



Impact analysis of a rural electrification project

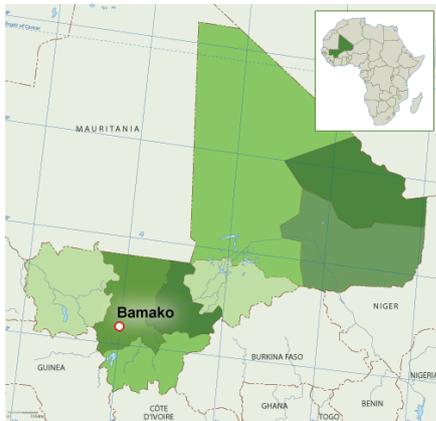
Field research in four villages in Mali

Garahnce Dekker



Impact of a Jatropha-fuelled electrification project

Field research in four villages situated in southern Mali



Master thesis

Author: G.S. (Garahnce) Dekker

Student number: 3115372

Date: 01-12-2011

Study: Master International Development Studies

Utrecht University

Supervisor: Prof. Dr. E.B. Zoomers



Stichting DOEN
Van Eeghenstraat 70
1071 GK Amsterdam
The Netherlands



Fact Foundation
Postbus 210
6700 AE Wageningen
The Netherlands



Mali Folkecenter
BP E4211
Bamako
Republique du Mali



Utrecht University
Postbus 80125
3508 TC Utrecht
The Netherlands

PREFACE

The base of this master and research is a long time ago. Thirteen years ago, I went with my parents to Guatemala to pick up my small adoption- brother. When I saw all those poor begging kids, I knew I wanted to do something with the existing poverty in the world. A few years later my sister came from Haiti, bit by bit I became more aware of the environment around me.

When choosing the Bachelor Human Geography & Planning at Utrecht University, the goal was to do the master; International Development Studies. I wanted to understand more of the problems in the world, to get involved with different cultures and to research them.

I want to thank everybody who did help me to complete this research and fieldwork in Mali. While working together with three different organizations, I had to create a good overview. But with a grateful contribution and comments of Nina Tellegen, director of Stichting DOEN, who gave me a great introduction to Mali with a visit to the 'Festival sur le Niger'; Winfried Rijssenbeek, director of the Fact Foundation, who visited me in my first week to organize everything and gave me a call every now and then; and many different colleagues of the Mali Folkecenter in Bamako, who provided me with a lot of information and organizing and all my dear colleagues, friends and family in Garalo I could finish a great field research. With special thanks for Aliou Tounkara; I would never expect to live four months 'without electricity', without a real shower and toilet, but he and his family always helped, supported and organized everything for me. Furthermore I want to thank Annelies Zoomers, my supervisor from the Utrecht University for her trust and comments but gave me the independence to do my own research.

Finally I would like to thank my big family, who did take me on a long planned trip to Central America, a break well planned in the time I had to write my thesis. They always motivated and supported me to finish my research soon. Even when I was in the field without internet, they called me often and supported me in the moments when I needed some Dutch talking. I want to thank them for the world vision they gave me, to start and finish my studies.

Garahnce Dekker, Utrecht, November 2011

EXECUTIVE SUMMARY

Rural electrification has many positive impacts on the life of the rural population of Mali. Mali, one of the poorest countries of Western Africa, has a population of 12 million inhabitants of which 80 percent do not have access to electricity. In this research the impact and the sustainability of a Jatropha generated electrification project in Southern Mali has been researched. A comparison is made between 4 villages, one, Garalo with electricity and three villages that are still without electricity.

The rural electrification project started with one village in southern Mali, nowadays the project is expanding to ten villages. Pending future positive results, it will be even possible to expand the project to a hundred villages. With the lack of a national grid and the high price of solar panels, the already know biofuel plant Jatropha could be a good alternative to provide sustainable energy in Mali.

The aim of the research - done for the DOEN foundation, the Fact Foundation and in co-operation with the Mali Folkecenter, is to explore the effects of the (sustainable) electrification project. This research gives an analysis of the impact and sustainability of a rural electrification project, which provides electricity on a base of Jatropha to ten villages in southern Mali. The research is based on observation and (semi-structured) interviews with several micro-enterprises, households and Jatropha farmers. Furthermore focus groups with the women and electricity association and in-depth interviews with some doctors and school directors are done.

Rural electrification has many positive impacts on the rural population. The village itself is growing and developing and it has a positive impact on a big part of the population. Important community usages are the health centres. With high birth-rates, it's important for the health centres and the maternity clinics to have strong lighting to work through the evening. Thanks to the electricity, Garalo can cool vaccinations itself. A constraint is however the timetable. From 1h00 till 16h00 the fridge is working on gas or oil and lights are running from a small solar panel. One doctor indicated; 'having electricity is not a luxury product, it's really a necessity. It does save a lot of money and it facilitates the work. Giving a mother birth with a torch by night is almost impossible, having electricity 24/7 is really, really important for us'.

The population can generate more income because the few existing micro-enterprises benefit from access to the grid, even if they are only using tubular lighting when they are able to work more hours by night. Where as in the not-electrified villages, all the activities ended at 19h00, in

Garalo everybody was working until 1h00. Having access to electricity for a restaurateur, a tailor, carpenter or other craftsman will positively influence their economic and work situation.

Every family member can benefit independently and together from the rural electrification. The head of the household can watch the daily news and he can reload his mobile phone easily. The access to electricity has also an influence on the independence of the rural women. Women who have a fridge and can generate income and independence. Also the education of the school children benefits from electricity, as it has a huge positive influence on the amount of potential study-time. Families can spend (leisure) time together. With daily access to electricity from 16h till 1h, children start watching TV at 16h, afterwards women watch soap series, and in the evening (European) news and important football matches are shown. Other social activities due to the access to electricity are the many parties that were observed by night. Accessibility to electricity creates many leisure activities for families and the whole village.

An important question for this research is; 'Is this project sustainable?'. At this moment only five to ten percent of the total energy production is originated from the Jatropha oil. This means that more than 90 percent of the energy is diesel, which price is depending on the world market. Initially, it was assumed that Jatropha would reach maximum yields maximum after a duration of four years. When the project started in 2007, the first 'pépinières' (small plants) were given to the farmers. Now, four years later, the production is still limited and nowadays research has shown that the duration that Jatropha reach maturity is much longer than four years (Fact Foundation; . The price given per kilogram is only 50FCFA/kg = 0.08 eurocent, where the price for corn or cotton is 250FCFA/kg (include source and year). Farmers have to spend a lot of time working on their Jatropha fields. Many farmers invested a lot of their money in managing the Jatropha fields, but the benefits are still low. All farmers do see a positive future and they all want to extend the number of hectares on which they can grow Jatropha, but before increasing their fields they want and need to get a higher price for the production and efforts they are giving.

The project could be seen as a big success regarding all the satisfied people who now have access to electricity. It facilitates their lives, it saves money compared with the use of other energy sources. It has a positive impact on the whole village. With the access to electricity, the health centres can deliver better work, and students can work more hours a day. Moreover it creates more economic activities for some women through having a fridge and it facilitate the work of already existing micro-enterprises. Because of the lack of Jatropha-oil and the usage of diesel, the project is not sustainable at this moment. It will be necessary to have a look at other renewable energies or biofuels with a higher selling price than the Jatropha crop has currently.

CONTENTS

Preface	- 5 -
Executive summary	- 7 -
Contents	- 9 -
List of Figures, Photos and Tables	- 11 -
1. Introduction	- 13 -
1.2 Relevance	- 15 -
1.3 Research structure.....	- 15 -
2. (Sustainable) Rural electrification	- 17 -
2.1 Rural electrification	- 17 -
2.2 Benefits of Rural electrification	- 19 -
2.3 Rural electrification & Renewable energies	- 20 -
2.4 Jatropha	- 21 -
3. Methodological chapter	- 25 -
3.1 Research objective and questions	- 25 -
3.2 Hypotheses / assumptions	- 26 -
3.3 Methodological Model	- 27 -
3.4 Research approach	- 27 -
3.4.1 Semi-Structured interviews	- 28 -
3.4.2 Unstructured Interviews	- 28 -
3.4.3 Focus group.....	- 29 -
3.4.4 Overview of all interviews	- 29 -
3.5 Sample selection	- 30 -
3.5.1 Villages	- 30 -
3.5.2 Population	- 30 -
3.5.3 Sample overview structured interviews.....	- 31 -
3.6 Translator	- 31 -
3.7 Conclusion.....	- 32 -
4. Regional framework	- 33 -
4.1 National context.....	- 33 -
4.2 Mali and Electricity	- 34 -
4.3 Biofuel Policy	- 36 -
5. Project characteristics	- 39 -
5.1 Project description	- 39 -
5.2 Objective	- 39 -
5.3 Location and intervention area	- 40 -
5.4 Organization	- 41 -

5.5	Target group	- 41 -
5.6	Duration.....	- 41 -
5.7	Budget	- 42 -
5.8	Technical aspects	- 42 -
5.9	Electricity committee	- 43 -
6	<i>Impact of rural electrification on village level.....</i>	- 45 -
6.1	Street lighting	- 45 -
6.2	Impact on public Facilities	- 46 -
6.3	Increased inequalities.....	- 48 -
7.	<i>Impact on the local micro-enterprises.....</i>	- 49 -
7.1	Restaurants	- 49 -
7.3	Carpenter	- 50 -
7.4	Tailor.....	- 51 -
7.5	Other enterprises.....	- 53 -
7.6	Conclusion.....	- 53 -
8.	<i>Impact on households use.....</i>	- 55 -
8.1	Head of the household and his Television & Radio	- 56 -
8.2	Women and her Fridge.....	- 57 -
8.3	Children and their study time	- 58 -
8.4	The whole family and the Leisure activities	- 60 -
8.5	At the other side.....	- 61 -
8.6	Conclusion.....	- 62 -
9	<i>Sustainability.....</i>	- 65 -
9.1	Productivity	- 65 -
9.2	Participation.....	- 67 -
9.3	Future	- 68 -
9.4	Conclusion.....	- 68 -
10	<i>Conclusion.....</i>	- 69 -
11	<i>Discussion.....</i>	- 73 -
12.	<i>Bibliography</i>	- 75 -
12.	<i>Appendix.....</i>	- 79 -
	Appendix A: Host Organisations.....	- 79 -
	Appendix B : Overview Interviews	- 81 -
	Appendix C : Planning / Logbook.....	- 85 -

LIST OF FIGURES, PHOTOS AND TABLES

Figure 1: World population without electricity access

Figure 2: Percentage of urban and rural people served by electrification in developing countries (by region)

Figure 3: Global indication of the most suitable climate conditions for the growth of Jatropha

Figure 4: Departments of Mali

Figure 5: Circle of electricity and development

Table 1: Potential benefits of rural electrification projects

Table 2: Characteristics and conditions for best performance

Table 3: Telephone and internet users

Table 4: Energy balance and traditional energy consumption in some Saharan countries

Table 5: Fuels used for cooking in rural households for some Sahelian countries

Table 6: Household electricity access by deciles

Table 7: Overview researched villages

Table 8: Amount of energy sources spent each day or month

Table 9: Amount of energy sources spent each day or month

Table 10: Difference before and after electrification for households in Garalo (n=20)

Table 11: Average of 13 farmers which are producing Jatropha seeds (1 = no influence, 5 = big influence)

Photo 1: Hypothesis of the MFC regarding the Jatropha cycle

Photo 2: Lights used in maternity room

Photo 3: Fridge at the hospital

Photo4: Small restaurant with electricity in Garalo

Photo5: carpenter at work at 15h00, not making use of electricity

Photo 6: Tailor at work

Photo 7: Watching all together

Photo 8: Watching Dutch television in Blade

Photo 9: Cooking on an improved stove

Photo 10: cooking on three stones (with a torch)

Photo 11: Top étoiles

Photo 12: DJ Cam

Photo 13: meeting with a Jatropha farmer

Photo 14: termites are destroying plants

Photo 15: Jatropha field dry season (Feb)

Photo 16: Jatropha seed

Photo 17: Jatropha field after rainfall (May)

1. INTRODUCTION

About two billion people currently have no access to affordable energy services. Annually, thirty million people being added to this figure in the developing countries. Improved access to clean modern energy in developing countries is a first step to reduce poverty.

Especially in the rural areas of Asia and Africa, some two and half billion people depend on traditional biomass. Thirty-five percent of the sources used for cooking and heating are retrieved from firewood, charcoal, harvest residues, and dung. Despite the important role access to modern energy sources plays, in these areas only a small part of the population has access to 'the national electricity grid'. Electricity retrieved from solar panels is too expensive for a huge part of the rural population and the grid expansion is limited. This can often be explained by a low population density in the rural areas and the lack of available (technical) knowledge and markets. .

The energy use in Mali is ninety percent from traditional sources. The dependency of the Malian population on fuel wood is seen as one of the causes of the rapid desertification in the country. The traditional sources have very low energy efficiency and can cause high levels of indoor pollution which can lead to health problems for the whole household. Access to (sustainable) electricity creates many benefit; light extends the day, people can study more hours, enterprises can be more productive, leisure activities can be created, electric material will facilitate labor, refrigeration allows local clinics to keep needed medicines and vaccines, etc.(Barnes, 1996).

Maiga (2006) states that the final goal of electrification projects is to reduce poverty: *Modern energy services enhance the quality of the life of the poor in countless ways. A modern energy can directly reduce poverty while the extensive uses of biomass in traditional and inefficient ways restrain economic and social development of the country.*

Brew-Hammond (2008) indicates in line with the projects the importance of NGOs in collaboration with government. *"They have to play a leading role in the introduction of biodiesel as an alternative fuel source to the Malian people."* In 1994, the United Nation Development Program (UNDP) and the Internal for Agricultural Development (IAD) introduced Multi-Functional Platforms (MFP) that provides decentralized energy to rural villages. The sustainable electrification process of the MFP now runs on raw Jatropha oil, an already existing biofuel in Mali. Jatropha is known from making hedges and borders to protect the field against animals and for making soap. Because of its drought resistance ability and the fact that it can do well in barren lands, in large scale production, it could be really affordable in Mali (Brew-Hammond, 2008). With the different possibilities to use the Jatropha, Asselberg (2006) even states that

Jatropha cultivation can also be seen as a poverty reduction tool for the mainly poor Malian people.

Since the creation of MFP, many rural electrification programs were set-up in Mali. One of these first small scale programs is set-up and implemented by the Mali Folkecenter (MFC) in Garalo; a village in the south of Mali. Some economic activities and small enterprises already existed in the villages and some farmers already started to grow Jatropha, the (bio) fuel which was known by the local population to possibly get electrified. Finally the village leaders convinced the MFC to start the rural electrification project in Garalo. Because of the assumed positive impacts on the population, the program started its expansion in ten other villages in 2010, named the Bagani-Courant 10 (BC-10). In these ten villages, the electricity generation project is based on Jatropha seeds. Most of these villages are situated in the region of Sikasso and had to meet the requirement to have already some economic activities and possibilities to participate. Parts of the program will be implemented 2011 whereby at least five out of ten villages will be electrified. The final goal of the project is to reduce poverty levels (through electrification) for fifty thousand people in and around the ten villages. A sustainable electricity project that works on the biofuel Jatropha, which is locally produced, can add value to local production, can contribute to improved livelihoods, and offers a more sustainable future.

In the village of Garalo a rural electrification project started in 2007 with the connection of the first households to the local electricity grid. Currently one third (340/100) of all households are connected and this amount is still increasing. The sustainability of the project is currently being argued; as 5-10 percent of its energy production derives from the Jatropha plant and the remainder from diesel.

To understand both dimensions of the rural electrification project i.e. the impact of electricity on the local population and also the sustainability of Jatropha production itself, the following question is being researched:

What is the impact of a Jatropha-generated rural electrification project in Mali regarding the benefits for the local population and its sustainability?

To address this research question, the research is divided in three sub questions:

Sub question 1: What are the characteristics of the project?

Background information regarding the Garalo and BC-10 project will be evaluated.

Sub question 2: Which changes occurred as a consequence of the implementation of the electricity?

The changes and impact on the village and population will be assessed, starting with the changes for the whole community. A focus will be given on the benefits of electrification for the whole community, with a special attention for the health facilities. Secondly on a lower scale, the economic activities undertaken by the local population who have access to the grid compared with those not connected yet and the way households are using electricity and their benefits.

Sub question 3: Is the project sustainable?

The production process of the Jatropha will be assessed and its effects on the work of the farmers and on existing agricultural production.

1.2 RELEVANCE

A few theoretical researches have been completed on the process and impact of electrification, and only a few field studies are undertaken in South East Asia and South Africa. The relevance of this research is the focus on the local population in another area (Sub Saharan Africa), to research the benefits for them and the impact on their lives, families and work. Furthermore is this research relevant regarding the production of Jatropha, whether this is a sustainable biofuel and the right source for a small scale electrification project.

1.3 RESEARCH STRUCTURE

This thesis is divided into eleven chapters. The theoretical framework, with relevant theories and themes are discussed in **chapter 2**, with the theme rural electrification, sustainable energies and its impacts. In **chapter 3** the different used methodologies will be explained to give an overview and to clarify how to respond to the research questions. The **4th chapter** will enhance the regional framework, including the national policies and use of energy in Mali. In **chapter 5** the project background and the different research villages will be described. The impact evaluation based on the observed and researched changes and the perception of the population will be analyzed in the next three chapters. The **6th (empirical) chapter** will elaborate on the way the village of Garalo is benefiting of electrification. The **7th chapter** will first evaluate the economic impact on micro-enterprises. **Chapter 8** will examine consumption side of households and its members. In the last empirical chapter, **chapter 9** the sustainability of the project will be described, which will lead to a conclusion in **chapter 10**. A discussion of the subject, will be covered in the last **chapter 11**.

2. (SUSTAINABLE) RURAL ELECTRIFICATION

In this chapter different aspects regarding the subject will be discussed. First, the overall theme, rural electrification, will be discussed. The latter will be subdivided, starting with its benefits and afterwards its connection with sustainable energies.

2.1 RURAL ELECTRIFICATION

In the developed world almost everybody has access to electricity and internet, contrary has two and half billion people in developing countries a total lack of access to electricity or are confronting serious energy supply challenges. Ninety percent of the population in developing countries, of which is the biggest part living in rural areas, does not have an appropriate access to sufficient and sustainable energy (Figure1&2) (Barnes, 2006). Regarding both figures especially Africa is lacking electricity access. Even though the rural and urban population doubled its people served by electrification between 1970 and 1990, has fifty percent of the urban population access to electricity and only eight percent of the rural population (figure 2). A similar number remain dependent on fuels such as animal dung, crop residues, wood, and charcoal to cook their daily meals. When the population is relying too much on the traditional sources, natural resources will be exhausted and productive land will be degraded.

Figure 1: World population without electricity access

Source: OECD, 2007

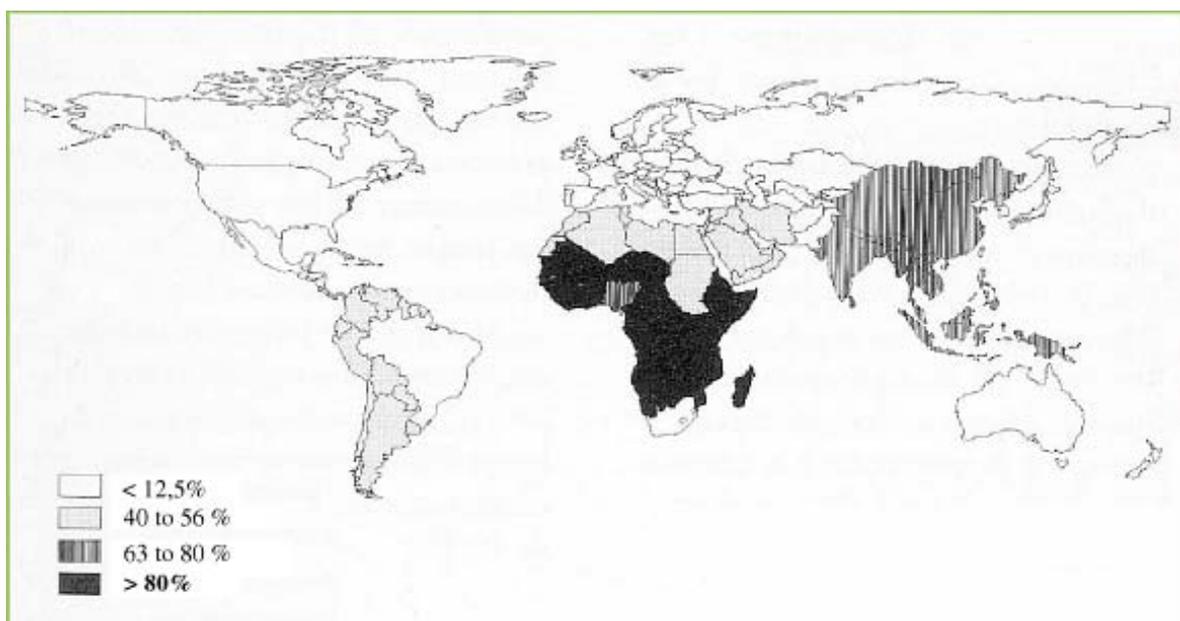


Figure 2: Percentage of urban and rural people served by electrification in developing countries (by region)

Region	Urban		Rural	
	1970	1990	1970	1990
North Africa and Middle East	65	81	14	35
Latin America and Caribbean	67	82	15	40
Sub-Saharan Africa	28	50	4	8
South Asia	39	67	12	25
East Asia and Pacific	51	82	25	45
All developing countries	52	76	18	33
Total served (in millions)	320	1100	340	820

Source: Barnes & Floor, 1996

An 'energy ladder' can be seen regarding the development of an area. Where especially in the low income stage people are using woods, residues and dung, in the medium stage people are making more use of kerosene and biogas and in the higher stage of LPG, coal kerosene and electricity (Barnes & Floor, 1996). Higher income households are more likely to have obtained access to grid electricity. Movement up the 'energy ladder' can be smoothed and sustained by policies and investments by local and international support (Barnes, 2006).

Energy has always played an important role in human and economic development and in society's well-being. Access to electricity and other modern energy sources is necessary, but not a sufficient requirement for economic and social development. Economic development, both in rural and urban, large and small-scale, can also be promoted and encouraged by making production processes more efficient, thereby making the final-products more affordable (Maiga, 2006). A definition of productive uses of energy is created by the Global Environment Facility (GEF) and the UN Food and Agricultural Organization (FAO) (in Cabraal, 2005), which states, "in the context of providing modern energy services in rural areas, a productive use of energy is one that involves the application of energy derived mainly from renewable resources to create goods and/or services either directly or indirectly for the production of income or value". In this definition will be the focus on the impact of energy use on the gross domestic product (GDP). But electricity is a means to an end and not an end in itself. Machines must be used by educated and healthy people to be effective in promoting development and improving income. The use of energy in the context of failing schools, poor health facilities, and poor water supply will not lead to development. However, regarding Cabraal (2005) 'without energy there are limits to any type of growth in rural areas'. Without efficient, clean energy, people are undermined in their efforts

to really reach and work effectively in productive activities or to improve their quality of life. People cannot farm efficiently or produce goods if much of their time must be spent searching further and further to gather diminishing wood fuels or if much of their income is used to pay for inefficient power. The lack of electricity deprives people of basic necessities such as refrigeration, lighting, and communications. And the use of traditional fuels can cause more problems. In domestic level use, cooking with wood fuels can cause serious respiratory illnesses, particularly among women and children.

The economic development of modern societies is crucially dependent on energy. Energy is vital for sustainable development. It is used to generate electricity for a variety of needs, among which are domestic, transportation, and industrial needs. Energy also plays a critical role in sustainable human development. It impacts on poverty, population, health, the environment, industrial investment, agricultural and socio development of a nation. The provision of energy services has been since a long time a central role in economic development.

2.2 BENEFITS OF RURAL ELECTRIFICATION

At the most basic level of subsistence, the only energy required is for cooking and keeping warm. The time spent on energy-related tasks (particularly cooking and fuel collection) is of major importance (Davies, 1998). Related to the Millennium Development Goals, there is a direct relationship between the absence of adequate energy services and poverty indicators such as infant mortality, illiteracy, life expectancy and total fertility rate. The key challenge facing the African energy sector is the provision of modern energy services to over 60% of its population, to facilitate economic development and poverty alleviation (Cabraal, 2005/ Maiga, 2006). Access to modern energy services is critical to each of the economic, social and environmental dimensions (table 2). It can help facilitate economic development by underpinning industrial growth, enhancing productivity, and providing access to global markets and trade (Millennium Development Goal 8). It can contribute to social development by helping to fulfill the basic human needs of nutrition, warmth, and lighting. Most of the benefits will be on the goals related to health and education (Millennium Development Goal 2-6). Making use of renewable energies can also protect the environment to reduce deforestation and reducing of CO₂ emissions (Millennium Development Goal 7).

Table 1: Potential benefits of rural electrification projects

Type	Benefit	Mechanism
Social and educational	Improved living standards	Access to appliances, time savings
	Reduced burden on women	Less effort collecting wood and cooking
	Improved communication	Access to television and radio
	Higher quality light, reduced crime	Household and community lighting
	Improved education	Lighting in schools, evening classes
	Improved water supply	Use of electric pumps
	Greater urban/rural equity	Increases in rural living standards
Health and environment	Reduced urban migration	New employment opportunities
	Reduced pressure on woodland	Less fuelwood collection
	Less indoor pollution	Use of electricity for cooking and heating
	Improved health services	Refrigerators, lighting, communication
Economic	Reduction in fertility rates	Higher standards of living
	Improved agricultural productivity	Irrigation, agricultural machinery
	Increase in employment	More businesses, growth in agriculture
	Greater number of enterprises	Opportunities, access to equipment
	Financial savings to users	Electricity replaces expensive fuels
	Foreign exchange savings	Electricity replaces kerosene and diesel

Source: Davies, 1998

2.3 RURAL ELECTRIFICATION & RENEWABLE ENERGIES

Rural areas in Africa are for more than ninety percent not yet electrified and many people are remaining dependent on the primary energy sources, biofuels and renewable energies can play a role in the development to sustainable electrification. Because of the expansion of the oil and gas markets and a currently increased use and knowledge of renewable energies, development policies are of major importance to support innovative electrification programs (Barns, 1996/ Barnes&Floor 1996). Renewable energy can be a mean to keep or lift households out of poverty, provide jobs, grow small businesses and combat climate change (SNV, 2010).

Renewable energy sources made their first real entry on the international energy scene in the 1970s when the two worldwide oil crises occurred. Recently more and more awareness is raised regarding the use of renewable energies. It has been acknowledged that renewable energies must play a key role to provide energy. Especially in the Sahelian countries, renewable energies have the potential to respond to global sustainability and environmental, safety, social and economic goals. There are different possibilities of renewable energies in the African countries. Especially solar energy and biomass are popular in this continent. Other possible renewable energy resources are; geothermal energy, hydropower, ocean energy, wind energy, and

hydrogen. All fuels have different characteristics which are different in each region (Maiga, 2006)¹.

2.4 JATROPHA

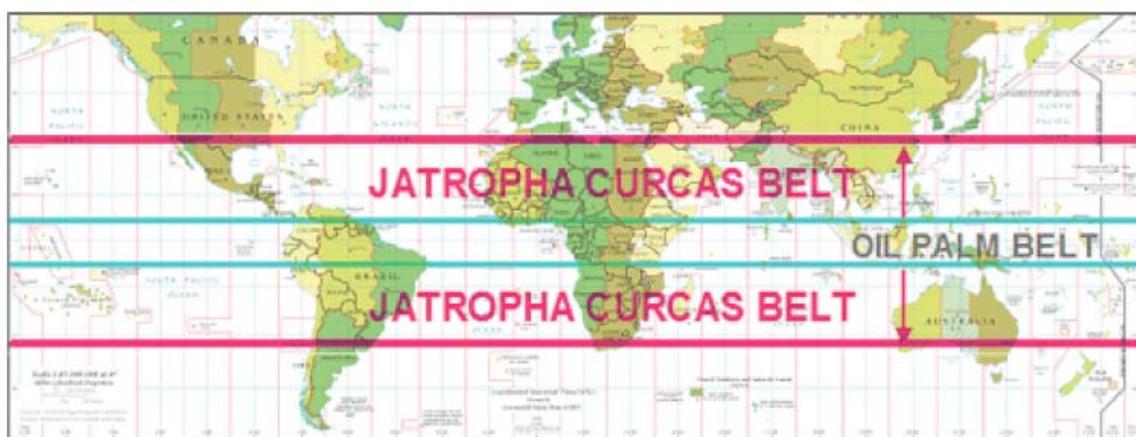
Biofuels are regarded as an important source for clean energy which can create jobs for the poor living in rural areas, and which can increase agricultural productivity (Boccanfuso, 2011). The uses of biofuels have probably many benefits regarding development of the human livelihoods. But the impacts and changes on the cultivated land must be carefully planned and implemented, unexpected influences must be stated. Criticizers argue that:

“African countries could explore the possibilities of small-scale farming of biofuels crops for households or local energy needs. But the consequences of growing fuel for export to the wealthy developing countries, instead of food for Africans, could be severe” (Teresa Anderson - Anderson, 2006).

“The development of biofuels poses risks as well as complex and often expensive trade-offs”(Clement Chipokolo - Newton, 2007).

Several experiences in Sub-Sahara Africa have shown the potential of the biofuel Jatropa (figure 3). With its geographical situation and growth potential, especially in the developing countries Jatropa could play a role.

Figure 3: Global indication of the most suitable climate conditions for the growth of Jatropa



Source: Jongschaap et.al, 2007:1

¹ More information of the possible renewable energies in the article of Maiga, A.S., Chen, G.M., Wang, Q., Xu, J.Y. (2006) Renewable energy options for a Sahel country: Mali. College of Mechanical and Energy Engineering, Zhejiang University, China

With the production of biodiesel based on oil seed crops, Jatropha is a biofuel which can produce energy as one of the renewable energies. It has to reach some specific conditions (table 2) to give seeds. Jatropha is receiving increased attention due to its specific characteristics of being drought resistant and able to grow on marginal lands and poor soils. Oil-based biofuels from Jatropha (Jatropha oil) can be used in old diesel engines, and, if applied in diesel generators, it could potentially support rural energy production. Furthermore, waste from pressing the oil (press-cake) can be used as fertilizer and for biogas production.

Table 2: Characteristics and conditions for best performance

Characteristics:	Conditions for best performance:
Drought-resistant	Tropical & semi arid regions at altitudes up to 500
Growing well in marginal/poor soil	Rainfall from as low as 300 mm
Easy to establish	Maximum time between harvesting and processing: Several months
Grows relatively quickly	Yield per hectare: 400 – 2200 l / ha of pure plant oil
Producing seeds for 50 years	Required economical scale for competitive biofuel production (Ha): 400-1000
High yield ability	4 years to mature
High oil content of 37%,	Press cake a good organic fertilizer
Good quality of the plant oil	
Combusted as fuel without being refined	
It burns with clear smoke-free flame	
Tested successfully as fuel for simple diesel engine	

Source: Centre for Jatropha promotion, 2011, 2010, DaeyOuwens, 2007, Sielhorst et al, 2008

While above mentioned authors are positive regarding the Jatropha crop, shows recent research another side of the effects of Jatropha. The amount of years to mature is not clear yet. After years of research, they now think it will be at least 8 years. But also these are hypotheses and are not fixed results. More research is going on, regarding the productivity of the plant. S. Bos of the Fact Foundation indicates broader effects related to the growth of Jatropha; *'Nowadays we realize that although the plant grows on marginal land, it this does not lead to good seed production'*. (Fact Foundation, 2011).

3. METHODOLOGICAL CHAPTER

In four months, questionnaires, interviews and focus groups are done with the local population of four villages in southern Mali. In this chapter the objectives, research questions, sample frames and some overviews will be given. To give a clear overview of all important and benefiting actors, (semi)structured interviews are taken with households, enterprises and farmers. In-depth interviews are done with some teachers and medicines and the employees of the local and national electricity companies.

3.1 RESEARCH OBJECTIVE AND QUESTIONS

The research will give an evaluation of the function of a sustainable electrification project. There will be a focus on:

- the benefits of the electricity for the local population
- the impact on the micro-enterprises
- the impact on household use
- the importance for social facilities like education and healthcare
- the perception of the population regarding the project
- The sustainability of the project

Considering the desires of the organizations and the feasibility of the research in four months, the following research question is developed:

What is the impact of a Jatropha-generated rural electrification project in Garalo, Mali regarding the benefits for the local population and its sustainability?

To give an answer on this research question, the research is divided in three parts, starting with the characterizations of the project, followed by an impact evaluation and finally the sustainability analysis of the project.

Sub question 1: What are the characteristics of the project?

Background information regarding the project will be outlined in chapter 5. Local information will be explored to understand the situation and issues the project is dealing with.

Sub question 2: Which changes occurred as a consequence of the implementation of the electricity?

The impact evaluation is divided in three parts to give a clear overview for answering this question. First of all, the impact of electrification for the village and its population in general. Secondly the impact of electricity on micro-enterprises. Finally, the impact of electrification on households and family members. With evaluating these three sorts of uses, the whole community will be included whereby the research is based on all comprising actors.

Sub question 3: is the project sustainable?

Working with the biofuel Jatropha is the base of the project. The productivity, problems, financial sustainability and effects on existing farming systems are outlined in chapter 9.

3.2 HYPOTHESES / ASSUMPTIONS

Giving an answer on the former stated questions, several hypotheses and assumptions are made. These hypotheses will be conducted with different methodologies and will be answered and discussed in the different empirical chapters.

1. Increased education level: Lightening at school can facilitate evening classes, and children can study by night. Energy can heat or cool a school to facilitate working. Television gives information. Women can be more educated and take better care of the children. Increase communication by telephone and internet networks.
2. Improved health facilities: Electric equipment can make it easier to cook food, water pumps can increase access to clean water and cooking electric will reduce indoor and outdoor air pollution. The combination of the factors can improve health of young children. Health clinics can increase access to vaccines to protect the children.
3. Increased time spends on leisure activities: When spending less time on other activities (cooking, searching water, working) more time can be spent on leisure activities.
4. Empowerment of women: Using water pumps creates more free time for women; electric equipment can reduce the amount of time spent in the kitchen; Women will have more time to undertake other activities like schooling and working. More girls can go to school instead of working at home.

5. Increased inequalities within the population: Households/companies having electricity can increase and develop their situation; households/companies without electricity are staying behind.
6. Environmental sustainability: Using electricity will reduce the usage of carbon coal, wood fuel and oil/diesel. This will reduce global carbon emissions, erosion, and desertification and will increase soil quality.
7. The energy production will change the land use: Producing Jatropha will change land use and can diminish the food production.
8. Jatropha will be a good growing crop in Mali. It will not take too much time and effort to work on the field.

3.3 METHODOLOGICAL MODEL

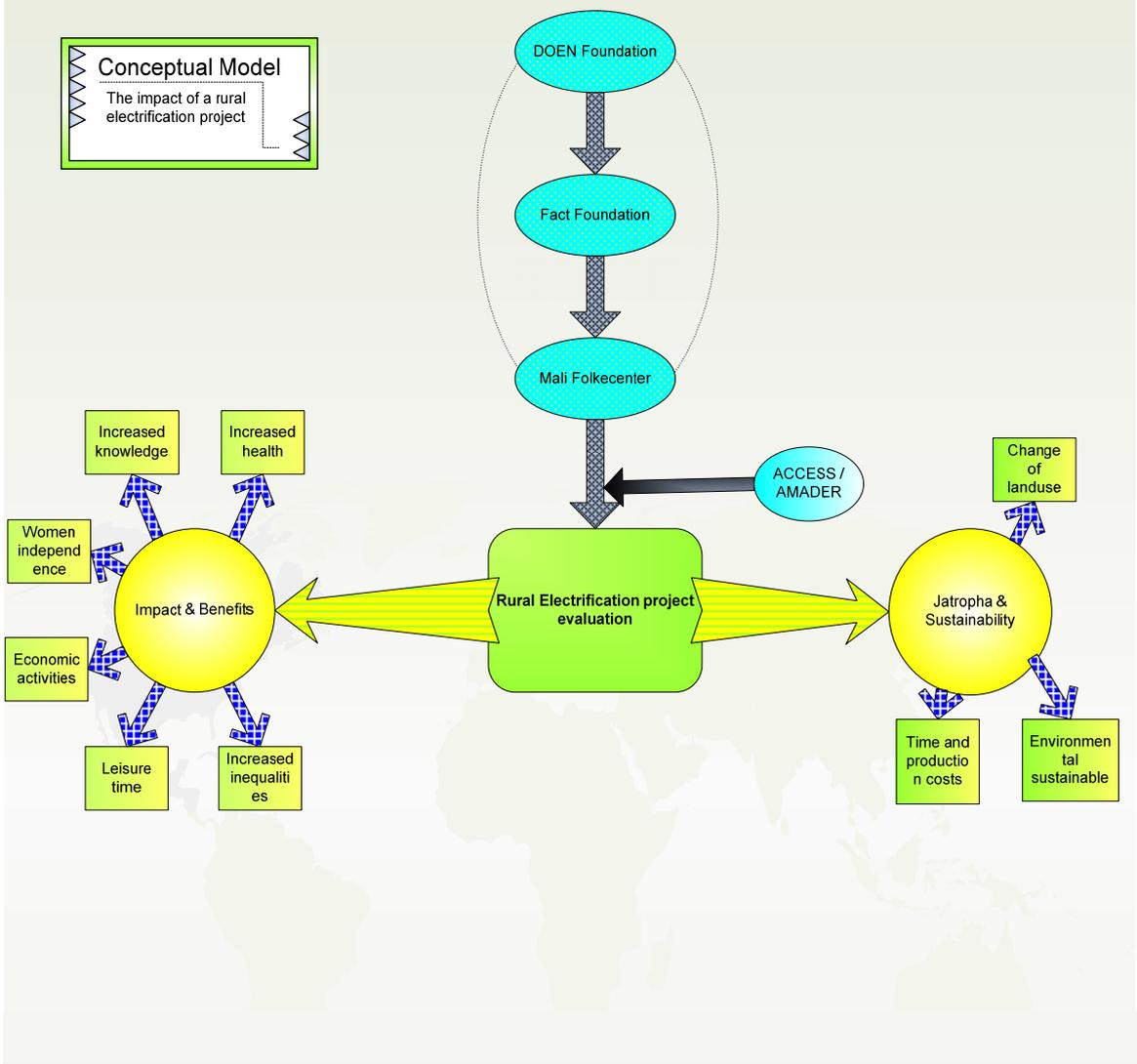
Different actors are playing a role in the electrification process. In this field research is cooperated with DOEN Foundation, Fact Foundation and the local host organization Mali Folkecenter. Together with the research question, sub questions and hypotheses the model is created to get a clear overview of all aspects of the project.

The conceptual model is divided in two parts, which will explain the research questions. On the left side of the model you can find the impact analysis. On the right side; the sustainability question.

3.4 RESEARCH APPROACH

The research is done with four villages in southern Mali. Garalo, the first and still only electrified village, compared with Bladiè, Zantièbougou and Kebila. Before starting with all (structured) interviews, a welfare ranking was made together with the different village leaders. To get a good overview of the different needs of the population semi-structured interviews are done the head of the households, with different micro-enterprises and Jatropha farmers. Open interviews are done with schoolteachers, medicines and the electricity companies. With the different actors a clear image can be given on the impact of electrification on the village level.

Figure 4: Conceptual Model



3.4.1 SEMI-STRUCTURED INTERVIEWS

To get a clear and structured overview of the different actors semi-structured interviews are hold with the households, micro-enterprises and Jatropa-farmers. This method is used to get a clear overview of the situation, with some basic (comparable) and more in-depth information. A comparison can then be made how the energy is and was used before and after having access to the grid. Working with semi-structured interviews will have the advantage that all questions are asked in the same way even when working with different translators.

3.4.2 UNSTRUCTURED INTERVIEWS

To get more detailed and thorough information unstructured interview are done with several people. In Garalo, unstructured interviews are done with two medicines from the health centers, one schoolteacher (French/ Geography) and one school director. Other interviews are done with AMADER and ACCESS, the electricity companies of Mali and Garalo.

The advantage of having open questions over closed ones is that the respondents could answer in their own terms. They were allowed to give their own opinions. The questions did not suggest any kind of answers of the respondent. The respondents were all higher educated and had a certain level of knowledge to provide a clear answer. The open questions were useful to get a clearer overview on topics (like healthcare or governmental issues) of which the researcher had a limited knowledge.

3.4.3 FOCUS GROUP

In this research two different focus groups are done. In all the villages special women groups are represented. Together with one of them, the gender aspect of rural electrification is discussed. The second focus group was done together with the electricity association of Garalo. They did talk about their work, their influence and the role they can play in developing the area.

Focus groups have to be ideally homogeneous regarding ‘race, ethnicity, language, literacy level, income and gender’ (Talking quality.gov, 2009). The women focus groups had the following characteristics: they were all women, who spoke only Bambara, none of them could speak French. All women 50 years and older and were married with several children. They all worked in agriculture and run the household (cooking, taking care of the children). The focus group with the electricity association was more mixed. All participants were men, some participants spoke French, other only Bambara. They were between 40 and 60 years old, were all married (some with one woman, some with more) and they all had several children. All men worked as farmers and cultivate Jatropha.

All participants did know each other but all participants were able to give their opinion. Sometimes the conversation took a side path. In that case the translator steered the conversation back to the topic. The participants were not familiar with the subject and the purpose of the meeting which resulted in people expressing them freely and in-depth discussion. As a compensation for their time all participants did not receive cash, but they all got a drink during the meeting of 60-90 minutes.

3.4.4 OVERVIEW OF ALL INTERVIEWS

Garalo	20 questionnaires households with electricity
	10 questionnaires households without electricity
	13 questionnaires different micro-enterprises
	6 interviews Jatropha farmers
	60 questionnaires students (7 th grade)
	2 interviews: director + school teacher

	2 interviews: medicines of the health centers
	1 focus group women association of Garalo
	1 focus group electricity committee
Bladiè	10 questionnaires households without electricity
	3 questionnaires different micro-enterprises
	3 interviews Jatropha farmers
Zantièbougou	8 questionnaires households without electricity
	4 questionnaires different micro-enterprises
	2 interviews Jatropha farmers
Kabila	2 questionnaires households without electricity
	3 questionnaires different micro-enterprises
	3 interviews Jatropha farmers
Bamako	Interview with ECOFIL
	Interview with AMADER
	Interview with ACCESS

3.5 SAMPLE SELECTION

3.5.1 VILLAGES

In this research four villages are compared. The first one is Garalo, the village on which the expansion of the project is based; the other three villages are included in the BC-10 villages, ten villages which will get electricity in the near future. Because of the amount of time, it was decided to take three villages of the project. Only Garalo has partly access to the electricity grid. The other three villages are still not connected to the network. An important issue for the selection was the geographical location and accessibility of the village. The villages had to be situated within a certain distance to travel by motor together with colleagues of the Mali Folkecenter which were working as facilitator and translator. Another criterion was the diversity of the villages. Bladiè is a smaller village, situated in a remote area with poor road conditions. Zantièbougou is a village which is more developed, situated on the main road between the regional cities of Bougouni and Sikasso. Kabila is a village with prospects for the future; situated on the main road (poor condition) between the cities Bougouni and Kolondièba.

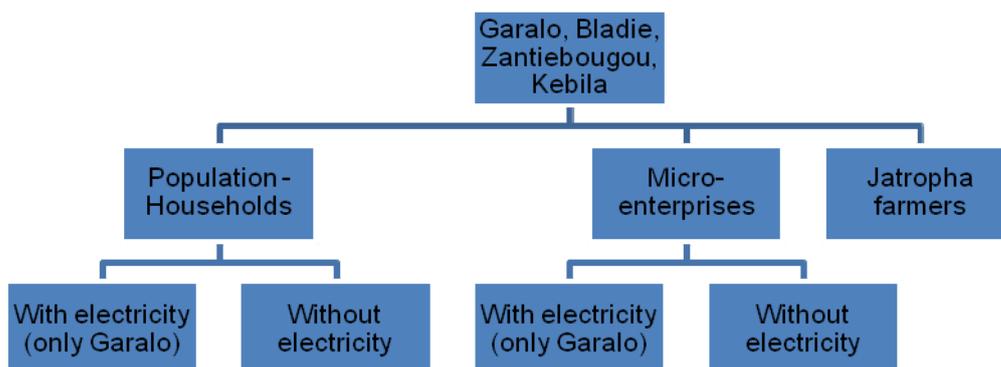
3.5.2 POPULATION

For the selection of households, different sample selection methods were used in the different villages. In the village of Garalo, interviews were done with households ‘with’ electricity. A systematic sample frame was used; a sample in which the sampling frame is arranged in order, and then every n^{th} unit is selected (Research for development, 2010). A list of all people connected to the grid was available. The list comprised 340 connections in February 2011. To speak with 20 different households, every 17th person on the list would be interviewed. With the selection of 20 households, a meeting with village leader was hold to make a welfare definition and ranking. In case people were not available for a longer period of time (some were migrated for work to other areas), the next person on the list was interviewed.

For households without electricity it was not possible to make a systematic sample frame. The government did not have a street plan or a list with all households. Finally a cluster sample was chosen. In all villages, the village leader identified the different households to interview, they all had to choose households with a different economical situation; 3 persons ‘rich’, 4 persons ‘middle income’ and 3 persons ‘poor’.

The Jatropha farmers are chosen by the MFC employees of Garalo and Zantièbougou. They chose the farmers randomly among a group of farmers that had produce a certain amount of seeds in 2010. The micro-enterprises with electricity in Garalo were available on a list of the MFC. All of them were interviewed. Micro-enterprises without electricity were chosen randomly.

3.5.3 SAMPLE OVERVIEW STRUCTURED INTERVIEWS



3.6 TRANSLATOR

Having a good translator is important for the reliability of the research. A translator has to be independent and should not use his own vision. The research in the four villages had to be done together with a translator, as the national language is French, but only a small number of people are speaking this fluently. The spoken language in the research area is Bambara, one of the local

languages. Different Malian internship colleagues of the Mali Folkecenter translated the interviews. Some of them lived in Garalo for more than half a year, others arrived in January.

3.7 CONCLUSION

Because of the involvement of different groups of inhabitants of the villages, a clear overview can be given in the next chapters. Different methodologies are applied to get a diverse overview of the impact electrification will have on the population. With all the semi structured interviews, unstructured interviews and focus groups, an answer can be given on the stated research- and sub questions.

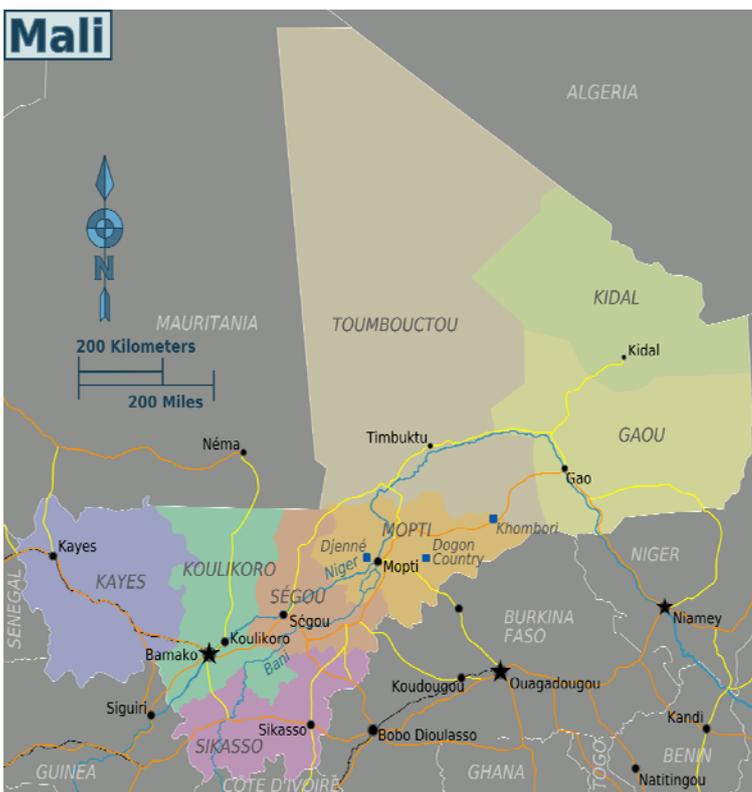
4. REGIONAL FRAMEWORK

4.1 NATIONAL CONTEXT

Mali is one of the largest Sub-Saharan African countries located in the middle of West-Africa. Mali's surface is for 65% situated in the desert or semi-desert. The country is divided into three natural zones: the southern, cultivated Sudanese, the central, semiarid Sahelian and the northern, arid Saharan. In general, the country knows high temperatures and high wind velocity. Mali is landlocked and surrounded with the countries; Senegal, Mauritania, Algeria, Niger, Burkina Faso, Cote d'Ivoire and Guinea. Mali is divided in eight regions, which have several departments (figure 4) Mali has a population of 14.1 million, of which 64% is living in rural areas (World Bank Report, 2011/CIA, 2011/MDG, 2007).

Figure 4: Departments of Mali

Source: Wikitravel.org, 2011



Where most of the population is living in rural areas is the main source of income for the Malian population agriculture; farming and fishing is the main source of income for 80% of population. Because of its landlocked situation, the importance of the Niger River enormous, most economic activity is largely confined to this area.

Mali is heavily dependent on foreign aid and exports. Export product as gold and cotton are highly vulnerable to fluctuations in world prices (Trading economies.com, 2011/ CIA, 2011). The government has continued an IMF-recommended structural adjustment

program (SAP) that has helped the economy grow, diversify, and attract foreign investment. Mali is developing its cotton and iron extraction industries to diversify its revenue sources because gold production has started to fall. Economic growth in Mali was also negatively affected by an unstable situation and continued unrest in neighboring Côte d'Ivoire, high oil prices, and lower-than-expected gold production. Because of different problems in their neighboring countries, remittances which are also important for the population are decreasing (CIA, 2011).

Since 1997, Mali's government has shown a strong will to fight against poverty. In many policies a focus was created by the national anti-poverty strategy (SNLP). Regarding the Human Development Report (2010), Mali is developing but is still far behind other countries on the African continent. An index of 0,309 compared with 0,389 of Sub-Sahara Africa points out that on the basis of 'a long and healthy life, knowledge and a decent standard of living' (HDR, 2010), the basic standards are still lacking in Mali.

4.2 MALI AND ELECTRICITY

Although the basic standards are still lacking in Mali, a progress can be seen. An example related to the electrification is the increasing amount of internet and mobile phone users. In a larger covered area telephone and internet connections are seen (table 3). The CIA (2011) is indicating the unreliability but improving domestic system. There is an increasing use of local radio loops to extend network coverage to remote areas. The use of the fixed-line subscribership remains very low. The population skipped the fixed lines and is using with higher numbers (30 per 100 persons) mobile-cellular phones.

Table3: Telephone and internet users

Telephone subscribers, total (per 100 inhabitants)	2008	26,4
Telephone subscribers, total (per 100 inhabitants)	2005	7,1
Telephone subscribers, total (per 100 inhabitants)	2000	0,5
Internet users (per 100 inhabitants)	2008	1
Internet users (per 100 inhabitants)	2005	0,5
Internet users (per 100 inhabitants)	2000	0,1

Source: HDR, 2011

An improvement in some facilities can be seen in recent years, but still many African countries are dependent on traditional biomass fuels (wood, carbon, dung), these biomasses are the major source of energy in Mali. Four countries of Western-Africa are shown in Table 4, to point out the energy balance and the traditional energy consumption. It can be concluded that, like the other countries, Mali its energy consumption is low, while its dependence on traditional energy resources is incredibly high.

Table 4: Energy balance and traditional energy consumption in some Saharan countries

Country	Total energy consumption (million Toe)	Traditional energy (%)
Burkina	1.7	91
Gambia	0.263	90
Mali	1.8	90.4
Niger	1.1	80

Source: Maiga et al. 2006

The dependence on especially wood fuels causes a deforestation rate of 400.000 ha a year. Firewood is especially used for the major sources of cooking and heating. In many developing countries, already the demand for fuel wood is far greater than the supply. Table 5 gives out the fuel used for cooking in rural area in some Sahelian African countries. From the table we can see that in Sahelian countries, firewood is the most used fuel which can be very dangerous for the environment of these desert countries. The table also shows the inexistence of electricity in the rural area for cooking.

Table 5: Fuels used for cooking in rural households for some Sahelian countries

Country	Firewood (%)	Gas, kerosene (%)	Charcoal (%)	Electricity (%)	Others (%)
Burkina Faso	91	2	4	0	0
Gambia	97	1	1	0	1
Mali	97	0	0	0	3
Niger	90	1	0	0	9
Senegal	84	1	12	0	1

Source: Maiga et al. 2006

Its connection to the grid and its production, 515 million kWh, and consumption, 479 million kWh, is extremely low, with a world rank of 158/163 (CIA, 2007 est.). In 2001, only 2.75% of the poorest 30% households were connected to the electricity grid, compared with 72.6% for the three richest deciles (Table 6). The connection rate for the two top deciles (25.54% and 28.75%) is much higher than for the poorest groups (0.3% and 0.4%). The low connection rate of the poor is partly explained by the fact that most poor households live in rural areas, beyond the reach of the grid (Boccanfuso, 2009)

Table 6: Household electricity access by deciles

Decile	Number (percentage) of households without electric meter (89.5% of all households)	Number (percentage) of households with electric meter (10.5% of all households)	Total
1 (poorest)	91,562 (9.38)	317 (0.28)	91,879 (8.42)
2	127,935 (13.1)	634 (0.55)	128,569 (11.78)
3	107,813 (11.04)	2,211 (1.92)	110,024 (10.08)
4	111,009 (11.37)	2,601 (2.26)	113,610 (10.41)
5	114,745 (11.75)	7,578 (6.6)	122,323 (11.21)
6	101,475 (10.39)	7,333 (6.38)	108,808 (9.97)
7	97,122 (9.95)	10,812 (9.41)	107,934 (9.89)
8	94,822 (9.71)	21,024 (18.3)	115,846 (10.62)
9	67,093 (6.87)	29,345 (25.54)	96,438 (8.84)
10 (richest)	62,661 (6.42)	33,031 (28.75)	95,692 (8.77)
All	976,237 (100.00)	114,886 (100.00)	1,091,123 (100)

Boccanfuso, D et al. (2009) from *Enquête Malienne d'Evaluation de la Pauvreté, 2001*

4.3 BIOFUEL POLICY

Where energy is essential for economic development, it is important to make use of natural resources as energy supply, Mali can, just like other African countries, provide for most of its energy needs from renewable sources (OECD, 2007). The Malian climate does have good conditions to work with renewable energies; the climate is dry and hot with intense solar radiation 5–7 kWh/m²/day and high wind speed about 3–7 m/s in the north (Maiga, 2006). This makes various renewable energies possible (annex 1).

Worldwide, at least 45 countries have policy targets for renewable energies. One of the ten developing countries focusing on a biofuel policy is Mali. But the Malian government does have problems to define its goals regarding its biofuel policy (Brew-Hammond, 2008). With the help of the United Nations, the 'Poverty Reduction Strategy Paper' (PRSP) was adopted in 2002 by the government and people of Mali. These strategies had several key strategies to the use of sustainable electricity. The main strategies of the PRSP are (MDGI, 2007, Brew-Hammond, 2008):

- ❖ production and distribution of low cost electricity
- ❖ increasing the population served by electricity
- ❖ reducing wood consumption through use of improved equipment and alternate fuel sources
- ❖ implementing a program to promote solar powered and photovoltaic equipment's for a large share of the population

The importance was put on an increased access to electricity and to reduce the traditional energy resources. The use of biodiesel is not stated directly, but it can be concluded that the

government has the intentions to promote biodiesel. Implementation strategies by the UN and the National Government are(MDGI, 2007, Brew-Hammond, 2008, Maiga, 2006):

- ❖ development and provision of cost effective energy sources including renewable
- ❖ awareness-raising among the population about the use of wood-substitute energy sources
- ❖ development of natural forest for energy use

Because of the rapid desertification process in the country, many NGOs together with the government, are playing an important role to introduce renewable energies and biofuels. Currently, all biodiesel projects are based on Jatropha. Because of its drought resistance, Jatropha can become an important resource for the electrification of Mali. The local production means local employment, and local generation of income (Stenkjeer, 2010/ PRSP, 2008 / Gualberti, 2009). One of the first NGOs in Mali focusing on biofuel projects is the Mali Folkecenter. They are playing an important role in the introduction of Jatropha in the country and are on the forefront of promoting Jatropha as an alternative fuel in rural Mali by producing and using the oil locally (more in chapter 5). The first project in Mali, which make a linkage between renewable energy and development (for women), started with the United Nations Development Program (UNDP) and the Internal Fund for Agricultural Development (IFAD) to support of the Mali Multifunctional Platform (MFP). This project provides decentralized energy to rural villages in response to women's associations' requests from these villages. The MFP consists of a small diesel engine mounted on a chassis. To this engine many electric equipment can be attached that are used by the local population. Examples of electric equipment are; grinding mills, battery chargers, vegetable or nut oil presses, welding machines and carpentry tools. This large scale project was originally working on diesel, but currently works with Jatropha oil as co-fuel. The final purpose was to run the engines for at least 15 percent on the oil extracted from the Jatropha plant. With the support of the UNDP, the number of MFPs in Mali reached in 394 engines in 2004 (Burn&Coche, 2000 in Panjwani, 2002, Brew-Hammond, 2008).

5. PROJECT CHARACTERISTICS

In this chapter an overview will be given on the current local situation. An outline will be given on the implementation of the project, and an overview of the villages included in this research.

5.1 PROJECT DESCRIPTION

The electrification project in Garalo is set up by the MFC, which has been actively working on the promotion of the Jatropha plant since 1999. MFC has started the Jatropha project in the village of Garalo in December 2006. One of the village leaders, Mamadou Kané, met the president of the MFC Ibrahim Togola and was requesting MFC for many years to implement electricity in his village. The population desires and efforts convinced MFC to start with the implementation of the project.

The MFC started a Jatropha project aimed at supplying electricity to the village by using oil from the Jatropha plant as fuel for generators. The project has installed 300 kW of power in the village.

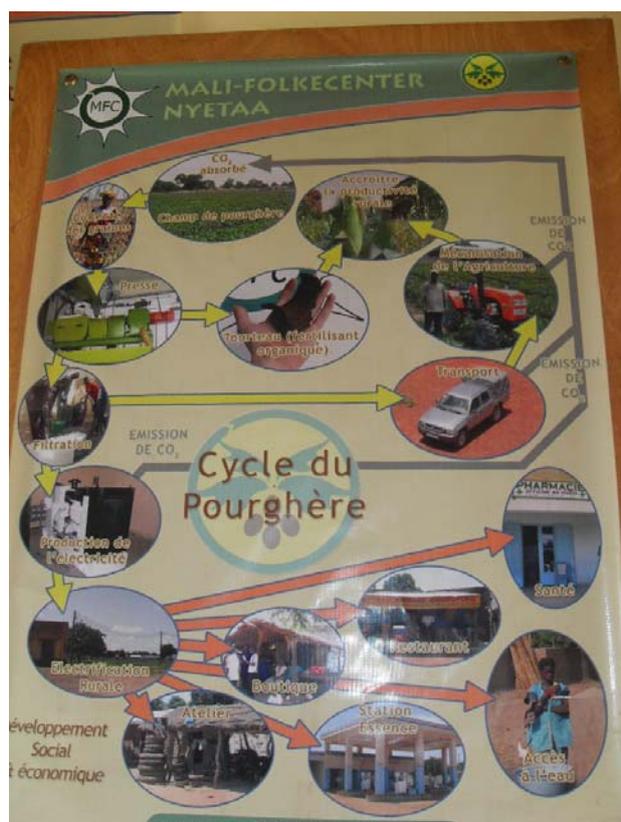
Based on the huge potential of the Garalo model, MFC managed to find support for a 10 village project, Bagani-Courant 10 (Jatropha power). By implementing this 10 village project, a bigger part of the population could benefit from having electricity. Also these villages will make use of clean power produced from Jatropha as a tool for local economic development. The project will be implemented step-by-step, in the year of 2011 five villages must have access to electricity, and the other five villages will get access one or two years later. Currently three new power plants are finished, two others are under construction.

5.2 OBJECTIVE

Goal Garalo project: The goal of the project is to change the living conditions for the rural population and to provide electricity to the whole village of Garalo of 10.000 inhabitants.

Goal BC-10 project: The global program objective is to reduce poverty levels for 50.000 people in and around the ten villages. The goal of the project to provide electricity to the population of all villages based of the biofuel Jatropha. The Jatropha is locally produced and which can a value to local produce and can contribute to improved livelihoods and a sustainable future.

Photo 1: Hypothesis of the MFC regarding the Jatropha cycle in Garalo



Source: G. Dekker (2011)

5.3 LOCATION AND INTERVENTION AREA

The Garalo project is only focusing on the village of Garalo, situated in the region of Sikasso and the district of Bougouni.

The BC-10 project is implemented in the two southern regions of Mali, in the region of Sikasso and Koulikoro.

In the region of Sikasso:

- District of Bougouni: villages of Manankoro, Zantièbougou, Oure, Kologo, Bladiè, Kola & Tabakoro
- District of Yafolila: village of Filamana
- District of Kolondieba: village of Kebila

In the region of Koulikoro:

- District of Kolokani: village of Didienie
- District of Kati: village of Bougoula

The field research is situated in the region of Sikasso. The region of Sikasso is divided in 7 circles, 143 communities and 1821 villages. The research is done in the circle of Bougouni with the

communities Garalo, Bladiè, Zantièbougou and the circle of Kolondiéba, with the community Kebila. In this research a comparison is made between the electrified village of Garalo, the village on which the expansion of the project is based, and three villages not yet electrified villages; Zantièbougou, Bladiè and Kebila. A criterion for the comparison was the diversity of the villages; Bladiè is a smaller village, situated in a remote area with poor road conditions. Zantièbougou is a village which is in development, situated on the main road between the regional cities of Bougouni and Sikasso. Kebila is a village with prospects for the future; situated on the main road (poor condition) between the cities Bougouni and Kolondiéba (Table 7). (INSTAT, 2009)

5.4 ORGANIZATION

The implementation of the BC-10 project is done by ACCESS, a Malian energy service provision company, which is established by the MFC (Mali-Folkecenter Nyetaa). Other participants and (financial and educational) contributors of the project are; AMADER (Agence Malienne pour le Developpement de l'Energie Domestique et de l'Electrification Rural), SHGW (Netherlands), Fact Foundation (Dutch organization specialist in biofuels) and the DOEN Foundation (Dutch financial supporter)².

The MFC is giving support and advice to the local Jatropha farmers association. They are working together with 180 farmers in Garalo, 37 farmers in Bladiè, 18 farmers in Tiemala-Banimontie and since 2011 with the communities of Sibirila and Ninindougou.

5.5 TARGET GROUP

The goal is to reach 50.000 inhabitants in the different municipalities. Half of them will benefit from the access to electricity and an increased income from the Jatropha production. The other half will benefit of an increased income due to Jatropha production.

5.6 DURATION

The whole process started in the beginning of the twenty first century, when one of the village leaders was lobbying at the MFC. The first official steps of the Garalo project were in 2005 (AMADER, 2008):

- Exercise date of the Preliminary Permit: 09/06/2005
- Date of signing of the agreement: 21/07/2006
- Date of establishment of the consideration: 05/01/2007
- Date of commissioning: 01/01/2008

² Overview of host organizations in Annex 1

In September 2007 the first 87 clients in Garalo got connected to the local grid. They started with 3 hours of electricity a day. After 3 months the amount increased to 5 hours electricity a day. Subsequently, this was increased to 8 hours when the amount of 200 connections was reached. After having 300 clients, regarding the schedule the amount of hours have to increase to 10 hours and so on. At this moment (May 2011) 340 households are connected to the grid. Since the first of April 2011 the schedule runs from 16h00 till 1h00 (=9h00).

Total planning for the BC-10 project is 5 years.

5.7 BUDGET

The Garalo project is estimated on 255,7 million Franc CFA of which is 191,8 million Franc CFA coming from AMADER and 63,9 million Franc CFA from other promoters.

The estimated costs for the BC-10 project are 4.500.000 Euro which is financed by DOEN Foundation, SHGW and 10 percent AMADER grant)

5.8 TECHNICAL ASPECTS

In all villages an electricity power house will deliver the electricity. In Garalo the electricity power house has three engines of 100 kW. Next to this it has a press that converts Jatropha seeds into oil. In some villages the installation will be equal; in others the power house will be smaller than the one in Garalo.

The network dispersion in Garalo is: 18 km. This means that a big part of the village is connected to the grid. Remote areas are not connected to the grid.

Used oil in the engines:

- Diesel: 6000 liter every 45 days
 - The diesel price was in 2006: 400 FCFA per liter, in 2011 is this 650 FCFA.
- Oil: 20 liter since January 2011 (till May)
- Jatropha: 86 liter used in 2010 = 300/320 kg of seeds. 12 ton of received seeds are given away to the new Jatropha farmers (A. Tounkara, 2011)

5.9 ELECTRICITY COMMITTEE

The timetable and the amount of hours are decided by the electricity committee of Garalo. They are the connection between the local population and the energy company ACCESS. When there are problems from both sides, these are passing by this committee. They proposed for example the increase of hours. They do also think the consumption by night of households is much higher than by day of small enterprises. The best option they are giving for another extension is one hour earlier and one hour after the current timetable.

Table 7: Overview researched villages

Village/ aspect	Geographical	Social-cultural	Economic	Health care	education	Electricity situation
Garalo	on the main road RN9; 55 km of Bougouni - Manankoro 673,200 km ² 30 villages	19.880 inhabitants Peulhs, Bamanan, Sarakolés	Agro pastoral, agriculture. Cattle, forest exploitation	1 CSCOM 1 pharmacy of the CSCOM 1 maternity 2 private pharmacies	5 first cycle 2 second cycle 26 community schools	Since 2007; 16h00 - 1h00
Zantiébougou	Main road; 27 km of Bougouni - 187 km of Sikasso 1500 km ² 42 villages	31.316 inhabitants Bambara, Peulhs High migration	Agriculture, cattle, forest exploitation, commerce.	1 CSCOM	6 first cycles , 1 second cycle, 43 alphabetization centers	In July/august 2011
Bladiè	15 km east of Garalo. In the circle of Bougouni 4 villages	2.888 inhabitants Peulhs	Agriculture, cattle, fishing, forest exploitation	1 CSCOM 4 water forages	1 first cycle, 1 second cycle, 3community schools	2011/2012
Kebila	Main road Zantieboukou - Kolondieba Circle of Kolondieba,	23.580 inhabitants (1998)	Agriculture			In July/august 2011

6 IMPACT OF RURAL ELECTRIFICATION ON VILLAGE LEVEL

Part of this research is the impact evaluation of the rural electrification project. Different perspectives of actors in the village of Garalo are included to give an overall image of the project. Regarding literature, electrification can have a positive impact on many different aspects which are influencing the wellbeing of a single person or on the village in general. To make an impact analysis of the electrification, a comparison is made between the village of Garalo (partly electrified) and three not yet electrified villages: Zantièbougou, Kebila and Bladiè. All villages are lacking many facilities, but the villages do have several schools (primary & secondary), health centers (and maternity) (overview table 7), churches and mosques and once a week a big market.

6.1 STREET LIGHTING

One of the first observed big differences between the villages is the street lightening. In Mali, it starts to get dark at 19h00. Without full moon, the villages are dark and activity stops. Street lightening and lightening of public buildings have a big impact on the (social) activities observed in the researched villages.

A.Toukara moved to the village of Garalo in 2006, just before the village got electrified. He has seen the difference before and after the electrification: *'there is a huge difference between Garalo now, and 5 years ago. I had to work for several hours a day in the power central, I had some dinner at 19h00 at a small restaurants and I went to bed. The village was deserted. Nowadays we can see many activities: enterprises are working till late, we can have a drink at the bar and we go to bed just before the electricity stops. Before, only on Sunday evenings more activities were going on, as big trucks, going to Ivory Coast stopped and caused some activity by night in the silent city of Garalo'*.

Observations were made in the villages of Zantièbougou and Bladiè where, it became silent at 19h00, the same as Garalo five years ago. All public buildings were closed; there was not any street lightening. Only some of the households were eating or reading near a Chinese lantern and a woman was cooking with a small torch. Furthermore many people in the village went to bed early to weak up very early the next morning.

The population has an increased feeling of security. Where the roads are in all villages in a bad condition, it is especially for the safety of bikes and motorbikes important to light the roads. Also having lights at the street are an enormous contributor to the common sense of a better security.

In Mali many snakes and scorpions are seen on the street and in houses which are dangerous. Also the population in Garalo does indicate a lesser amount of crime in their village.

6.2 IMPACT ON PUBLIC FACILITIES

Since the electrification of Garalo, some public building got lightning; several mosques, the town hall, the hospital and the library. Most of the buildings are used by a big part of the population. People can go to the mosque to pray in the evening and they can make use of some facilities (like photocopying) in the town hall. The population have the possibility and are invited to work and study in the public library, but according to the school director the population is not making use of this offer: *'The people prefer watching TV or do other things, the library is electrified, but most of the evenings it is empty there'*. Probably the population is tired after a whole day of working in the field. This is also one of the reasons the schools are not electrified. The school director also states here: *'When the population is not eager to go to school by night, it is not a priority to electrify them, we would like to offer evening classes, but the population prefers to watch television'*.

Healthcare is an important part of the Millennium Development Goals and an indicator for the development and well-being of the population of a village. Also other literature states the importance of electricity to improve healthcare. Three of the MDGs are related to health care and facilities. With having a lower workload for women and girls, they have more possibilities to go to school, which will increase their knowledge and independence and improve the health situation of themselves and their children. This impact on electricity is thus related to the population, but also the health centers itself are benefiting. According to two doctors of the health centers in Garalo the use of electricity in health centers is very important. They are using a fridge to keep vaccinations and they are using lights for working by night. The doctors are indicating the importance and necessity of the electricity for their work. They really see the importance of having access to the electricity 24/7.

The centers are especially profiting by using the electricity in the evenings. Lightening is really advancing their work. Especially in the delivery room, it is important to have strong lights. In periods with cloudy or rainy weather, when the solar system is not working optimal, the medicines have to work with a head torch. Giving a women birth with a torch is not an ideal situation.

Photo 2: Lights used in maternity room

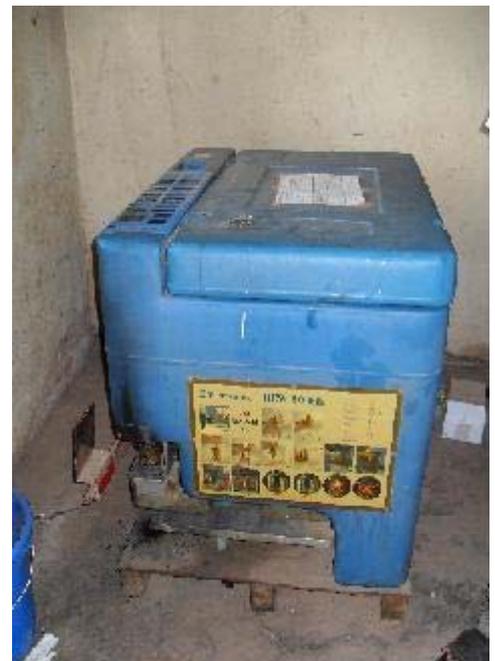
Source: G. Dekker, 2011



In one of the maternity, which exist since 2000, they only have access to the grid since five months. Before, they were using a solar panel and a storage battery from 20h00 till midnight. Now they are using the battery only from 1h00 onwards. Before having electricity they only used two lamps. At this moment they are using five lamps which can facilitate their work in the evening. Working with electricity is reducing their energy bill each month, but still they are depending on other energy sources as gas or petrol. Working with different energy sources is sometimes giving even more problems than before. The doctor is giving two examples; *'Once in a while there are problems with the conversion of the fridge from gas to electricity or the other way around, where the fridge was not cooled for the whole night'*. Or: *'Sometimes one of the cables was not well connected to the fridge, while changing these'*. That is one of the reasons the doctor stressed the importance of having electricity 24/7. *'The electrification it not as a gift to us, having electricity is not a luxury product; it's really a necessity to do our work'*.

Photo 3: Fridge at the hospital

Source: G. Dekker, 2011



Nowadays the electricity is also used to cool the vaccinations in a special fridge. Before and after the electricity use, the cooling process is working on gas. Before the electricity connection, the fridge worked totally on gas, which costs more money. The money they pay know on electricity is 7.000 to 10.000 FCFA a month, while the gas cost 16.000 a month.

Most of the households do have access to visit the doctors. Health insurance does not exist, therefore the population has to pay themselves for every visit, treatment and drugs. Most of the treatments are for people with malaria, bacteria and diarrhea. About 7 to 8 people are scheduled every day in the general health center. 2 to 3 times a month people are coming with burning wounds or other problems causing by cooking, often those are children which are burnt by the stove. At time of research the national government spread anti mosquito nets all over the country to protect especially children against malaria. Announcements for this campaign were made on the national television and radio.

One of the basic needs for a healthy life is clean drinking water. Garalo has one big water basin. Mahamadou Kané is the director of the Water Company, he takes care that the population has access to clean drinking water every day. Many households still have a well, but nowadays many people do have access to tap water, which is cleaned and thus safer to drink. To pump up the

water, they are making use of an engine that works after 16h00 every day. In busy and dry periods, the basin is emptying fast. On Mondays, the market day, all households taps are closed when too much people want to make use of it. He states the necessity to increase the volume of the basin or to have a second one. Before the electrification there was a huge lost of energy use. 240 FCFA each hour lost compared with the use of electricity instead of diesel. Before the electrification 200 liter of diesel was used every month, nowadays only 40 liter is necessary for the times it has to work before the electricity works. Furthermore does the engine making less noise, it costs less physical work, it reduces the CO2 emission. For the use of water for the whole village, it is a huge advantage to work on electricity than on former sources of energies.

6.3 INCREASED INEQUALITIES

On the village level we can see many positive impacts. Especially street lightening and lightening of public buildings is influencing the whole population on a positive way. But a problem is the extension of the grid. Not every neighborhood is connected to the local grid. In these areas the population cannot benefit from the streetlight and the households are not connected to electricity at home. The connected areas can develop and increase economic activities and benefits, the non-connected areas stay behind, when living without electricity; the possibility to buy equipment to facilitate and develop their life. Most of these areas are already situated in a remote area, where the population already has less economic means.

7. IMPACT ON THE LOCAL MICRO-ENTERPRISES

In this chapter will be distinguished the impact on micro-enterprises. Where ninety percent of the population is working in agriculture, are there still some people working in other sectors, for which the availability of electricity is important. A basis of development is economic growth. Economic growth can be created by the micro enterprises in the villages. Making use of electricity can have an influence on the production and clients of the small company. In the research a comparison is made between enterprises with and without electricity. When compare both, enterprises with electricity are far more developed than enterprises without electricity. In Garalo eleven enterprises are making use of electricity. With all these micro-enterprise interviews are done. Especially small restaurants, carpenters and tailors were presented on the list. Those are compared with the same kind of enterprise without electricity in Garalo, Bladiè, Zantièbougou and Kebila.

7.1 RESTAURANTS

In all villages we can find small restaurants, where women are selling (cold) drinks and food like aloko (fried banana), meat, fish and rice. Almost all restaurants want to increase their business. Some need a refrigerator, new (electric) material and even new furniture.

They all see the importance of having electricity. Having strong lightening will facilitate the work. The women in a small restaurant in Zantièbougou had to work with a torch by night. Having good light will also increase the amount of customers.

Another important object is the fridge. When having a fridge, your daily income can increase enormously. One small restaurant in Garalo was just situated two restaurants with electricity and with a fridge. Because of some problem she couldn't pay her electricity bill anymore. But without the electricity her income is only reducing. All customers are buying food in combination with cold drinks at her neighbors.

Photo 4: Small restaurant with electricity in Garalo Source: G. Dekker, 2011



The women of the different restaurants would like to have more (electric) equipment to cook with. When selling drinks like 'gingembre', it would be a big advantage when having a simple device. Also literature states the time saving regarding to electricity when using equipment. The women do not sell enough to buy electric devices to increase and facilitate their work.

While new sources of energy and the using of electricity is available, are still all women (with and without electricity) making use of wood fuel to cook with. Every month, each restaurant is using between four and thirty trailers with wood to cook. Only a few women are making use of charcoal to cook and batteries to lighten their place.

The electricity use for the small restaurants is thus not replacing former kinds of energy fuels. It is an advantage for their job; it is a source for development and for facilitating their work. Especially the fridge is an important source for income and development for the women. They did all see the importance of having a fridge and they were really thinking that working more hours a day and selling cold drinks could boost their enterprise.

7.3 CARPENTER

Another job, highly presented on the list and present in every (small) village are the carpenters. Also all carpenters wanted to increase and develop their micro-enterprise. The carpenters are selling products like doors, tables, chairs, bikes, motors, trailers and ploughs. For increasing their production and to develop their enterprises, they want to have new and better (electric) materials.

Photo 10: Carpenter at work at 15h00, making use of diesel for welding

Source: G. Dekker, 2011



They all indicated the importance of the electricity. Two forms of development can be seen. First of all, an increased production per day:

- They can work more hours a day; they can work by night with strong lightening
- When having electric equipment their production will go faster

Secondly money saving when using electricity:

- It will save time and money when not using a generator
- While using electricity in staid of former energies the

production will be less expensive.

One carpenter in Garalo was explaining ‘*Sometimes we are using a generator when needed, but this is quite annoying because the clients will have to wait for a while before the generator is working on full capacity. When we are using electricity we don’t need to wait before the engines are started up, we can start working directly. So when we have electricity we can produce much more things every day*’. It gives them an advantage in the amount of time which they spent on waiting for the equipment to work. For some activities they need ‘electric’ equipment to work. When this is sometimes now working on diesel or gas, this costs much more money than when it is connected to the net.

While all carpenters in Garalo are still making use of diesel, charcoal and wood, before 16h00, they are having a financial advantage compared to the carpenters without electricity. They are saving a lot of money while not using the generator all the time, but only in the morning. The three carpenters in Garalo with electricity are spending half the money on diesel, charcoal and wood fuel than before (table 8). They are not using batteries by night, but they have strong lights. It does save the carpenters time, money and effort when working with electricity.

Compared to the small restaurants, carpenters have a double advantage using electricity. It does increase and facilitate their production and work, and secondly, it does save them money compared with their former situation.

Table 8: Amount of energy sources spent each day or month

Electricity	Village	Energy kwh/month	Diesel Liter/day	Diesel Liter/day after electricity	Coal sac/ month	Coal sac/ month after electricity	Wood car/ month	Wood car/month after electricity	Batteries/ month
Yes	Garalo	16 kwh	7,5	3,5	10	5	2	1	
Yes	Garalo	45 kwh	31	21					
Yes	Garalo	50 kwh	5	2,5	2	0	1	0	
No	Bladie		3		30				
No	Zantiebouyou		4		2				6
No	Garalo		2		1,5				
No	Garalo		1						
No	Kabila		1		2				8

7.4 TAILOR

Also the tailors were high presented on the list for enterprises with electricity. Tailors are important in Mali, with every festival or special event, women and men are creating new outfits. The population is buying a piece of fabric and the tailor is creating a dress, skirt & blouse or trousers out of it. The five interviewed tailors all needed to have new, better and adapted

materials. They would especially use it for embroider they are making on the shirts and skirts. A machine is more precise, more advanced and finally when they can produce more, it can increase their income. Without the electricity they have to do the work with their foot (photo 6). *Photo 6: Tailor at work* *Source: G. Dekker, 2011*

Both of the tailors with electricity were spending 6000-7500 FCFA per month on their monthly electricity bill. All other tailors were making use of a solar panel, a generator and electric groups. Some were using coal for the iron (1 to 2 sacs a month). Some of the tailors did even had other extra jobs to earn a bit more (table 8). One tailor in Garalo with electricity indicated to spend less money than before. He stated that it does facilitates his work; *Before I was working with petrol light and torches, now I am using 2 strong lights connected to the grid.*



The other tailor in Garalo opened his shop on the day that the electricity arrived in 2007. He told not to work without electricity, because with his stitching-machine it is only possible to work with electricity. Now he prefers to have electricity during the day. In the morning he is doing some of the work by hand but he prefers to have electricity for more hours a day.

The other tailors can only dream by the use of electricity; they can work faster, they can earn more, the work will be less physical and finally they will have more clients. As the carpenter they will also have a double benefit while they will save money when using electricity instead of batteries, and the charging of their generator at home in staid of somewhere else.

Table 9: Amount of energy sources spent each day or month

Electricity	Village	energy price/month	Diesel /day	Coal sac/month	Wood car/month	Batteries/month	Solar panel kW	generator	Group electro gene
Yes	Garalo	23 kwh	41 --> 0,5						Yes
Yes	Garalo	16 kwh		2					
No	Kebila			1			50	12V	Before
No	Bladie		1	2		48		500 FCFA / jour	
no	Zantiebouyou			1		4	15	60V + 100V	Before

7.5 OTHER ENTERPRISES

Where the most common and presented micro-enterprises are outline above, are there more small enterprises in every village. Some exist since a long time in the village, some enterprises are only created since Garalo got electrified and they could use their equipment. One example is the new created bakery in Garalo. Many people want to have 'real' bread from a 'real' bakery. But for having a real bakery, electricity is needed. In Garalo, they started finally with the building of a bakery in May 2011. A baker from Zantiébougou also stated also the importance of electricity for his small company. Every morning and afternoon he is baking one type of bread, but his dream is to create real and different kinds of bread and pastry. He really believes in a huge increase of production, while nowadays many surrounding villages are passing by to buy some bread, when having a real bakery, all surrounded villages can enjoy his bread. But for a bakery electricity is needed, the oven must work on electricity and some special equipment is necessary to make the dough.

Another enterprise created because of the electricity is the petrol station 'Gatrola'. He started his company 4 years ago, and opened on the day Garalo got electricity. Next to the diesel, he is selling cement and oil to do something in the morning and the midday. Every night the machine is filling with petrol, on the day he is using bottles. When a truck is passing by and really needs fuel, he has to use the petrol pump by hand, a work what is really heavy and takes a lot of effort.

There are not many offices, at the municipality they are working with computers and at the micro finance office (of MFC Nyetaa) in Garalo. The office is working from 8h00 till 16h00, which are exactly the hours without electricity. The power starts working at 16h00, while the company cannot benefit from the electrification. The same was the case in another electrified village in the east of Mali. Those companies are using computers and need photocopying, but always have to work with generators. For those kinds of companies, which are not highly represented in the rural area, it would be a big financial advantage to work with electricity in staid of generators.

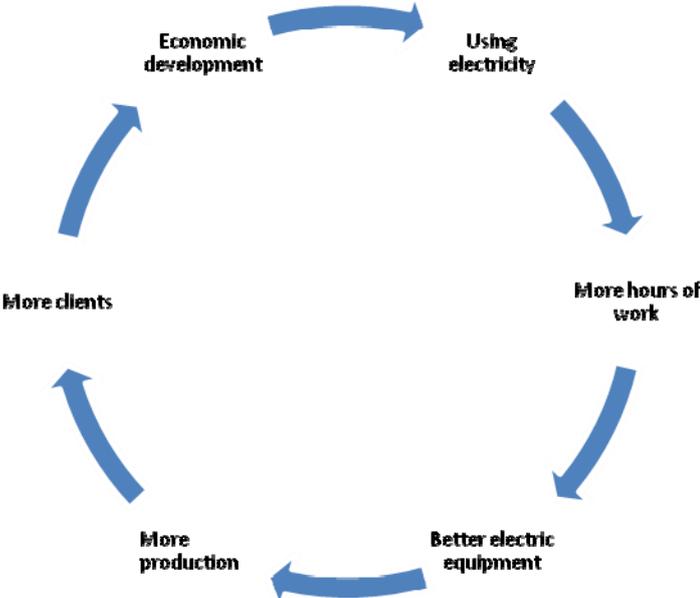
7.6 CONCLUSION

All micro-enterprises can work more hours a day. They can work with better and faster equipment. They can produce more, which will lead to more customers and economic growth. Nowadays many micro-enterprises are making use of diesel/oil, gas or coal, on which they are spending a lot of money. Working with adapted material for electricity, will save also a huge amount. When having no access to electric material, many employees are working by hand.

The work is heavy and cost a lot of power. Having material is facilitating the work, saves a lot of energy and will increase the production.

At the moment, the biggest benefit in Garalo is the usage of lights in the evening. The enterprises can produce and work for more hours a day. The village has only electricity from 16h00 till 1h00 and these times, the employees are working full time. They really want to make use of every second they are having access to the electricity, to benefit the most is possible. The problem is the current economic situation of many enterprises, they are lacking means to buy or rent electric equipment, equipment what can especially facilitate their work.

Figure 5: circle of electricity and development



8. IMPACT ON HOUSEHOLDS USE

The most important group users regarding the electricity association in Garalo are the households. Questionnaires and interviews are done with several households and children/students. Together with the focus groups with women, we can draw conclusions on the impact for the population. The electricity is starting in Garalo from 16h00 onwards, were families turn on the television and freezing their drinks. But the biggest part of the population is most of the time only making use of some tl-lights and a television at home. The average households are using is 8,5 kWh per month.

Table 10: Difference before and after electrification for households in Garalo (n=20)

Households in Garalo	Without electricity	With electricity
Total lights	137	191
Mean lights	6.85	9.55
Total Batteries	225	165
Mean batteries	14.06	9.71
Total radio	45	57
Mean radio	2.25	2.85
Total television	10	24
Mean television	0.5	1.2
Total fridge	1	7
Mean fridge	0.05	0.35

Most of the households are only using the electricity for lightning for their houses. People can work in the evening, and children can study by night. In the villages without electricity, many families went to bed early. Some did have torches on batteries or Chinese lanterns, but at many households it was dark from 19h00 onwards. Almost none of the households are making use of petrol lights. In some households many batteries are used each month. Having electricity would diminish their monthly energy costs which are spent on batteries. One small household in Garalo for example was spending more than 6000 FCFA each month on batteries for lightening his house and finding material by night. While he had a small house, it would cost him probably not more than 3000/4000 FCFA each month for the electricity. The problem this man indicated was the impossibility of saving money each month, he was buying batteries when needed and could

not wait till the end of the month to pay the electricity bill (more in paragraph 8.6). Only a few households are having a generator or solar panel. But when having a solar panel, generator and a satellite receiver, it is possible to watch Dutch television in the not electrified village of Bladiè (photo 8).

8.1 HEAD OF THE HOUSEHOLD AND HIS TELEVISION & RADIO

A huge part of the population loves to watch television. In the bigger families, everybody is watching together. Families start to watch television at 16h00, with children watching programs like SpongeBob, at 17/18h soap series for the women and at 20h00 and later the news, football and actuality programs on the French channels. Also on the street, people are watching television together. Especially when there are important football matches, all men are gathering to see the game. Watching television is a real way of leisure time, but in the meantime, it can increase their knowledge. In the villages there is no internet, neither

Box 1: Own experience of television and information

I'm sitting in a minivan on the way from Bamako/Bougouni to Garalo. The way is a bumpy road which takes 2 hours of 87 kilometers. It's 2 o'clock; the bus is stopping again. 'What's happening now?' many people gathered around a television. The whole bus is emptying. It's exciting, everybody is watching at a very small television, in a very small village without electricity and basic needs. There is only one small television in front of a small shop. Then everybody is shouting and jelling, everybody is happy! I am still asking myself, what happened? Finally they inform me; the population took the president of Cote d'Ivoire. People can go back, to practice their old job and to earn some money for their families. When we arrive in Garalo everybody is telling this big important news to everyone who wants to know. In Garalo, most of the people have to wait till 16h00 till the news is spreading around. The importance of the television is enormous at this moment!
Garalo, May 2011

newspapers. Watching television gives more knowledge about what is happening in the world. Before having electricity in Garalo had only ten out of twenty households a television. After the electrification seventeen households had access to the channels, with a total of twenty-four televisions. To make a comparison with the whole research group had forty percent of the households before the electricity a television compared with eighty-five percent of the households which had a television after the electrification.

Photo 7: Watching all together (black/white tv)

Photo 8: Watching Dutch television in Bladiè

Source: G. Dekker, 2011



All households and all 'older' men do have a radio at home. Only seven out of forty-five households did not have a radio at home. The radio is the first source of information, which works on batteries and is thus available and affordable for every family.

8.2 WOMEN AND HER FRIDGE

Next to the television in some households, we can sometimes also find a fridge. Having a fridge at home will lead to a stronger independence of women. The fridge at home is always used by the women. Not many households do have a fridge, before having electricity had only one household a fridge; after the electrification 7 households had a fridge in Garalo. All the women in the village of Garalo are doing commerce with the fridge. They are making locally preferred drinks like 'gingembre' and 'bissap', orange lemonade and cold/ice water. Everything a woman earns in Mali, she can keep herself. Often the children and the servant are helping to sell the drinks at school, on the street and at the market. With selling drinks, she can earn more than 1000 FCFA a day. For women of the focus group in Garalo, who are living without a fridge, it is really a dream to have one. Many women are seeing the advantage of having more independence, buying clothes for themselves and their children and the contribution to their household.

The literature states the importance of electricity for facilitating cooking. In Mali, the man is the head of household. He decides most of the time what is happening with the money and how to spend it. Most of the time, he prefers to buy a television then buying new equipment and material for the kitchen or a new stove. When a woman wants to have some new material, she has to facilitate this herself, with a minimum income. Most of the women are cooking on a traditional or improved stove with wood (photo 9 & 10), the average amount of wood used per month is 4,71 charettes (trailer). All households are collecting the wood themselves, when the women are going to their fields they collect the wood. Only a few households are making use of coal (6 out of 28) and nobody is using gas. Most of the women would like to cook on gas or electric, but they are also indicating the limitations of this. Most of the newer stoves are not adapted to the big amounts they are cooking for. Furthermore is the wood they are getting themselves for free, electricity, gas or coal they have to pay themselves.

The women didn't talk about other electric equipment they can use to facilitate their work. An article about women cooking in Mali (Ha, Porcaro, 2005) states that 'a platform service can save a woman anywhere between 1,0 to 3,3 hours of grinding per day'. It states that it saves a lot of time on milling cereals, ginger and de-husking rice, activities which women in the villages are doing several times a day. Having an electric stove or material could benefit the women in the villages a lot. But the current situation is not ready and adapted enough to make profit out of this.

Photo 9: Cooking on an improved stove

Source:

http://www.cilss.bf/predas/IMG/equipements/equip8_bf.jpg



Photo 10: cooking on three stones (with a torch)

Source: G. Dekker, 2011



8.3 CHILDREN AND THEIR STUDY TIME

The most important electricity use for the children of the head of household is the usage for studying. All men (with and without electricity) stated the importance of education and study time of their children.

There are several first and second cycle schools in Garalo. Children start going to school at the age of 6/7 year till 16/17 years. After the second cycle, students have to go to Bougouni, Sikasso or Bamako for higher education and university. Teachers are not well paid and are spending parts of their school time on their field to earn a bit more. Not all teachers are well qualified and some classes contain more than 120 students. When a teacher has so many children in one classroom, the time schedule is divided where some kids are only going in the morning and some only in the afternoon.

In the villages without electricity it is more difficult for the students to study. In Bladiè and Zantièboucou for example, all children went to school in the morning and evening. Afterwards they had to do their homework just before sundown or with a torch.

Also the parents do see the importance for the education of their children, all households were indicating an increased amount of time spent on studying. But not everybody is agreed on benefit of electricity. In an interview with a school director he states:

Q: Can you see changes?

A: Not really, children got worse...

Q: Are there evening classes?

A: Not yet, people don't want to use that

Q: How is the electricity used at school?

A: In the library and some classrooms

Q: Are the results of the children better than before? A: No, worse

The reason why the results of the children did not improve or even got worse he could not explain. The created leisure time by playing on the street or watching television can play a role. Other teachers do think to see better result at students who have electricity at home, but also this can be accidental.

Interviews are done with a geography/French teacher and with two directors of the different schools in Garalo. A short questionnaire is done with one 8th grade class (around sixty students). Both students and teachers are indicating the importance of the electricity for their families and village. When having a good light at home, students can study the whole evening and make their homework. *'We can learn more hours a day'* says one, and; *'It helped us learning our lessons and making our exercises'*. Many teachers are thinking to see an improved result of the children. They do think students are working more at home than before. Not every student does have electricity at home but they are studying together with class mates or at the houses of friends.

Also for the students is lightening the most important factor. The word 'darkness' was indicated by many students, which means probably that they don't see darkness anymore. Students are indicating having lights at home, they can see clear, they can find their stuff. *'Before we had to find our things with a torch, but now since we have electricity we don't need to find our things with a torch.'*

All children loved to watch television, and many households do have one at home. *'I learn my lessons and I love to watch television and movies'* is a statement often made by the students. Also they do like to have cold drinks; *'We now have a freezer and a fridge at home'*.

Also these children indicated the increased feeling of security; *'We can now follow thieves and the mosquitos'*. Some went a bit more into depth. *'The electricity helped us developing our economy'* and *'it changed an increased solidarity'* another; *'it gave freedom to men'* and *'it changes culture and life'*.

Fahirou Sangare, a girl of the 8th grade:

Fahirou is 15 years old; she is living with 10 persons in her family and has since 2009 electricity at home. They have 11 lamps and a television. She loves to go to school and to make her homework, even her parents are helping with this. The biggest change for her is having lights at home: *'Since the electricity came, the students were free, same as the village. The power gave many benefits for us. We are going to study our lessons very good and we make our homework every day under the light. Often we are watching television in our court.'*

Regarding all these reactions on the question: 'What is the biggest change for you after the electrification?' Many different reactions are given. The children are happy and satisfied having electricity. It does give them and their village a better feeling.

8.4 THE WHOLE FAMILY AND THE LEISURE ACTIVITIES

Since the arrival of electricity in the village of Garalo, the national television station ORTM has its network suspended. When having a bigger satellite receiver people can watch television coming from all around the world. One of the programs of ORTM is 'Top étoiles', a television show which visits different villages all around Mali where famous artists are performing. Garalo has electricity, thus it was also possible to invite the show. The whole village was preparing the show for days, people were totally dressed up and an enormous amount of people bought tickets to see the artist performing. Thanks to the electricity it was possible to put the village on television and to have a nice evening for the whole population.

Next to watching television loves the Malian population dancing and music and many parties are organized every week in the village of Garalo. The electricity has an important influence on the availability and possibility for organizing events and parties for the population. There are several DJs in the village which provides music and play at weddings, school parties etc. There is a huge difference compared with the village of Bladiè, where a youth leader (2011) told *'Without electricity it is really difficult to provide a party. There are so many children and teenagers who need a party. Sometimes we are organizing something, just with a cd-player on batteries. With electricity we can create our own big parties for all younger people'*. When there was a party at the secondary school in Garalo, many students and teachers from Bladiè also joined this party.

Photo 11: Top étoiles Source: G. Dekker, 2011

Photo 12: DJ Cam Source: G. Dekker, 2011



8.5 AT THE OTHER SIDE

All household are really satisfied having electricity or getting it in the near future. All head of households indicated one problem related to the electricity; the electricity bill. Many households did indicate the too high fixed price they have to pay every month. While when they do make a comparison with before the electrification, the amount of money spend is less.

The price the population in Garalo has to pay monthly is higher than desired. First of all, they have to pay a fixed price to get branched to the grid; 15.000 FCFA = €22,90. Furthermore the households have to do a first payment of 12.950FCFA= €19,77 (5 ampere) or 23960 FCFA = €36,58 (10 ampere). Furthermore the population has to pay their monthly bill. A fixed monthly price of 2.000 FCFA (€3,05) for the supervision and maintenance of the counter. A fixed monthly price of 500 FCFA (€0,76) for the public lightening and 210FCFA (€0,32) for every consumed kWh (till 1th of April 190FCFA/ kWh).

Depending on the number of clients, the hours of electricity will be decided. Before the 1st of April, the time of electricity in Garalo was from 16h00 till 0h00. After this date, it was increasing with one hour, till 1h00 (ACCESS Garalo, 2011). The bills are distributed every month and have to be paid within two weeks. not having paid for one or two months, will lead to the closing of the till a new 2.000 FCFA is paid. Most of the people (65.9%) were satisfied with paying every month. 22.7% wanted to pay the bill every two months and 4 households (9,1%) preferred to pay every trimester.

The pharmacist of the villages also complained about the payment of public lightening; *'I don't like to pay for the public lightening. I just want to pay for my own usage. I try and learn my children not to spend too much every month, but know I need to pay for others. I don't agree with that!'* He

told to feel save enough in his neighborhood and he states it is the responsibility of the municipality to provide public lightening, not some of the consumers only.

One of the problems is that the population is of origin used to pay when they have money. A big part of the households is disconnected one of more times since the electricity came in Garalo. They are not used to save money till the end of the month; they prefer to pay when they have the money provided. ACCESS states the possibility of paying in forehand, but the households do not have trust in those constructions and would just like to pay their monthly bill. In the raining season (especially August and September), most households (13/15) have indicated of having difficulties paying the electricity bill. .

8.6 CONCLUSION

In the villages without electricity, the population is in a hurry to receive it. All households and micro-enterprises reviewed wanted to make use of the electricity in the near future. All households with electricity in Garalo already wanted to increase the hours of electricity. Many people were happy with the extension from 0h00 till 1h00 on the first of April 2011. Small enterprises would benefit even more when the electricity starts earlier in the afternoon. The microfinance office of MFC Nyetaa is for example working till 16h00, when the electricity starts in Garalo. Their computers and other material are now working on a big battery, solar panel and diesel. Also other small enterprises could start their production process earlier in the day and benefit more.

Households are thus especially making use of the electricity by night. At 16h00 the television is on, at 19h00 lights are starting to work in the kitchen, in the court and living room. Street light is starting to work so people can drive and walk around without difficulties. Children can study on the street and people feel secure by night. Some women are benefiting from the independence with the commerce they are doing with their fridge. Also in other public areas people are able to gather. The population can pray at 19h00 under the light in the mosque and study in the library.

After four years of electricity in Garalo, more than 1/3 of the households is connected to the local grid. Many households in future electrified villages already subscribed and paid for their connection to the grid, which means a great dedication of the population and their trust in their future with electricity.

We can conclude that there are many positive impacts for the population when having electricity. Enterprises increase their production, enterprises and households are spending less money on the diesel of generators, batteries and charcoal.

9 SUSTAINABILITY

One of the primary conditions of the project is to run the power plant on sustainable energy with the production of the biofuel Jatropha. A sustainable electrification project, where the electricity is locally generated and locally consumed.

Jatropha is an already existing known crop in Mali. Some farmers had already some knowledge on the working with Jatropha and used it as hedges and for making soap. Others started to work with Jatropha to provide electricity in their village. When growing Jatropha plants in cooperation with the Mali Folkecenter, the farmers received free Jatropha seeds to start their work. After the cotton crisis of 2006 (the cotton price was enormous low), it was more feasible for the farmers to change their crops. Many farmers had still empty hectares and had the space enough to start to produce a new crop. The Mali Folkecenter provided them; small plants, seeds and a fertilizer, which made it easier to start the production of Jatropha seeds.

9.1 PRODUCTIVITY

The first farmers in Garalo started to produce Jatropha seeds in 2007, thus only four years ago. In 2010, in the BC-10 villages; Bladie, Zantiebouyou and Kebila, the farmers started to grow Jatropha. The Jatropha plant needs some years to grow before to produce optimal. After four years of growing only a few plants can deliver seeds and the amount of seeds getting from the Jatropha plant is still very low. The maximum production an interviewed farmer had in 2010 was 85.7 kg per hectare.

Not only is the early stage of the growth process of the plant is indicated as a problem by the farmers. Often they are lacking the use of (organically or chemical) fertilization. Most of the farmers are not making use of this. Many farmers do have a problem with termites and plagues of insects. Another problem seen by Konaté and the farmers is the bad maintenance of the fields and the cleaning of the field, which is a time consuming process and it does take a lot of effort

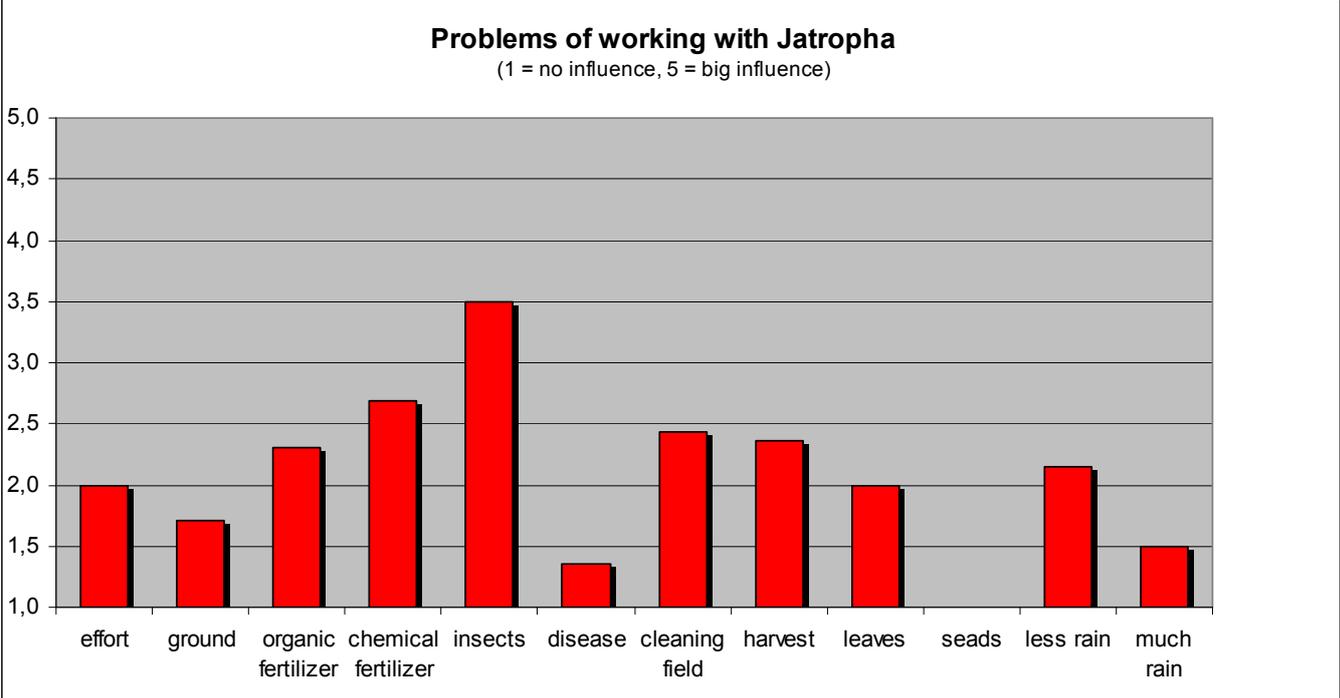
Photo 13 & 14: meeting with a Jatropha farmer, termites are destroying plants

Source: G. Dekker, 2011



(More other problems, table 11). The farmers do indicate not to collect all seeds, as reason that they can earn more money when working with the other crops. Furthermore they are still not earning with the maintenance of their field. They say it is difficult to maintain an area where you can not earn anything for more than four years. The farmers are putting a lot of money, time and effort in working with the Jatropha. The average the farmers spent in 2010 was 56.500 FCFA on their Jatropha field. Many of them indicated an increased work pressure compared with their work before the Jatropha.

Table 11: Opinion of 13 farmers who are producing Jatropha seeds



When working with a new crop many questions are asked regarding the land use and food production. The amount of time spent on the field compared with their other work is still low. The average of 2.88 ha of Jatropha (per farmer) compared to 15 ha of other crops can indicate a low change of land use; the Jatropha crop will only have a small an influence on the cultures the farmer is working with. Often is the Jatropha situated in a new, extra field whereby areas which are meant for food production will not get lost. Many farmers are intercropping by which fields do have a mixture of Jatropha and another culture; often is worked together with earth nuts, but some farmers are intercropping with haricots, sesame, anacardium (cashew) and many more crops.

9.2 PARTICIPATION

In the village of Garalo, MFC is working together with 180 individual *Jatropha* farmers, in total these farmers have 239,5 ha in total to work on (= 1,33 ha each farmer). The MFC is working together with the local *Jatropha* farmer associations in Bladiè and Zantièbougou. In the village of Bladiè, they are coming together two times a month to speak and discuss the production; they give advice to the *Jatropha* farmers and sympathizer how to maintain the field etc. They are following the process of starting up, collecting and more till three years after the start-up. To be part of the association the farmers need to pay 500 FCFA to subscribe, with the hope of joining them. In Bladiè the MFC is working together with 37 farmers, which have in total 32 ha. More farmers would like to join the association in the future (interview president of farmers, Bladiè). Furthermore is the MFC receiving seeds from the villages Tiemala-Banimontie (27ha) and new fields in the villages Sibirila & Ninindougou.

In the village of Bladiè collective fields are created; one for women and one for the 'older' men. The same project will soon be implemented in Zantièbougou. Everybody is contributing a little bit and the profit will be shared afterwards. Many more women want to join on the collective fields, but they don't have the time, money and means to participate.

Most of the farmers are happy with the participation of the Mali Folkecenter. Because of their intervention and support to work with the *Jatropha*, their village will get electrified. They did give the first seeds (1 kg) and fertilizer. Besides this, the MFC is giving information four times a year, and trainings for the farmers which are working with the *Jatropha* how to use and maintain the field. Most of the farmers are lacking materials to work on their field; they would like to have support from the MFC to provide this. They would like to have a tractor, plough or a trailer to facilitate their work on the field.

Photo 15 – 17: Jatropha field before(Feb) and after (Mai) rainfall & Jatropha seed.

Source: G. Dekker, 2011



9.3 FUTURE

All farmers desire to increase their amount of fields in the future. They often have spare land and can make a mixture of Jatropha together with other products. To facilitate their work they would like to have more and better agricultural material. They want to have a tractor, a trailer and a plough to facilitate their work. Some wanted to have working cows, others even a donkey. For protecting and increasing the productivity of their field some needed a product against the termites, a grill against animals, more water and fertilizers.

But what will happen with the production when they will not obtain above products? Will they continue working on their field? One of the biggest issues currently is the amount of money they receive for their production. The price given per kilogram is only 50FCFA/kg = 0.08 eurocent, where the price for corn or cotton is 250FCFA/kg. This is a fixed price regulated by the Malian government which will not change in a short amount of time.

Is Jatropha thus the right biofuel to work with? When other crops are selling three, four or even five times the actual Jatropha price. When farmers do not want to increase their Jatropha field and do not want to spend too much more time on collecting the seeds, how can the engines increasing the production from 5 to a 100 percent in five years? Are there other possibilities to let the engines work on renewable energies? Solar energy will be too expensive and will always be dependent on foreign aid, what can other biofuels and biogas bring in the future?

9.4 CONCLUSION

Many farmers are indicating to have a positive view on the future on their work with Jatropha. They all hope to have increased selling prices and many of them believe in a sustainable future and environment. Problems are actually the low selling price, the amount of time spent on the field, the problems regarding termites and insects, etc. will the production increase that much that the engines will work with a 100 percent on Jatropha? Question can be raised regarding the right biofuel and which other possibilities as renewable energies and biofuels the engines can work on.

10 CONCLUSION

This research master thesis will be concluded with an overview of the answers of the several questions researched. As a result a final answer will be presented of the research question that was the basis of the research and of this thesis: *What is the impact of a Jatropha-generated rural electrification project in Garalo, Mali regarding the benefits for the local population and its sustainability?*

In the year 2007, the electricity project was set up in the village of Garalo. With nowadays one third of the population connected to the local electricity grid progress is made in the village. On the aspects where Garalo is compared with three other villages; Bladiè, Zantièbougou and Kebila (where the electricity grid will be installed in the villages somewhere in 2011/2012) a major difference in development was observed. The local population, micro enterprises, households and hospitals are benefiting from the access to electricity. Regarding the Jatropha production there is more difficulty in giving a positive assessment. Where some of the plants started to grow four years ago, the production is not optimal. The engines are working on diesel and in the last years only five to ten percent of the oil was produced by the Jatropha seeds.

Benefits

The total population of the village is completely satisfied regarding the use and access to electricity. In accordance with the potential benefits from table 1 (p. 18), the access to electricity leads to a social, educational, health and economic benefit. The populations in the researched villages were very pleased to receive in the future or to already have electricity at home or at their workplace.

Economic benefits for enterprises and households are especially related to the diminished use of other energy sources. Especially lights without the use of batteries save them a lot of money. Furthermore enterprises make less use of coal, gas and diesel and save money when making use of the electricity grid. Enterprises can work more hours a day, they can work by night, and with electric materials they can reduce their workload which results in a faster and easier production. With an increase of their production and economic situation as an outcome. An economic benefit for some households is the use of refrigeration. Especially some women are doing commerce by selling cold drinks, which gives her more independence from her husband.

A change in the social situation of the society is visible, people are grouping together to watch television. Other social activities, for example parties and shows, are benefiting from the electricity. Children are spending more hours a day studying than before and are making

homework together. The health centers are especially benefiting from the light by night and the refrigerator which cools vaccines. Finally there is an increased sense of security in the village. The population is less afraid for robberies and dangerous animals.

Aspects which could not be included in the above stated benefits is the reduced burden on women, less indoor pollution and reduced pressure on woodland. Where other sources are not available and expensive (gas for example), women are still collecting wood to use for cooking. Every day women collect wood for several hours. Each time they have to look for fuel wood more far away, which affects the environment and the daily life of the women.

Some problems related to the electricity grid are the payment of the electricity. Many people complain about the high fixed price. Even though people indicate that they spend less money on energy sources, they do often have difficulties to pay the bill. This problem exists especially in the harvesting season (July-August) when people earn less money.

Where table 1 showed a smaller difference of the living standards between rural and urban areas, bigger differences can arise between and within villages. Not all streets and neighborhoods are connected to the electricity grid, where the population can not benefit from street lightening and electricity at home.

Sustainability

Taking into regard recent literature on the crop *Jatropha*, many discussions are related to its sustainability. *Jatropha* was seen as a 'wonderplant', a plant which grows under all extreme conditions. Nowadays researchers are indicating a contradictory image on the plant. In addition, this research shows a negative outcome on the *Jatropha* cultivation. Where it could have been a solution to the recent situation of deforestation and the raising prices of oil and diesel, several problems exist related to the production, collection and selling of the *Jatropha* seeds.

Nowadays the plants are too small to produce enough seeds, the plant is still not fully grown after 4 years and the farmers are not working and cleaning their field enough. The conditions of the soil is playing a role, where there is not always enough rain, and insects/termites destroy the fields. But not only the difficulties related to the collection and production of the crop are a problem, also the price given for the plant is a limitation for the farmers to produce and cultivate *Jatropha*. At this moment the price farmers receive is too low compared to the investment costs and the money earned with other crops. The price they receive for one kilogram of *Jatropha* is five times as low as the price they receive for cotton or earth nuts.

Even though the farmers and the Mali Folkecenter are hoping for a better future, in which the farmers are producing more Jatropha and the engine will run for 100 percent on Jatropha, it would be sensible to have a look at other possibilities. Other biofuels from which the oil is compatible with the engine or other renewable energies that can be connected to the engine, from which the selling prices are higher, could be an alternative for the Jatropha crop.

Final conclusion

This rural electrification project has a good and positive impact on social services, households and micro-enterprises of Garalo. All households and enterprises are pleased with the positive impacts the electricity has on their lives, the doctors of the local health centers are especially indicating the 'need' of electricity for their hospital. Where the project is currently working, but not on a sustainable base, more research has to be done in relation to the Jatropha crop. Other possibilities have to be taken under consideration, which will cost the farmers less effort and money, and which will make the project more sustainable in the future.

11 DISCUSSION

This research was focused on many different aspects. There's been discussed with households, women, micro-enterprises, Jatropha farmers, health centers and students. With 10 to 30 (structured) interviews per villages, it's not possible to do a representative study. It would be necessary to do more interviews in each village to get representative answers of each actor or researched group. The research only comprises four villages. To get a better overview, it would be necessary to conduct the research in more and different villages, which are also located outside the project area to have a control group.

To give some recommendations for further research it would be good to have a more detailed look at the different aspects:

General review on the project:

The project is implemented in the village of Garalo and ten other villages. Recommendation for further research and further implementation of the project is the reason of choosing villages. The geographical situation and current position of a village will be of major importance of a successful project.

- Location aspect; what is the influence of a geographical situation?
- What are the basic necessities for a successful electrification project; next to a main road? Intersection? Population density? Telephone network?
- What are the necessities to increase the project to a hundred villages?

Population:

Between all households members there is a difference in the usage of electricity. Not all members are benefiting equally and some members could benefit more;

- What is the importance of gender differences? How can all household members benefit of electricity? Why can the man buy a television and a woman not a fridge?

16 out of 45 households are making use of micro-credit; how can they benefit and make use of this related to electric material or equipment?

- How can the younger population get more trained to create micro-enterprises?

It seems that many people are having problems paying for the electricity-bill. Maybe it will be possible to introduce a different payment system (e.g. credit-system that makes people pay upfront)? Further research regarding the usage of the electricity could be interesting;

- How can you overcome the problem that the population is not paying always?
- How do you deal with unsatisfied customers?
- They think their bill is too high, but maybe they use too much electricity?

Sustainability:

Regarding the sustainability process of the project and thus the production of the energy, two different methods can be used. The most radical option is to have a look at other kinds of renewable energies or other kinds of biofuels. Which other already existing crops can be converted to oil to make a use of in the engine;

- What other renewable energies are possible?
- Which other biofuels are available in Mali?
- Are there other suitable already used seeds which can work in the engines which selling price is higher than the Jatropha?

Another possibility is, less radical but uncertain for the future, to increase the Jatropha production. Where the farmers indicated not to collect all seeds and not to put too much effort on their field, it will be possible to increase their production. Even when using fertilizers or other tools, it will be easier to earn some money with the production of Jatropha.

- How can more farmers be attracted to work with Jatropha?
- How can the farmers be trained to get an optimal seeds production?
- What kinds of fertilizer are needed?
- How can the work of the farmer be facilitated?
- What are the benefits of collective Jatropha fields? Can these be implemented on a higher production scale in all villages?
- Will it be possible to increase the selling price of the Jatropha seeds?

12. BIBLIOGRAPHY

- ❖ Adams, A., Adams, C., Anna L. (2008). Questionnaires, in-depth interviews and focus groups. In: Cairns, Paul and Cox, Anna L. eds. *Research Methods for Human Computer Interaction*. Cambridge, UK: Cambridge University Press
- ❖ Asselbergs, B., Bokhorst, J., Harms, R., et al (2006) Size does matter. The possibilities of cultivating *Jatropha curcas* for biofuel production in Cambodia. ECDO, Universiteit van Amsterdam.
- ❖ Barnes, D. & Floor, W.M. (1996) Rural energy in developing countries: a challenge for economic development. *Annu. Rev. Energy Environ.* Vol 21
- ❖ Barnes, D. & Sen, M. (2004) The impact of Electrification on Women's lives in Rural India. *Energia News*, vol. 7, nr 1
- ❖ Barnes, D. (2006) *The Challenge of Rural Electrification. Strategies for Developing Countries*. RFF Press book, Washington, USA
- ❖ Boccanfuso, D., Estache, A., Savard, L (2009) Electricity reforms in Mali: a macro-micro analysis of the effects on poverty and distribution. *South African Journal of Economics*, vol. 77.1
- ❖ Brew-Hammond, A & Kemausuor, F. (2008) *Guidebook on modern Bioenergy Conversion Technologies in Africa*. The Energy Centre, KNUST, Kumasi, Ghana.
- ❖ CIA (2011) *World Factbook 2011*
- ❖ Daey Ouwens, K. (2007) *Position Paper on Jatropha curcas. State of the Art, Small and Large Scale Project Development*. Fact Foundation, Eindhoven
- ❖ Davies, M. (1998) Rural household energy consumption. The effects of access to electricity – evidence from South Africa. *Energy Policy*, vol 26, no 3, 1998
- ❖ DOEN (2011) Stichting DOEN; www.doen.nl
- ❖ Fact Foundation (2011) www.factfoundation.nl
- ❖ Jongschaap, R.E.E., Corré, W.J., Bindraban, P.S., Brandenburg, W.A (2007) *Claims and Facts on Jatropha curcas L. – Global Jatropha curcas evaluation, breeding and propagation programme*, Plant Research International B.V., Wageningen, Stichting Het Groene Woudt, Laren. Report 158.

- ❖ Gualberti, G., Alves, A., Micangeli, A., Graca Carvalho, M. (2009) Electricity privatizations in Sahel: A U-turn? Energy Policy, vol 37, nr 11.
- ❖ Goldemberg J. (2000). World Energy Assessment: Energy and the Challenge of Sustainability, United Nations Development Program
- ❖ Ha, P., Porcaro, J. (2005) Energy and the Millennium Development Goals: the impact of rural energy services on development. Journal of International Affairs, vol 85, nr 2.
- ❖ Hiremath, R.B., Shikha, S. and Ravindranath, N.H. (2007) Decentralized energy planning; modelling and application-a review. Renewable and Sustainable Energy Reviews, Vol. 11
- ❖ Human Development Report (2010) Human Development Index
- ❖ IEA (2011) International energy agency
- ❖ IMF (1998) www.imf.org: Data and Statistics
- ❖ INSTAT (2009) Mali : instat.gov.ml/contenu_documentation.aspx?type=23
- ❖ Centre for Jatropha promotion (2011) Jatrophabiodiesel.org; About Jatropha plant
- ❖ Maiga, A.S., Chen, G.M., Wang, Q., Xu, J.Y. (2006) Renewable energy options for a Sahel country: Mali. College of Mechanical and Energy Engineering, Zhejiang University, China
- ❖ Mali Folkecenter (2010) www.malifolkecenter.org
- ❖ Millennium Development Goals Indicators (2010) UNStats
- ❖ Ministere de l'elevage et de la peche, Sikasso (2008) Projet d'amenagement piscicole du Marigot <Samakò>. Cercle de Bougouni, Commune de rurale de Bladie-Tiemala, Village de Bladie
- ❖ OECD (2007) Mali. African Economic Outlook
- ❖ Panjwani, A., Cecelski, E. (2002) Major activities and actors in energy, poverty and gender.
- ❖ Philibert C. (2010) Case study 1: concentrating solar power technologies. International Energy Technology Collaboration and Climate Change Mitigation, OECD Environmental Directorate, IEA, Paris
- ❖ Program Evaluation (2011) www.programevaluation.org/focusgroups.htm

- ❖ IMF (2008) PRSP Mali Poverty reduction strategy paper. IMF Country Report no. 08/121
- ❖ Robert, N. (2005) Shock energy technologies for the 21st century—the roles of renewable energy.
- ❖ Sims, R.E.H. (2003) Biomass, Bioenergy, and Biomaterials—future prospects. Biomass and Agriculture: sustainability, markets, and policies, Organization for Economic Cooperation and Development, Vienna.
- ❖ Stenkjaer, N. (2010) Electrification with plant oil in Garalo, Mali. Nordic Folkecenter www.folkecenter.net
- ❖ Stichting DOEN (2010) www.doen.nl
- ❖ Trading Economics (2011), <http://www.tradingeconomics.com/mali/population-density-people-per-sq-km-wb-data.html>
- ❖ UN Data (2010) Countries and Areas: Mali
- ❖ Wikitravel.org (2011) Figure Mali
- ❖ World Bank (2002) Kenya country brief
- ❖ World Bank report (2011) Data Mali
- ❖ World Energy Council (2004) Survey of Energy Resources, World Energy Council, London

12. APPENDIX

APPENDIX A: HOST ORGANISATIONS

DOEN FOUNDATION

Stichting DOEN is a Dutch foundation with the ambition which helps to build a world in which everyone can make a contribution. DOEN is looking for pioneers who will make a positive contribution to developments on the following aspects: cultivating positive effects on climate change, cultivating an open society based on solidarity and promoting new economy. DOEN Foundation achieves its objective through the revenues it receives from the Dutch Postcode Lottery, the Vrienden Lottery and the BankGiro Lottery (Stichting DOEN, 2010).

Mission

The DOEN Foundation's ambition is to help build a world in which everyone can make a contribution. DOEN promotes sustainable, cultural and socially-minded pioneers. To make this work, DOEN discovers, supports, connects and inspires these pioneers.

Basic principles

DOEN supports pioneers of sustainable, cultural and social innovation.

From 2010 DOEN Foundation is active in three principal themes. One of these themes is climate change. DOEN contributes to combating further climate change by focusing on reducing CO2 emissions. In order to achieve this in the coming years DOEN will support initiatives in the field of sustainable energy and sustainable transport:

- Energy which will be available for an unlimited period of time; using it means the living environment and opportunities for future generations are not harmed.
- Alternative forms of transport or transport using sustainable fuels.

The Garalo project and the BC-10 villages project are examples which are financed by the DOEN Foundation. Similar projects, working on Jatropha are situated in other areas.

1.1. FACT FOUNDATION

The Fact Foundation is one of the organizations which is financed by Stichting DOEN. In 2009 they received €1.788,594 euro. FACT Foundation assists partners in developing countries with know-how for the production, use and commercialization of biofuels for local development. FACT acts as a network organization with research and development institutions world-wide.

Mission

FACT promotes sustainable biofuels for local communities in developing countries, by providing knowledge and expertise on biofuel implementation, by field testing innovative biofuels and by giving specialist advice on demand.

Basic principles

Biofuels can provide an affordable and reliable energy supply in rural areas in developing countries, reduce the dependence on fossil fuels, stimulate local entrepreneurship, increase farmers' income, and improve quality of life. Biofuels to be effective require sound policies for both agriculture and energy. By focusing on agroforestry and intercropping both food and fuel production can be increased in developing countries.

Fact foundation is one of the technical supporters of the Mali Folkecenter, with visits, research and information are they supporting the MFC since several years (Fact Foundation, 2010).

1.2. MALI FOLKECENTER

The Mali Folkecenter received 650.000 euro for the BC-10 project from Stichting DOEN. Mali Folkecenter (MFC) is a Malian NGO which represents the Danish Folkecenter for Renewable Energy. Folkecenter is an independent, non-profit institution, managed by a board of 11 members representing the trades, local authorities, energy organizations, sciences and concerned citizens. Folkecenter forms part of international networks including partners in Western, Eastern Europe and in the Developing Countries (Lituania, Uganda and Mali). The Mali Folkecenter is an independent NGO, cooperating with the government and other NGOs.

Mission

MFC mission is to promote the sustainable management of natural resources and the use of these resources to catalyze local economic growth & sustainable development by working in partnership with rural populations and local entrepreneurs.

Basic principles

Activities include: environmental protection, provision of clean energy services to meet the needs of rural and un-served areas using renewable energy technologies, drinking water supply, technology transfer and the training of local technicians, and delivery of enterprise development services for rural companies in the clean energy sector. MFC also participates in energy & environment policy work with the Malian government.

Since 2009, the MFC has been organized into three programs: Local Economic Development, Good Governance and Decentralization, and Environment, Energy and Climate Change. MFC has also elaborated its 5 year plan for years 2009-2013 with specific objectives and intervention areas, designed to meet the needs of MFC's most important partners - the rural and peri-urban populations (Mali Folkecenter, 2010).

APPENDIX B : OVERVIEW INTERVIEWS

Micro Enterprises	
Restaurateurs	
Garalo	Bintu Kane
Garalo	Bintu Kone
Garalo	Kene Kane
Bladiè	Agatta
Zantièbougou	Mariam Revette
Kebila	Agatta Diarra
Tailor	
Garalo	Mamadou Sangare
Garalo	Alessan Doumbia
Kebila	Birama Troare
Bladiè	Adema Traore
Zantièbougou	Ousmane Diallo
Soudeurs/minusièr	
Garalo	Ousmane Keita
Garalo	Siaka Samake
Garalo	Sedejou
Bladiè	Oumar Sangare
Zantièbougou	Abai Doumbia
Garalo	Bakary Mariko
Garalo	Soury Traore
Kebila	Yakouba Coulibaly
Other	
Bladiè	Babakar Tjakite
Garalo	Abou
Garalo	Bassamory Kane
Garalo	Mamadou Kane
Zantièbougou	Isa Kane
Households with electricity	
Zantièbougou	Amor Doumbia
Zantièbougou	Moussa Kone
Zantièbougou	Ousmane Coulibaly
Zantièbougou	Amadou Doumbia
Zantièbougou	Nouhoum Kiate
Zantièbougou	Aya Bagouyougou
Zantièbougou	Boacar Samake
Zantièbougou	Kariz Toure
Bladiè	Cedou Balo
Bladiè	Bourama Sangare
Bladiè	Madou Sangare

Bladiè	Bakary Bamba
Bladiè	Daouda Sangare
Bladiè	Sedou Sangare
Bladiè	Adema Sangare
Bladiè	Abdou Sangare
Bladiè	Yousseuf Sangare
Garalo	Souleymane Sangare
Garalo	Cesedi Coulibaly
Garalo	Mamadou Sangare
Garalo	Amadou Sangare
Garalo	Adema Sangare
Kebila	Drissa Doumbia
Kebila	Seydou Bamba
Kebila	Yaya Kone
Households without electricity	
Garalo	Sangare Abda
Garalo	Kolima Samake
Garalo	Samata Kané
Garalo	Adema Doumia
Garalo	Diremo Doumbia
Garalo	Fafran Kane
Garalo	Madou Sangare
Garalo	Famourou Kane
Garalo	Amadou Sangare
Garalo	Jaffet BOBO
Garalo	Sidi Bougayougo
Garalo	Simon Coulibaly
Garalo	Mamadou Kane
Garalo	Baba Kane
Garalo	Paul Ginou
Garalo	Daouda Konare
Garalo	Mourlaye Sangare
Garalo	Iguire Tolo
Garalo	Salif Kane
Garalo	Mamari kane
Farmers	
Zantièbougou	Bakary Kané
Zantièbougou	Isiaka Kané
Garalo	Moussa Sangaré
Garalo	Bazumane Kone
Garalo	Bourlaye Sangaré
Garalo	Flabou Sangaré
Garalo	Dramane Sangaré
Garalo	Sidiki Kané
Kebila	Moustafa Coulibaly
Kebila	Abrama Koné
Kebila	Bintou Bakayougou

Bladiè	Abdou Sangare
Bladiè	Habdoulay Diakite
Bladiè	Siaga Sangare
Open interviews	
Bamako	Aliou Tounkara (ACCESS)
Bamako	AMADER
Bamako	ECOFILS
Garalo	Mory Konaté (MFC)
Garalo	Doctor
Garalo	Doctor
Garalo	School Director Garalo Markala
Garalo	School Director Garalo Cycle B
Garalo	Professor Geography/France

APPENDIX C : PLANNING / LOGBOOK

Date	What done?	Explanation
2 -11-10	Meeting with Stichting Doen: Nina Tellegen & Jeff Prins	Introduction of the topic, the country, their interests
26-11-10	Meeting with Ywe Jan Franken (Fact Foundation)	Getting more info about Mali / Garalo. Discussion farmers, MFC. How can I position myself? St. DOEN – FF – MFC – inhabitants...
7-1-11	Meeting with Jeffrey Prins + Winfried Rijssenbeek	Info about project and implementation in BC-10 villages – my contribution
21-1	Meeting at Fact Foundation	Research proposal discussed with Winfried. Clear questions. Thinking of amount of villages. Methodology?
3-2	Leaving to Mali with Nina Tellegen – research proposal discussed	Need to focus. What do I really want to find out?
4-2	Heading to Ségou	Festival sur le Niger
5-2	Meeting / dinner with Hugo Verkuijl (Mali biocarburant)	Project is working better with them. They are a company, not a NGO. Maybe I can have a look sometimes at their projects. Business approach should be better discussed in Garalo and BC-10 project
6-2	First visit to Garalo and 1 BC-10 village together with Ibrahim Togola and Nina Tellegen – introduction and ceremony with the population and Mayor.	Poster is really suitable for my proposal. Looking at the production and the usage of the electricity. People are really happy and want to do more. Setting up a bakery, and other sorts of activities. The production of the jatropha was a bigger issue than I expected, while only 5 % is now used in the machines. The idea is that in 5 years the total production of the oil exist of Jatropha, 70% gas (from the cake) the rest from the jatropha oil.
8-2	Arrival of Winfried Rijssenbeek; first meeting with Ousmane (director of MFC)	Setting up terms of reference; contract Introduction to my research questions and methods
9-2	Visit to Garalo with Winfried & Ousmane	Searching for a suitable accommodation
10-2	Meeting with Hugo Verkuijl (MBC), MFC, Fact Foundation	Talking about the issues; problems between this are likely to be solved.
11-2	Morning: Visit to Koulikoro; production area of MBC Evening: Winfried returning back to NL	First time seeing a Jatropha field. Huge production process—not a NGO, but working as a real company
17-2	11h: Meeting with Kone, director of Ecofil/ILS 12.30h: Meeting with Karin Wilms; working for Rural Energy Foundation	Doing many questionnaires in rural areas. Having a talk together what is the best way to ask question; getting a definition of a household; example questionnaire Wilms: PV- / solar panels. Working for a NGO which is promoting economic activity; setting up local businesses with a service point
18-2	Very short meeting with Ibrahim Meeting with Diarra; former employee of ACCESS; busy with BC-10 15h: Meeting with director of energy of Amader ; national energy company	Ibrahim: There is not a student anymore available for translating; do I need to hire a professional? Diarra: Talking about questionnaire; having a closer look at the most important points Amader: Interview about their influence in the projects. They are giving subsidies of 80% of the costs – rural electrification projects
19-2	Day 1 in Garalo; arrival 15oclock getting dark at 19h; Some small reparations of my new motorbike	Observation 1: it's getting dark around 19h. We still have to have a look at my motor. They are still working in the night. Lights and machineries can work in the dark with the electricity → more productivity hours
20-2	Day 2 in Garalo: 11h: meeting with technical professor	Observation 2: joining Tounkara to a meeting; 2 of the 3 generators are not working anymore. A prof from Bamako must come to have a look at the machineries to fix them. When the last

	16h: electricity is on till midnight	generator will break there is no electricity anymore. → lack of local knowledge / vulnerability of the product Observation 3: At 16h sharp everybody is putting the television on ; whole families are watching the only malian tv channel. Some others have a satellite and can see all french tv progr. Furthermore there's nothing to do in the night → social activity Observation 4: it's already getting hot this time of the year. It's great to have a cold coke from the shop nextdoor. → economic activity
21-2	Day 3 in Garalo: Market : Many vendors from the whole region are coming to sell there stuff	Observation 5: With the electricity they can communicate with eachother about market prices; new issues etc.telephone connexion → communication ; productive use Observation 6: Everybody has 2! Mobile phones. Fixed phones are not used here. Orange and Malitel are common. → productive use
22-2	Day 4 in Garalo: Introduction with Mayor, Chef de Village, Chef de l'eau et l'électricité. The children are going in shifts to school, depending on their age they are going in the morning, afternoon or evening	Presentation at municipality of what I will do. Meeting everybody so I can have a better contact later on. Observation 7: Because the amount of children they had to divide the time. Because of the electricity a part of the children has education in the evening → community use Observation 8: The children from the neighbors are making their homework at our place where is a good light. → education & social use Observation 9: The moon is not shining strong tonight, it's really dark on the street. Street lightning is very important for the activity and safety on the road → communal use
23-2	Day 5 in Garalo: Visit with neighbor (he is working at small NGO for strengthening women) two other villages without electricity in a very remote area.	In comparison with there, Garalo is a huge city. There are no economic activities in the area of shops, petrol, streetlights. Observation 10: Not only are families watching television together... at four o'clock programs like Pokémon are watched by all the kids →Community use
Week 4/5	Starting with first questionnaires. First meeting with Mamadou Kané, making the sample	Working together with several colleagues. Especially Sangaré likes to do the translation and to work with me. In total we did 15 questionnaires in 2 weeks
Week 6	Willing to work on the questionnaire but my translator Sangare is not there. Visit with one of the other colleagues, Sidibe, a school.	Sangaré is in another village, without Tounkara it is hard to motivate the others to work together with me. Finally finished the 20 questionnaires for households with electricity. Meeting with a school director. He was not positive about the electricity. We visited some classes, many children in one room. Girls and guys are shouting and screaming when I'm passing by.
Week 7	Visit of minister Top étoiles (ORTM show) Working at the office in Bamako	A busy week for all colleagues, not able to work on the interviews. A minister came to visit Garalo; I had to make photos of his visit. I got a special introduction for him. The TV show came in Garalo. Some days of preparing. Also Adeline (from France) came to visit me for some days. Wednesday I returned with her and a famous Malian artist in his luxury car back to Bamako.
Week 8	Interview at the maternity center 6 questionnaires households without electricity in Bladie 9 questionnaires Micro-enterprises Garalo	Before the Dutch people came to Mali I wanted to do a lot of work. I had an interview with a medicine. I went for one day with a colleague to Bladie. The municipality workers were really kind and found all households for me. They brought them by motor at the meeting point and did the translation. In Garalo I got a list of all micro-enterprises with electricity. The ones which were present I visited, including some similar ones without electricity.

Week 9	Visit Fondation Doen and Dutch TV crew visit in Mali. I was there to translate.	A great week together with two colleagues of Stichting DOEN. They didn't speak French so I could travel with them to translate. We visited several project, also working on Solar Energy.
Week 10	50 questionnaires at a public school; 8 th grade Interview with a professor of Geography. Next day I gave a course about the 'Géographie de Hollande' 3 questionnaires Micro-enterprises Garalo	I wanted to see and experience a schoolclass in Garalo. I met a nice geography teacher which also taught French. After a short interview he asked me to give a lecture on the Netherlands. The day after I had some questionnaires with the students and afterwards I gave a lecture.
Week 11	4 questionnaires household + 4 micro-enterprises + 3 farmers in Bladie 3 questionnaires without electricity in Garalo Working at the office in Bougouni	In Bladie, with a colleague we stayed there overnight at somebody of the municipality who spoke French. We had a walk by night; the whole village was silent at 20h00. not any activity was done at that time. I didn't want to travel the whole way back to Bamako, so I went by bus to Bougouni to use a bit the internet. Finally 5 hours travelling for 2 hours internet...
Week 12	6 interviews with Jatropha farmers 2 questionnaires without electricity in Garalo Interview a la centre de Sante Working at the office in Bamako	Finally Konate was back in Garalo and had time for me to work together with the jatropha farmers. Not everybody was even willing to respond on the questions. Too much researchers are coming to the village to interview the farmers.
Week 13	10 questionnaires + 5 enterprise + 3 in Zantiébougou 2 questionnaires without electricity + 3 enterprises + 2 farmers in Kebila	The whole week I stayed in Zantieboucou at a family member of the MFC director. I worked together with 2/3 colleagues to translate. You get used to live without electricity. Only the Chinese lamps are attracting too much animals. With two motors we went to Kebila, the others didn't want to stay overnight so we did many questionnaires in a short amount of time.
Week 14	Focus group: Men (electricity committee) Focus group: Women (6-8 femmes)	Two focus groups, with women and men in Garalo. Tounkara joined to translate. He was a good group leader.
Week 15/16	Writing report. Goodbye in Garalo. Presentation results in Bamako	Final presentation in Bamako on the first results of the research.

