategy.
[41] The improved cow is a cross breed of a Frysian cow and an indigenous African cow. The cross breed produces more milk than the indigenous cow and is better able to withstand the warm climate in Tanga than a full blood Frysian cow (Farm Friends, 25 April 2011).

help to maximise the value and appreciation for the cow. Moreover, the loans should be demand driven: "*Farm Friends was visited by representatives from a solar PV company that wanted to sell via Farm Friends. However, I sent them to the members themselves. The demand has to come from them.*" (Farm Friends, 25 April 2012). For loans that don't relate to milk production, for example for covering school fees, Farm Friends advices to go to SACCOS. Despite this clear prioritization, this type of established networks can be the basis for an AEE cluster. In this instance biogas is the most logical point of entry for having AEEs linked to a collection centre. On average centres have 140 households that all have zero-grazing cows and a source of income to pay off the investment. A biogas technician linked to a cooperative could potentially earn an income based on this market potential. Also other appropriate energy technologies can be introduced in collaboration with the cooperatives at the collection centres.

Similar to the Jatropha case, such clusters can be vulnerable to changes in the dairy sector. The close cooperation of the Tanga Basket seems beneficial for development of enterprises, since stakeholder know each other, and mutual arrangements can be made, for instance on specific loans. But as also mentioned in section 4.3.1 it should be clear what the Tanga Basket and the dairy farmers in particular gain from the entry of AEEs. Finally, the close cooperation within the Tanga Basket can also be explained by individual involvement. Namely, the director of Tanga Fresh is also the director of Holland Dairy Farm. As long as the prices of the loan and the cross-breed cows are open to competition, there is no conflict of interest[42].

6.3 Analysis of the types of cluster promotion

6.3.1 Strengths and weaknesses

Below five types of cluster promotion are summarized. Even though the characteristics of the inceptive clusters were assessed above some strengths and weaknesses deserve an additional explanation.

As is the case for the SNV consortium example an **organizational cluster** can provide information about the state of the sector through research and involvement of stakeholders. This can create "market intelligent" interventions and for example prevent duplication. Also stakeholder can become more vocal and advocate their wishes in a consortium. The purpose of such a cluster is directed at the synergy between organizations, not directly at formation of AEEs. The **customer cluster** can most easily be set up and managed by a large energy company that can meet the collective demand of the customers. Therefore, it seems unlikely that AEEs are promoted that are not affiliated with this energy company. Lack of internal promotion of AEEs requires an additional strategy to create AEE

[42] One other breeding farm has supplied to Farmer Friends, but had trouble to meet the ordered number of cows (Farm Friend, 25 April 2012).

clusters. This is not the case in **one stop shops** where AEEs can have services such as promotion and administration arranged. The examples of the one stop shops show difficulties such as theft and corruption. The local management of the shops can thus be a weakness. This is true as well for **energy platforms**, and the risk of a platform is that it becomes owned by an individual or group that abuses their position. In this sense the "monopoly of an energy provision" can lead to exploitation. Furthermore, to make connection to the platform it requires households and businesses to be relatively close and able to pay enough to at least keep the platform running. But platforms can provide trustworthy and large amounts of energy suiting household preferences (see section 4.1). Also SMEs can be promoted by introducing related income generating activities in the form of charging services for solar kiosks, or ICT services for larger-scale cases, such as Nice International. Finally, **existing value chains** can sometimes be linked to household energy provision such as biogas for milk farmers and a reciprocity system where Jatropha farmers buy back Jatopha pellets for cooking fuel. Cluster strategies are designed to make rural energy provision independent. A weakness of linking energy provision to another sector is that this independence it lost.

Table 6.1 Strengths and weaknesses of types of cluster promotion

Cluster Promotion	Main Strengths	Main Weaknesses
Organizational Cluster	-Coordinating function -Promoting market intelligent interventions -Strengthening advocacy of AEEs	-Formation of AEEs is dependent on partners -Risk of exclusion or over privileged partners -Risk of dissimilar interests of small and large partners
Customer Cluster	-Creating economies of scale	-Dominated by large energy companies -Lack of internal promotion of AEEs
AEE Cluster: **One stop shop**	-Focal point for all energy related issues on the local level -Easy promotion of AEEs through business services	-High investment and long-term involvement of an NGO -Local management issues
AEE Cluster: **Energy platform**	-Highly valued energy provision (e.g. similar to grid connection) -Productive uses such as milling and pressing -Combination with other income activities (e.g. Jatropha) -Solar kiosks can add a business component to solar PV projects	-Local management issues -Monopoly of an energy provision -mostly limited to locations that have a sufficient concentration of households and businesses -Lack internal promotion of AEEs
AEE Cluster: **Existing value chains**	-Network is already in place -Smart linkages with existing sector, such as cattle farming and Jatropha value chain.	-Need to prove added value for the companies involved in the existing value chain -Interdependence of the two sectors

6.3.2 Types of cluster promotion in the institutional setting

In this section the institutional setting and the inceptive clusters come together. Table 6.2 shows how the factors identified in table 5.1 enable or hinder the five types of cluster promotion. Also the agglomeration advantage to which the type of cluster relates is shown in the right hand column. Below a brief account is provided on the choices shown in this table.

The **organizational cluster** is a form of promotion of sector development at the regional level, for example Lake Zone in the case of the SNV consortium. The organizational cluster is initiated most likely by a civil society organization. It is thus depends on the ability of CSOs in Tanzania to coordinate AET stakeholder that enable this type of cluster promotion. The involvement of LGAs and ideally other governmental institutions is required for a properly functioning cluster. Because of the lack of representation of energy at this level this can be considered a hurdle. Organizational clusters bring together otherwise separated actors, this cluster is thus mainly directed at accomplish active collective efficiency. **Customer clusters** can arise when demand is sufficient to create economies of scale. This is the case for solar PV, but may become interesting for other AETs in the future as well. Customer clusters do require existing structures such as SACCOS and VICOBAs and in the case of the Camco example a loan product. A hurdle is thus the lack of experience with AETs at financial institutions. These clusters make AEEs (in this case solar PV) more competitive because prices can be dropped. The reason **one stop shops** can be initiated is the involvement of CSOs and donors. For the long term this an institutional hurdle as well, because dependence on non-commercialized services hinders survival of such initiatives. Overall, the associated advantage with one stop shops is the ability to create an enabling environment for new AEEs. The **energy platform**, such as TaTEDO's MFP is based on a large and complex installation and requires an infrastructure to serve customers. Initiation of these platforms is thus stimulated by an institutional setting with the available technological knowledge. The example of TaTEDO shows, however, the difficulty of scaling up the technology. An institutional setting focussed on sharing and commercializing the technology could have prevented this. As also stated in table 6.1 platforms can be linked with other income activities, such as Jatropha production, ICT services or even small-scale activities such as charging services in the case of solar kiosks. The advantage relating to this type of cluster promotion is thus that it is directed at endogenous economic growth. To develop AET clusters via **existing value chains** the private sector needs to assume an important role. The main institutional hurdle seems the trust to expand from one sector (Jatropha or dairy) to the energy sector. In the example of the Tanga Basket the trust is far developed because of continued interaction and dependence. Once established such a cluster would stimulate active collective efficiency through the smart linkages between the two sectors as mentioned in table 6.1.

Table 6.2 Cluster promotion in the institutional setting

Cluster Promotion	Main institutional conducive factor	Main institutional hurdle	Relating agglomeration advantage
Organizational Cluster	-Civil society organization or private sector can take leading role in coordination	- Representation of energy issues at the local level	Active collective efficiency: Input sharing/ supplier and buyer advantages (and labour pooling effects)
Customer Cluster	-High growth and market driven character of solar PV sector	-Lack of experience with AETs at financial institutions	Increased competitiveness
Enterprise Cluster: **One stop shop**	-Much involvement CSOs	-Domination of development aid	Enabling environment
Enterprise Cluster: **Energy platform**	-Technological knowledge in AETs available at parastatals and NGOs	-Dissemination (sharing and commercialization) of technical knowledge	Endogenous economic growth
Enterprise Cluster: **Existing value chains**	-Civil society organization or private sector can take leading role in coordination	-Trust in business beyond family ties	Active collective efficiency: Input sharing/ supplier and buyer advantages (and labour pooling effects)

6.4 Chapter conclusion

This chapter set out to learn from the inceptive clusters encountered during the research to explore the potential for cluster promotion in AEEs. Based on the inceptive clusters five types of cluster promotion were identified. The organizational cluster is well designed to form the initial enabling environment for a AEE cluster, but doesn't include direct AEE promotion. One stop shops are directed at enterprise development, but require much external involvement. Cluster promotion through existing value chains is suitable strategy to make use of existing infrastructure and create mutual benefits from integration with appropriate energy technologies. These and other results from the study are further analysed in the conclusion and lead up to an answer to the research question.

Conclusion and discussion

The UN Secretary-General Ban Ki-moon has called for governments, businesses and civil society organizations to achieve universal access to modern energy services by 2030 (AGECC, 2010; UN, 2012). Sustainable energy provision is of importance for Tanzanian households to prevent respiratory illnesses, decrease dependence on finite resources and increase study and business opportunities. This master thesis reported on ways identified in the field to achieve universal access in rural Tanzania. This concluding section contains the results of this study and an answer the research question. After recapitulating the objective and structure of this master thesis the subquestions and research questions are answered. In the discussion the value of the conceptual framework is analysed. The development picture returns to the introductory considerations and explores what the results mean in the development debate. Finally, the way forward is discussed and recommendations for further research are provided.

Study objectives and structure

Sustainable energy provision to households requires enterprises in appropriate energy technologies. This study set out to explore to what extent cluster strategies can lead to sustainable energy provision. Three steps were identified that assist in reaching the study objective and answering the research question. The first step was to explore the current energy provision in Tanzania based on the contextual information and the research results from the energy sector. Based on these results the appropriate energy technologies for the current Tanzanian context could be selected. The second step was to describe the institutional setting for appropriate energy enterprises (AEEs) and assess how cluster formation in the related technologies is stimulated or hindered. This resulted in a selection of conducive factors and hurdles for AEEs. The third step includes the inceptive clusters that could be identified. Similar to a SWOT analysis the strengths and weaknesses of the cluster categories were assessed and finally the cluster categories were compared to the institutional setting for appropriate energy enterprises. Even though this analysis is based on inceptive clusters, it indicates to what extent cluster promotion can stimulate sustainable energy provision, and thus answer the research question.

Results

In this section the results of the study is presented. For every subquestion an answer is formulated.

Subquestion 1 (SQ1): Which appropriate energy technologies can meet the household energy demand in rural Tanzania?

Households in Tanzania in the deep rural and rural areas typically rely on firewood and charcoal for cooking fuel. It depends on the available forest area if households pay for fuelwood and in cases where fuelwood is not commercialized what distance has to be bridged every day to collect firewood. For lighting in rural areas the main energy resources are paraffin or kerosene, despite the resulting indoor air pollution. In peri-urban and urban areas, households generally rely on centralized energy resources. But the type of resource remains largely the same as in rural areas, i.e. fuelwood, except for lighting which is partly met by electricity grid connection.

Three appropriate energy technologies were identified for households in rural Tanzania that can provide sustainable energy: solar PV, biogas and improved cook stoves (ICS). Solar PV panels seems most appropriate for lighting, even for the rural poor thanks to pico solar systems, such as the small solar PV panels that can power a mobile phone and a small lamp. Improved cook stoves are an appropriate solution for almost any household, because the majority of Tanzanian households rely on fuelwood. Stoves can create budget savings and prevent depletion of forest areas, which is even more promoted in combination with agroforestry, which manage woodfuel resources. Improved stoves also decrease indoor air pollution and reduce the high risk of respiratory illnesses. Also waste management can lead to sustainable energy provision, for example by using pressed shells or husks in combination with matching improved stoves. Also biogas installations provide waste to energy solutions, but these kind of solutions often require users to change waste handling and cooking habits. Furthermore, biogas installations are an expensive energy technology and are therefore more appropriate for rural or (or even urban) areas with relatively high economic activity. There is much to be gained from the introduction of appropriate energy technologies, but realizing this potential depends on the habits of the users. For example, cooking fuels and stoves sometimes change depending on household budget and energy demand. The behavioural side of household energy demand should be taken into account to create sustainable energy provision.

Subquestion 2 (SQ2): To what extent is the Tanzanian institutional setting conducive to cluster formation of appropriate energy enterprises?

The institutional setting in Tanzania in the energy sector is mainly formed by public and private sector stakeholders and civil society organizations. The topic of rural energy provision is largely unrepresented by district governments, the portfolio holder REA or energy company TANESCO. Expanding the mandate of district governments to a new topic is difficult because district funding and power structures are based on the existing service provision, but it would make the institutional setting more conducive for appropriate energy enterprises. There is potential to increase knowledge about energy at the local level via parastatal organizations that are directed at technological development, such as CAMARTEC and COSTECH and civil society organizations such as sector association TAREA and NGO TaTEDO. This would require sharing of knowledge and a focus on commercialization. Also stronger involvement of REA with these organizations could stimulate a focus on rural energy instead of their current focus on rural electrification. Another role of the civil society organization is to take the lead in coordination of interventions in the appropriate energy sector. This can prevent duplication of projects or trainings and increase the efficiency of the stakeholders' involvement. Currently this is done by the NGO SNV on a regional level and in the ICS subsector. Also the involvement of TAREA stimulates the coordination of knowledge and tenders for enterprises in the sector. One of the hurdles for appropriate energy enterprises (AEEs) is the lack of trust in business beyond family ties. Trust is an important factor for clusters of AEEs to form, because it increases chances that linkages form between enterprises. Overall, it seems unlikely that clusters will form spontaneously in the energy sector by enterprises in a bottom-up way. The civil society is the most suitable candidate to kick-start cluster formation and stimulate trust between AEEs.

Subquestion 3 (SQ3): To what extent does cluster promotion in appropriate energy enterprises take place in rural Tanzania?

A distinction was made between cluster formation and cluster promotion. Promotion can be explained as interventions that can lead to cluster formation, the start of a cluster. In chapter 6 five types of cluster promotion were described and classified all the inceptive clusters that were found during the research. A distinction was made between a cluster of appropriate energy enterprises, an organizational and a customer cluster. The latter two, that bring together organizations and customers can promote the development of appropriate energy enterprise clusters. Firstly, the SNV consortium shows that an organizational cluster can have a strong coordinating function on the regional level, a first step to a local energy impact. Secondly, the consultancy firm CAMCO showed that their customer cluster is an interesting strategy available for large energy companies in the solar PV sector that try to create economies of scale. Thirdly, the one stop shop is an interesting model and comes close to a functioning appropriate energy enterprise cluster. These one stop shops can be decentralized and fulfil communal and commercial functions and promote enterprise development. However, the (NGO) Oikos example of a one stop shop showed that the initiation of the shop and assistance to run it and associated enterprises relies much on NGO involvement. Fourthly, energy platforms such as the multifunctional platform by TaTEDO (NGO) that delivers energy to households, are best suitable for village centres or institutions. The management of energy platforms is challenging, certainly if it depends on Jatropha growers for operating a generator in a sustainable way. Platforms can function as a focal point for energy provision, but it requires an additional strategy to actually promote clusters of appropriate energy enterprises. Fifthly and finally, smart linkages between energy provision and an existing value chains can be made. For instance, the biogas installations and the dairy sector both rely on cattle, hence mutual benefits are created if the two are linked, as was observed in Tanga region. To some extent the same can be said from Jatropha production and improved cook stoves as was found in Arusha region. When it is shown that appropriate energy enterprises (AEEs) add value to an existing value chain, key stakeholders can initiate AEE clusters.

Research question (RQ): To what extent can cluster promotion stimulate sustainable energy provision in rural Tanzania?

Currently the appropriate energy enterprise clusters exist in theory: no examples of full-grown AEE cluster were identified. The inceptive clusters that were researched did show a number of routes to an AEE cluster. As mentioned in the introduction, the priority in development of energy provision lies not in the creation of enterprises, but the ability to meet household energy demand. But appropriate energy enterprises and enterprise clusters are a means to create sustainable energy provision. Below the ways an AEE cluster is thought to stimulate sustainable energy provision are mentioned

Firstly, setting up a cluster, especially an organizational cluster is a first step to align the interests of rural energy stakeholder. The theory points to the importance of the multi-stakeholder network. Aligning the energy sector stakeholder before stimulating appropriate energy enterprises deserves priority in rural Tanzania. This is mainly the case because of the lack of attention to sustainable energy provision on the local level and risk of duplication. Direct promotion of AEE clusters, however, requires a different approach, because members of an organizational cluster are not necessarily involved with enterprise development.

Secondly, creating a cluster of appropriate energy enterprises creates a focal point for all energy related topics in a community. This was mainly shown by the Oikos example of the one stop shop, where customers could discuss all energy related issues.

Thirdly, a cluster of appropriate energy enterprises provides a location where business development services could be directed to. An example of such a locations are the workshops of the parastatal organization for (small) industrial development SIDO which accommodates and supports starting enterprises, however this example is not limited to the energy sector.

Last but certainly not least, the one stop shop seems best equipped to stimulate AEE development. The model is, however, very much “donor-driven” and questions can be raised to what extent civil society organizations can take the initiative to scale-up the model across rural Tanzania. Promotion

To end energy poverty and reach the universal energy access goal of 2030 opportunistic solutions for appropriate energy enterprise development are necessary. This study shows that cluster promotion through existing value chains is a promising solution.

through existing value chains seems most favourable, because in rural Tanzania where limited infrastructure is present, integration with existing business activities is easier than re-inventing the wheel for service delivery. But even though energy provision can temporarily depend on the infrastructure of an existing sector, or involvement of NGOs for that matter, it should become independent to be there for the long-term. Cluster strategies are devised to do just that. To end energy poverty and reach the universal energy access goal of 2030, opportunistic solutions for appropriate energy enterprise development are necessary. This study shows that cluster promotion through existing value chains is a promising solution.

Discussion

The conceptual model as presented in chapter 3, figure 3.1 was visualize the study and can now be used to show where the results from this study stand out from the model.

The conceptual model includes "current energy demand", "awareness of livelihoods improvements" and "chances for increased productivity" as part of the **energy needs context**. Firstly, not just energy needs are of importance in grasping energy demand. For example, the Total Energy Access model just describes the minimal energy needs, but also energy preferences should be considered to understand energy demand. Planning of energy provision and setting a goal in energy provision ensures that provision can eventually lead up to energy preferences (see section 4.1). Secondly, as part of the "awareness of livelihoods improvements", such as improvement if indoor air quality, the behavioural side of energy demand is at least as important as important as the introduction of an energy technology. Large savings can be made by small behavioural changes, especially in cooking inexpensive solutions such can significantly increase efficiency. Moreover, the benefits of appropriate energy technologies are completely dependent on its users (see section 4.2.3). The issue touches upon culturally determined practices, which don't change overnight. In the conceptual model the **institutional setting** was depicted to consist of six factors. Some factors didn't stand out in the research or were considered a given. Firstly, "social capital" was mentioned as an institutional and indeed one of the main hurdles that was found for enterprise development and cluster promotion is trust in business beyond family ties. Secondly, the factor "involvement of financial institutions" seems an important hurdle in the institutional setting. Mainly financial institutions such as SACCOS and VICOBAs lack experience with appropriate energy technologies, which hinders new appropriate energy enterprises to come about, looked in a so-called "catch 22" situation. Potentially the lack of involved financial institutions can be counteracted by donors that support enterprises through loans or guarantees at financial institutions, but this does distort the free market process. Thirdly, of the "national energy and conservation institutions" mentioned in the institutional setting, no organizations involved with conservational issues could be interviewed. Also, no respondent talked about the involvement of governmental conservation institutions in the energy sector, despite the linkage between energy provision and conservation of forestland in Tanzania. As mentioned, forest management is linked with energy provision in rural Tanzania, and should also be treated like that on the policy level.

The development picture II

In the introduction the institutionalism of Myrdal and North was presented. Much of this study focussed on the institutional setting for cluster promotion. The institutional setting contains inefficient and enabling institutions. If the "rules of the game", as institutions can simply be referred to (North, 1995), create a higher outcome for unproductive behaviour than economic growth and thus sustainable energy provision is unattainable. This is illustrated by the problems that seem to affect one of the types of cluster promotion identified during this research: the energy platform. The energy platform installed in a village is a valuable energy technology that can only positively impact the entire community as long as ownership and management are well taken care of. There is a real risk that instead of trying to extend energy access and services to households, managers use the platform to earn as much as possible from their existing customer base. If indeed in this way a monopoly is exploited the most productive outcome or even proper functioning of the energy platform is unattainable. This is perhaps also what Schumacher meant with: "*it is always easier to help those who can help themselves than to help the helpless*" (Schumacher, 1973: 159).

To prevent the inefficient outcome, enabling institutions need to be created, that is the productive outcome needs to be favoured by the "rules of the game". Repeated successful transactions and compliance to rules can build relations of trust that allow customers and enterprises to work together and increase collective efficiency. The trust that is created can lead to more transactions and thus propel the process. In many instances a kick-start is necessary to stimulate this perpetual process. A third party can set the conditions, for example enforce a contract, distribute profits or just simply stimulate interaction (North, 1989). If the third parties that create such enabling institutions are lacking than the mentioned perpetual process of trust can be hard to achieve and become caught in a "catch 22" situation, wherein both parties wait on the other to move first.

This unfavourable situation without trust can keep African countries in an unproductive deadlock. The difference in trust and repercussions when trust is violated was illustrated by one informant by the way business is dealt with in Asia and Africa (see section 5.2). It partly explains the difference in the performance between Asian and African countries in creating sustainable energy provision. In specific, appropriate energy enterprises are dependent on these enabling institutions. Cluster promotion can increase the likelihood that enterprises will break out of the "catch 22", for example by decreasing the distance between enterprises and hence the transactional costs (North, 1989).

Truly creating enabling institutions that stimulate trust between appropriate energy enterprises is not a matter of the short term. Direct interventions to meet the energy needs of households in Tanzania are probably more effective in the short term. But sustainability requires to prefer the smaller and long-term impact instead of vice versa.

Recommendations

This final section suggests the road ahead in research on cluster promotion and AEEs. The explorative character of this study already indicates that it is a building block for further research. Firstly, types of cluster promotion were reported, but further research is required before a cluster intervention can be designed. This master thesis could be used to select one type of cluster promotion based on the analysis in chapter 6, which showed the importance of looking at existing value chains. Subsequently, the type of cluster promotion needs to be worked out in detail and a feasibility study for the implemented area should indicate whether it is suitable. For developing the type of cluster promotion the examples of (inceptive) clusters mentioned in this master thesis can be used, such as the Integrated Rural Energy Utility (IREU) in South-Africa, which has been developed by the partnership organization REEEP. Secondly, in terms of further research, cluster initiatives in other sectors of the Tanzanian economy may be of interest to make generalizations. Especially lessons from the ICT sector in Tanzania might be valuable for the energy sector, because of the high growth and some incubator initiatives in this sector. Thirdly, the institutional setting of the energy sector in Tanzanian deserves more attention. In order to add to what is known, in depth studies of energy projects are necessary. For example the electricity cooperatives study mentioned in chapter 6 provides detailed information of potential energy solutions (Ilskog et al., 2005). Moreover, the highly competitive situation that arose in recent years in the solar PV sector is worth studying in depth. As mentioned in box 7 the rapid commercialization of the pico solar PV products did not always benefit households. Fourthly, development studies requires scholars to experience the research area. For instance the local transport, small shops (dukas) on the streets, and stark contrast of quite rural life and bustling urban centres helps to understand a culture and a research topic. At the same time many scholars have done research in Tanzania. Before planning research, knowing about the rich (grey) literature should prevent duplication and wasting time, not in the least that of respondents. Finally, to end with a concrete recommendation for cluster promotion. This master thesis focuses on rural energy provision and studies strategies to reduce energy poverty, to kick-start a cluster it might be advisable to initially focus on accessible markets and popular energy technologies. Some inceptive clusters were reported to start with the so-called "low hanging fruit", i.e. the customers in relatively wealthy and accessible areas. In this way the energy cluster can be popularized and the service area extended. However, as also mentioned in the previous section, there is a real risk that attention, investment and interventions remain limited to these cases and prosperous areas. The ultimate goal and challenge is to provide appropriate energy technologies to the entire rural population in Tanzania.

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Appendix A: overview interviews

#	Organization	Main Findings	Actions	Location
1	Fres, Foundation of Nuon	Solar PV franchise concept information	Compare situation Uganda and Tanzania	The Netherlands
2	Former Diligent energy systems, Jatropha production in Tanzania	TaTEDO involvement with MFPs	Follow up in Arusha with Diligent	The Netherlands
3	Phillips, consumer electronics multinational	Total energy access, as proposed by Practical Action	Use Practical Action methods	The Netherlands
4	Hivos, development organization	Procurement problems	Follow-up with TaTEDO	The Netherlands
5	SNV, development organization	Determine local needs	Follow-up with SNV in Tanzania	The Netherlands
6	Tanzania Tujifunze Project, charity, school	Problems with delivery of the panels	Determine if a fieldvisit will add to the research	The Netherlands
7	Dutch Ministry of Foreign Affairs	Jiko Bora cluster. Positive connotation of TaTEDO approach	Determine scalability of cluster concepts	The Netherlands
8	Nice International, lighting centres	Low-hanging fruit.	Contact in Moshi and compare Fres	The Netherlands
9	Dutch Ministry of Foreign Affairs	PREP programme and three level of provision	Use the mentioned three levels in discussion on modern energy	The Netherlands
10	TaTEDO	Stage of development of a cluster	Determine functioning of MFPs	Tanzania, DSM
11	TaTEDO	Low functioning of MFPs, energy teams, why a CPU and role of TaTEDO		Tanzania, DSM
12	TaTEDO	Paying for BDS and competition TaTEDO		Tanzania, DSM
13	TAREA	Local control of technology, TaTEDO critique, MW, policy and strategy	Confirm MW policy	Tanzania, DSM
14	UDSM, College of Engineering and Technology	Not demand driven, awareness and productive strenght	Focus on productive value of energy resources. Get dissertation.	Tanzania, DSM
15	REA	Masterplan, costs of operating in rural areas	Follow-up on masterplan	Tanzania, DSM
16	Ministry of	Masterplan, district level.	Go to Mwanza Solar	Tanzania, DSM

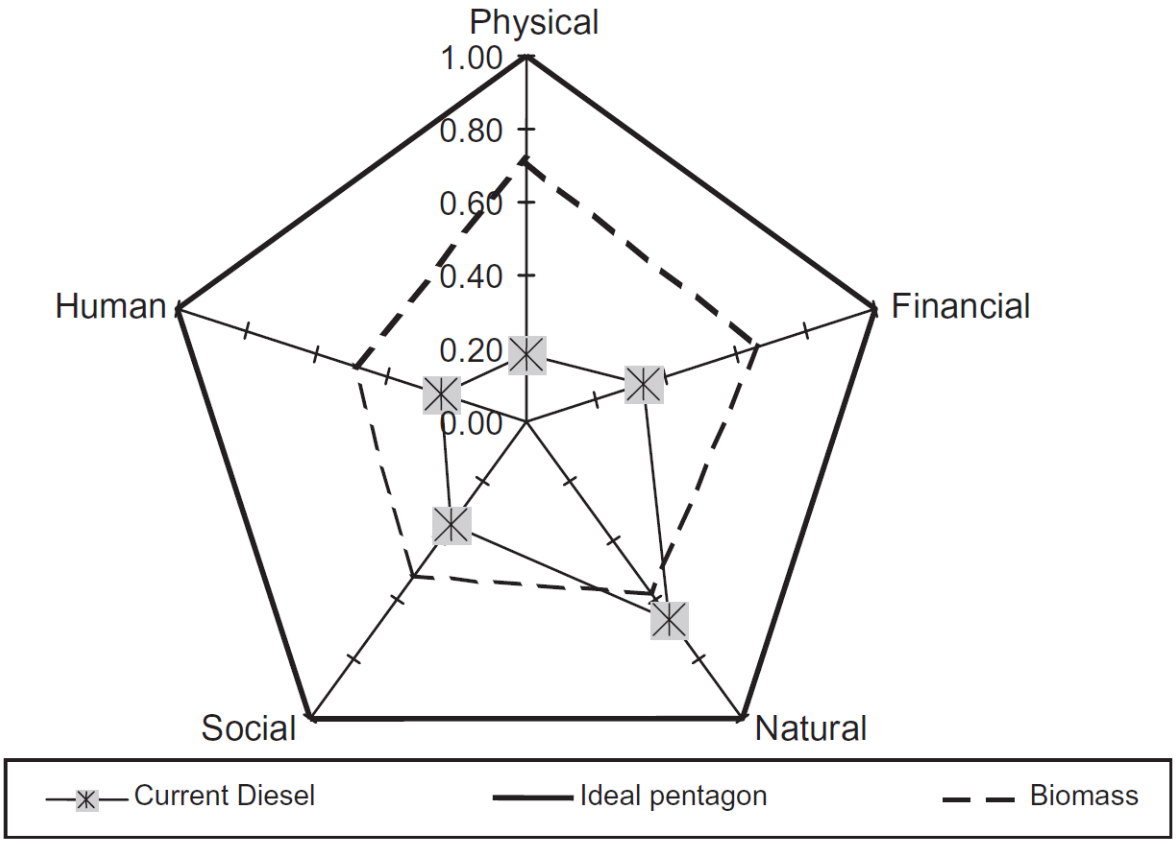
	Energy and Minerals		Photovoltaic and facilitation of the PV Market	
17	SolarAid	High fixed costs. Distribution is not the problem, awareness is. Variability of service		Tanzania, DSM
18	COSTECH	RE as productive goods	Compare with UDSM	Tanzania, DSM
19	TANESCO	The masterplan is a REA assignment, see mail	ToR, keep emailing for the actual plan.	Tanzania, DSM
20	ENSOL	SACCOS and marketing of ENSOL		Tanzania, DSM
21	ARTI	Margins in supply chain, D-light case. RE need for a quick or incremental change	Compare D-light story	Tanzania, DSM
22	SNV	Supply side versus demand side	Compare to UDSM	Tanzania, Bagamoyo
23	SNV	Liaison role, follow up in Mwanza	SNV visit in Mwanza	Tanzania, Arusha
24	Oikos East Africa	Community driven/private driven, Scalability, common goods	Fieldvisits to Oldonyo Sambu and Ngarenanyuki. Get report	Tanzania, Arusha
25	Diligent	Application of Jatropha cake, CDM	Visit PfD	Tanzania, Arusha
26	Linked to CERC in Oldonyo Sambu	Company formation with Ngarenanyuki	Follow-up in Ngarenanyuki	Tanzania, Oldonyo Sambu
27	Linked to CERC in Oldonyo Sambu	Meetings, microfinance, branding	Make a microfinance spreadsheet	Tanzania, Oldonyo Sambu
28	Partners for Development	Interrelation of production and use pellets/woodfuels (again is wood renewable?)	Visit the workshop, Get report	Tanzania, Arusha
29	Linked to CERC in Ngarenanyuki	No clear progress, no biogas masons	Follow-up with Oikos	Tanzania, Ngarenanyuki
30	Linked to CERC in Ngarenanyuki		Compare to previous year	Tanzania, Ngarenanyuki
31	Camartec	The three wheel truck story. No commercialization		Tanzania, Arusha
32	Partners for Development	Outsourcing to local artisans is difficult: electricity and productivity	See thesis UDSM	Tanzania, Arusha
33	Oikos East Africa	Second interview, responding to observations, Hydropower	Consider including hydropower	Tanzania, Arusha
34	ViAfrica	Middle class focus for this franchise		Tanzania, Moshi
35	SNV	Lack of finance, awareness, and training are all not true	Check with at TaTEDO	Tanzania, Mwanza

		barriers		
36	GVEP (2 interviews)	Business plan appreciation, competition is not an issue	Get report	Tanzania, Mwanza Tanzania, Mwanza
37	EMEDO and Rongead (2 interviews)	Multiple users for one digestor and communal function		Tanzania, Mwanza Tanzania, Mwanza
38	Acord International	Energy doesn't seem to be a central theme		Tanzania, Mwanza
39	Zara Solar	Flat price and creating economies of scale, monopolist like position	Follow-up with TAREA	Tanzania, Mwanza
40	Tujifunze Project	Corruption and development, the short-term perspective of the project		
41	L's Solutions	Monopolist position of few large solar PV suppliers. TAREA should stay in DSM.		Tanzania, Arusha
42	Energy Devices Company Limited	Import of high quality plastics is restricted by GoT. Isolated position of EDC		Tanzania, Arusha
43	Orkonerei Maasai Social Initiative (OMASI)	Mini-grid of 250 TSh. per KWh. Integrated solutions, extensive social services inc. energy supply	Follow-up figures and potential visit Terrat. Compare figures to TANESCO	Tanzania, Arusha
44	Tanga Fresh	Seasonality of the industry and demand. Losing faith in Simgas.	Fieldvisit. Check Africa Entrepreneurial Challenge Fund	Tanzania, Tanga
45	Farm Friends	Demand driven. Energy will always be of secondary importance in the portfolio.	Fieldvisit	Tanzania, Tanga
46	Primary Cooperative Pongwe, under Tanga Dairy Cooperative Union (TDCU)	Collective action problems in the cooperative		Tanzania, Pongwe
47	Shamba Technologies	Real quantities/scalability cannot be reached with the CAMARTEC model. Note hidden subsidies story	Got another copy and permission for publication of their BCE conclusion (hidden subsidies)	Tanzania, Tanga
48	TAREA	Consultancy services, membership fee		Tanzania, DSM
49	Simgas	Buy back guarantee. Subsidy through TDBP and CDM	Check Wonderbag	Tanzania, DSM

50	SNV	Arusha TAREA office. 8% hh target ICS 2020	Remind about the three documents	Tanzania, DSM
51	Camco	Clustering customers. Revolving funds.		Tanzania, DSM
52	e.quinox	Household surveys. Issues with the shopkeeper and black charging. The smart mini-grid system	Find out if a DC mini-grid is viable?	United Kingdom

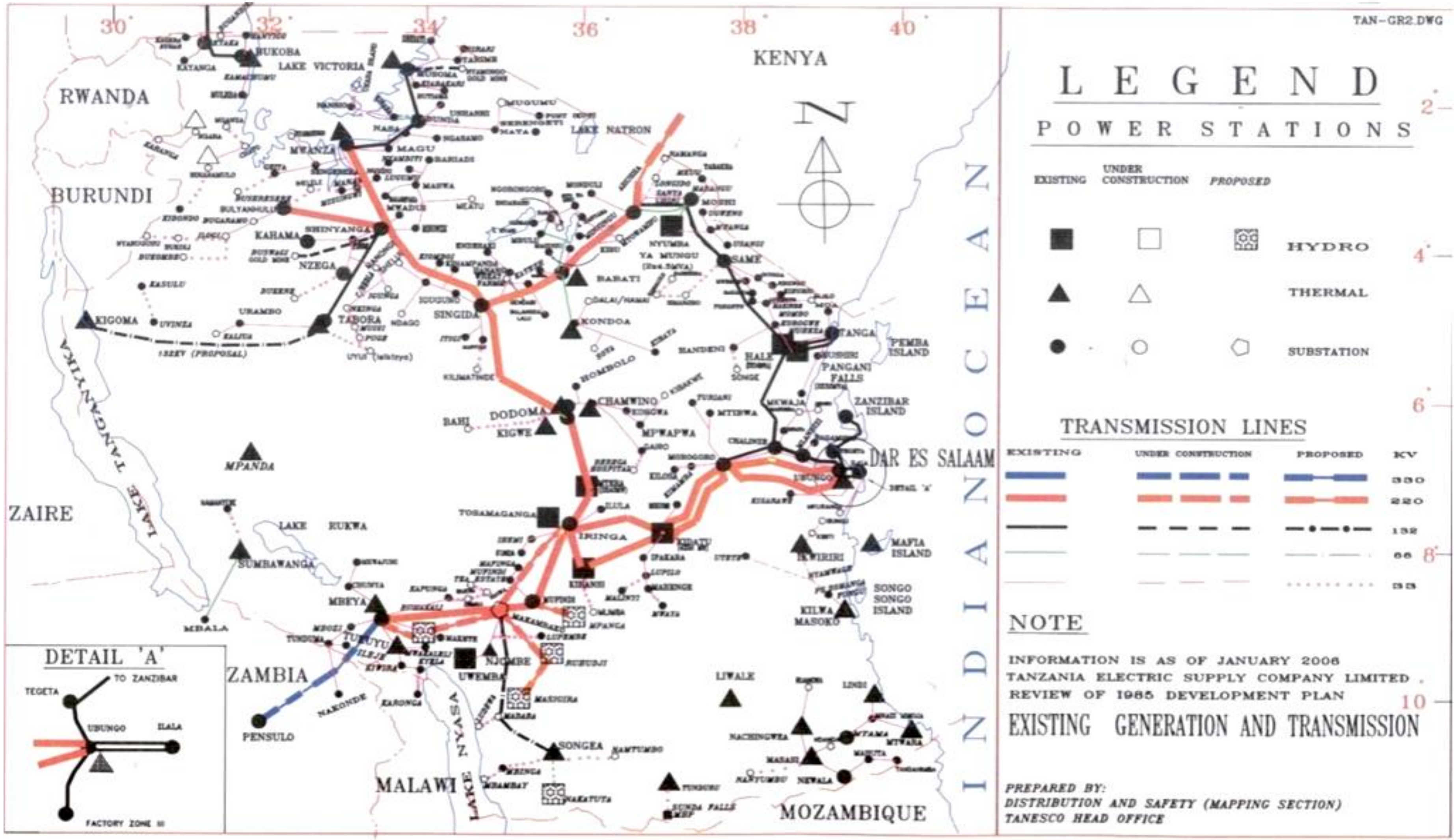
The respondent's function and contact details are known by the researcher.

Appendix B: SL pentagon for a biomass plant in Jambaló province, Colombia



Source: adopted from Henao, et al., 2012

Appendix C: the Tanzanian national grid system



Source: TANESCO, 2007 in Riedijk, 2010