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Women and Renewable Energy: Implications of the Implementation of Biogas on Women in Rural Kenya

Heidi Hustad Gleditsch
International Environmental Studies

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Heidihgled@gmail.com

Noragric
Department of International Environment and Development Studies
The Faculty of Landscape and Society
P.O. Box 5003
N-1432 Ås
Norway
Tel.: +47 67 23 00 00
Internet: <https://www.nmbu.no/fakultet/landsam/institutt/noragric>

Declaration

I, Heidi Hustad Gleditsch, declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature.....

Date.....

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Abstract

This paper analyses how the implementation of biogas can have an impact on women in rural areas in Kenya. It looks at different aspects of women's lives and investigates how gender roles, labour distribution, economy, health and time management are affected by the implementation of small-scale domestic biogas technology. To investigate this field of interest, I interviewed 41 women in rural areas of Kenya about their personal experiences on biogas. The findings show that the implementation of biogas has several benefits for women. Among the most mentioned were an improvement in economy through reduced expenses related to biogas production. Better health conditions and increased personal safety while cooking was also a positive change for many of the participants. Faster production and use of biogas compared to traditional energy sources, reduce time consumption. This allows the women to spend more time on other activities, such as hobbies and work outside the home. However, there are certain challenges and limitations related to biogas production and use, such as a lack of necessary resources that in some cases limit biogas production. Lack of funding, water and knowledge about biogas have in some cases restricted progress and these issues should be considered in the implementation of development projects. Findings suggest that there have been changes in gender roles in some of the households. Due to easier and faster cooking conditions, many men have started participating in cooking, causing some changes in labour distribution. The paper highlights women's positions as producers, users and managers of biogas. The findings suggest that the participants have an influence on biogas technology as a result of their important positions as energy managers. This emphasises the importance of acknowledging women's knowledge and experience with biogas and use this to help shape further development of the technology.

Keywords: *Biogas, renewable energy, gender equality, labour distribution, women, Kenya*

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List of Acronyms

EU	European Union
GAD	Gender and Development
GAM	Gender-Analysis Matrix
GHG	Greenhouse gases
GNP	Gross National Product
HAS	Help to Self-help in Africa
IPCC	Intergovernmental Panel on Climate Change
KENDBIP	Kenyan National Domestic Biogas Program
NGO	Non-governmental organisation
UN	United Nations
WIN	Women in Development

1. Introduction

Access to affordable and reliable energy sources is important for human welfare. We need energy to cover basic needs such as lighting, heating and cooking. As the world's population continues to grow, the global demand for energy is increasing rapidly. It is estimated that approximately 88% of the global energy demand is covered by the use of fossil fuels. Extensive use of non-renewable resources such as oil, gas and coal is linked to environmental pollution and greenhouse gas (GHG) emissions (Akella et al., 2009). High energy consumption worldwide has led to an increase in global warming, and caused an urgent need to replace fossil fuels with renewable energy sources. A recent climate report published by the Intergovernmental Panel on Climate Change (IPCC) lays out possible effects of a global temperature rise of 1.5°C and necessary measures to avoid the increase. Human activity related emissions, such as fossil-fuelled vehicles, air travel, industry and use of electricity must be dramatically reduced or transformed to achieve this (Trenberth, 2018). The 1.5°C represents a threshold. If this is exceeded, the consequences are not only disastrous, but re-establishing a stable climate may be impossible.

There has been an increasing global focus and attention on environmental issues and the world's emissions. Most scientists and organisations agree that the rising concentrations of greenhouse gases in the atmosphere caused by the burning of fossil fuels are major contributors to global warming and are to a large extent caused by human activities. A common goal among the world's leaders is to find a solution that can cover the world's energy requirements, while reducing or ideally eliminating GHG emissions, to ensure a safe and functional world for future generations. At the United Nations Framework Convention on Climate Change (UNFCCC) in Paris in 2015 (COP21), 195 countries agreed on a legally binding contract and action plan that aims to reduce the emissions to keep the global temperature increase under 1.5°C (Scarlat et al., 2018). To achieve this, emissions must be reduced by 45% by 2030 compared to 2010.

The utilisation of renewable resources to create biogas is considered an important and effective strategy to reduce emissions, conserve forests and improve human health. The many different forms of bioenergy resources, such as solid, liquid and gaseous bioenergy, makes the sector

complex, but offer numerous opportunities for production and use. A transition to biogas production in rural areas using anaerobic digestion of cow dung, can provide affordable and reliable energy where it is needed. The use of biogas is effective in providing clean cooking facilities, which is important for health and environmental reasons (IEA, 2011). Biogas as an energy source has gained increasing attention among development actors and governments around the world due to its affordability, user-friendliness and potential in reducing GHG emissions.

Because women in developing countries generally spend more time performing domestic tasks than men, they are the main users of household energy (World Bank, 2001). According to a report by the UN Women organisation, women 'do 2.6 times the unpaid care and domestic work than men do' (UN Women, 2018). This work includes, among other things, water and fuel collection, care for children and elders, cooking and washing. Having safe and reliable access to energy is an important and necessary part of this work and a lack of this is likely to affect them in their everyday lives. At the same time, the renewable energy sector has tended to ignore women, which is believed to have caused unequal and unsustainable development. Inequality within the energy sector means that access to energy, capital, technology and land rights differ between men and women. As women are the main users and managers of household energy, they are likely to benefit from renewable energy technology.

Research on women's roles in biogas production and how the implementation of biogas affects them is important. Because of their roles as energy managers, they possess valuable knowledge and experience that is important to consider when implementing new technology. Women's knowledge and perspectives should be in focus among manufacturers, policymakers and energy researchers (Cecelski, 2000). Where this fails, negative outcomes for women and energy projects may result. This research paper aims to investigate the challenges women face in the access to and use of biogas technology and highlights how biogas can benefit rural women. The paper explores gender roles and how traditional cultural values can impact women's access to and use of biogas energy.

1.1 Sustainable Development and Gender Equality

‘Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future.’ (Brundtland, 1987, para. 49). The term gained its popularity during the United Nations World Commission on Environment and Development in 1987, also referred to as the Brundtland Commission. The report from the Commission, “Our Common Future”, addressed issues of gender equity and poverty reduction as important measures towards environmental conservation and sustainable development. Including women in development to the same extent as men is essential for the future lives and opportunities created for girls today. It is believed that by improving women and girls’ living conditions, include them in decision-making processes and enhancing their roles as economic and political actors, it can contribute to the reduction of harmful emissions.

1.2 Problem Statement

The use of traditional fuels, such as firewood and charcoal, in rural households is unhealthy. It is also a major drive for deforestation and greenhouse gas emissions. As women are the primary users of household energy, the burdens of poor energy access fall on them. Issues related to the use of traditional fuels can be high time consumption, high economic costs and health hazards. The implementation of biogas technology has increased in rural households in Kenya, but there is still a lack of research on the impact of this technology on women and household dynamics. From a socioeconomic perspective, the use of locally produced biogas should be investigated by looking at how the implementation and use of biogas influence women in terms of challenges and benefits, as well possible changes within the household. Understanding this is important when it comes to development and investments in developing projects and to improve environmental sustainability in the future.

1.3 Research Objectives

The main objective of this study is to examine the use of biogas in rural households in Kenya and investigate how women are affected by the implementation of biogas in their households. The study aims to understand the limitations and possibilities of biogas viewed by women in rural areas. Through interviews with women, the research study aims to gather information about their perspectives and involvement in the use of biogas and investigate how women are affected by

the implementation of biogas in their households by looking at time management, health and economy. I will explore their motivations for biogas use and possible changes in gender roles and labour distribution after the implementation of biogas. The aim is to identify and understand the limitations, possibilities and benefits of biogas use from a female perspective and discuss the importance of women's involvement in energy projects today and in the future.

1.4 Research Questions

1. In what ways do the implementation and use of biogas in rural households in Kenya affect women?

- i. What are the benefits and limitations linked to the establishment and maintenance of the biogas digesters for women, in terms of economy, health, resource access and time use?
- ii. What are women's motivations for implementing biogas and to what extent do the women perceive their energy needs as being met?
- iii. How are gender roles and labour distribution affected by the implementation of biogas?

2. What role do women in rural Kenya play in the future development of biogas?

- i. How might the views and attitudes towards gender equality affect women's positions within the energy sector, today and in the future?
- ii. How do the women view changes, opportunities and future development of the biogas technology themselves?

1.5 Structure of the Paper

The second chapter of theoretical framework and literature review will provide a description of gender in a development context to give an overview of women's positions within the energy sector and briefly outline women's historical positions in the development field and research. A framework will be introduced to accommodate the research and analysis on the topic of women and renewable energy. This will be followed by information about our global climatic conditions and the role of biogas in sustainable development. The third chapter of methodology gives a summary of how this research has been conducted, how the fieldwork was carried out, as well as recognising ethical questions and limitations of the fieldwork. The fourth chapter will present the

results from the research and discuss the findings. The first research question is mainly centred at the current situation for women, and direct impacts of biogas technology. The second research question will discuss the possibilities of biogas in the future and how women can help shape this. Chapter five is a summary and conclusion.

2. Theoretical Framework and Literature Review

The following section provides an overview of how the development field and policies have viewed and conceptualised women. Further, it will present how the subjects of renewable energy, gender and biogas are placed in the development discourse.

2.1 Understanding Gender in a Development Context: Women and Renewable Energy

“The concept of gender is used by sociologists to describe all the socially given attributes, roles, activities, and responsibilities connected to being a male or a female in a given society. Our gender identity determines how we are perceived, and how we are expected to think and act as women and men, because of the way society is organised.” (March et al., 1999, p. 18).

In all cultures and societies we find socially constructed expectations and roles that shape our behaviour and how we view others (World Bank, 2001). Legal rules, norms of behaviour and expectations are social structures that shape us based on our gender. We all uptake different roles, both within our households and within society, that sometimes determine how we act and influence how we see the world arounds us – and how the world sees us. In some cases, roles are forced and impose structures upon us. These structures determine opportunities, expectations, restrictions and influence the choices we make (Kevane, 2014). An example of how gender can determine our roles and activities can be found by looking at labour division in households, and how this further contributes to unequal distribution of resources, capital and last but not least, opportunities.

Division of labour based on gender is found in all societies, but takes different forms and it changes over time (March et al., 1999). What nearly all societies have in common, is how women are considered the main caregiver for infants and children, while the responsibility of military service and national defence is given to men (World Bank, 2001). Skewed gender power relations in favour of men are common, and this also influences the value given to the different

tasks of men and women (March et al., 1999). This has especially had an impact on gender roles within and outside the household which puts men and women in different roles in the energy system (Wilkes & Dijk, 2017), where the work of men is generally valued more than the work of women. A study done on poverty and time use in Sub-Saharan Africa shows that women and girls in Kenya spend more time performing household and care work, compared to boys and men (World Bank, 2006).

The inequality between men and women does not only affect the well-being of men, women and children, but it can also hinder productivity and economic growth as well as weaken development policies (World Bank, 2001). Research shows a link between mother's illiteracy rates and their children's well-being. Educated women are more likely to provide higher quality care for their children, thus reducing mortality rates and malnutrition (World Bank, 2001). It is also been showed that improving the financial situation for women, yields larger benefits for her children and household than improving men's economy (World Bank, 2001). This proves that providing girls and women with the same access to education and resources as boys and men, is important both for personal development, as well as for economic growth.

Esther Boserup's research on women's economic contribution to development showed that women play an important role in their country's economy and a significant role in food production (Razavi & Miller, 1995). Unpaid work conducted by women is a big economic contribution, but the value of their work is often unrecognised and undervalued (Cecelski, 2000). As this work is often not recognised it also means that their labour and economic contribution is not included into GNP calculation (Cecelski, 2000; Zinsser, 1990). The agricultural labour force in Kenya is composed of 80% women generating approximately 60% of the farm-derived income. However, only 5% of registered land holders in Kenya are women (Human Rights Watch, 2003). All over the world, women face discrimination, restricted access to land, resources and financial rights, less pay than men, and fewer opportunities regarding health care and education. These differences between men and women are more significant in poor communities and countries (World Bank, 2001).

As women and girls constitute half of the world's population, we can only achieve our full potential when men and women are equal. The focus on gender equality in a development setting has gained increasing attention over the last few decades.

“Gender equality is a core development objective in its own right. It is also smart economics. Greater gender equality can enhance productivity, improve development outcomes for the next generation, and make institutions more representative” (World Bank 2011 as cited in Kevane 2014, p. 31).

Although increasing in the previous years, there has for a long time been a lack of research done on women's roles within the renewable energy sector. There are major differences in the access to energy, resources and credit between men and women. At the same time, women's lack of income can detach them from new energy technology (Wilkes & Dijk, 2017).

Because women's contribution to the energy sector is largely unpaid and unrecognised, technological investments that can improve women's work have been ignored (Cecelski, 2000). Many development organisations operate today with external gender specialists and there has been an increased focus on gender equality and women's empowerment in development work and policies (Beetham & Demetriades, 2007). Attention towards improving women's work through investment and technology development is significantly less, than towards men's (Cecelski, 2000). Drawing attention to this and providing women with more efficient, affordable and convenient energy sources is likely to benefit not only her, but her children and family as well. Because women are the main producers and users of household energy, their involvement in renewable energy projects is crucial to ensure successful projects (IRENA, 2019).

The main barriers to energy access are high costs and poor accessibility (Wilkes & Dijk, 2017). Poverty affects women and men differently, and energy access is also closely related to income level. As the primary collectors of wood fuels for household energy, the scarcity of fuel predominantly affects women (Cecelski, 2000). Highlighting the role women in the study of renewable energy technology can improve their access to energy. It is therefore important to study the situation on women and evaluate how projects affect them.

2.1.1 From Women in Development to Gender and Development

Changing trends in development thinking have influenced how gender-sensitive research is conducted (Hoare, 2007). Traditional development and research shaped by western ideals have often ignored women's involvement in development processes (Beetham & Demetriades, 2007). The term Women in Development (WID) emerged in the 1970s in response to western development work, arguing that the development process had different impacts on men and women (Razavi & Miller, 1995). The widespread assumption that development and men's economic success would "trickle down" on women was highly criticised by women in the development field (Beetham & Demetriades, 2007). There is a male bias, not only in development theory but also in the structure of development work which has been reflected in the lack of acknowledgement of women's work and contributions. This does not mean that women have been intentionally excluded, but the work they do has not been defined within the energy sector (Cecelski, 2000). In the emergence of WID, came the rise of the liberal feminist approach in North America fighting for equal rights, equal employment opportunities and equity for women (Razavi & Miller, 1995). WID disagrees with the common limiting view on women as being wives and mothers and aimed to expand the view on women to members of society and active contributors to economic development (Razavi & Miller, 1995).

The United Nations (UN) aimed to focus on women's situation through declaring the United Nations Decade for Women 1975-1985, with the aim of presenting women's voices, concerns and perspectives (Zinsser, 1990). One of the three conferences of this decade was held in Nairobi in 1985 as the first international women's conference in Africa (Zinsser, 1990). The Third World Conference on Women first introduced the concept of gender mainstreaming which gained popularity within the UN development community. The UN Decade for Women played a vital part in establishing new legislations to protect and promote women's rights in the development process (Razavi & Miller, 1995). By the end of the decade, 170 countries had signed or ratified the United Nations Convention on the Elimination of All Forms of Discrimination Against Women (Zinsser, 1990).

In the 1970-80s, the WID approach, mainly developed in North America, was highly criticised by women in the Global South. They argued that this theory of development did not reflect the

situations and contexts of their own experiences, but rather applied to Western ideals (Beetham & Demetriades, 2007). Issues of focusing on women as a homogenous group in isolation in the development field were raised and the underlying reasons for women's restricted access to resources were questioned (Razavi & Miller, 1995). The approach was also criticised for its lack of addressing power imbalances, thus enforcing gender roles impairing women's positions in society and not viewing women as active agents (Beetham & Demetriades, 2007).

The result of these critiques was the Gender and Development (GAD) framework. There was a shift away from women-only research, towards power relations and more focus on socially constructed power imbalances between men and women. This challenged gender roles and norms and women were considered actors rather than beneficiaries (Beetham & Demetriades, 2007). GAD takes into account other factors that could impact women's positions in society, rather than only gender, such as race, class and religion. (Beetham & Demetriades, 2007). Conducting research from a GAD perspective means to recognise and identify not only how women live their lives, but also how development projects and policies affect them. The GAD approach aims towards a participatory methodology that includes local knowledge and participation by local communities. To be able to promote sustainable development that benefits both men and women it is important to have an inclusive development approach, that considers different experiences, knowledge and voices (Beetham & Demetriades, 2007). The approach also must be able to acknowledge the fact that in many cases, development practices 'have often done more harm than good' (Parpart, 1995 as cited in Beetham & Demetriades, 2007, p. 202)

2.1.2 Gender-Analysis Framework: Gender-Analysis Matrix

The purpose of a gender-analysis framework is to understand the situation on gender within a community. This can be done by investigating underlying causes of inequality and to determine possible consequences and issues of development initiative on men and women (FAO, 2014). Gender-analysis frameworks are commonly used by development organisations to analyse gender roles and relations, and to promote gender equality in a development context (Hoare, 2007). There are several different gender-analysis frameworks that can be used for structuring and carrying out gender research, each with their own focus and approach (FAO, 2014). Popular

frameworks are the Harvard Gender Roles Analytical Framework and the Moser Framework. This paper draws on the Gender Analysis Matrix (GAM) Framework.

The GAM Framework, developed by Rani Parker, will assist in conceptualising and understanding women in a development context by providing an overview of how to conduct gender research (March et al., 1999). The top-down, modernisation approaches to development, popular since the 1950s, experienced a shift in the 1990s towards more participatory development projects at the local level (Hoare, 2007) which can be recognised in this framework. It has a community-based technique of gender research that uses a bottom-up analysis where community members themselves are encouraged to identify and challenge their own assumptions about gender roles (FAO, 2014). This is done by identifying development interventions' impacts on four levels: women, men, households and community (FAO, 2014). In addition to this, it analyses the impacts in four different areas: labour, time, resource access and control, and socio-cultural factors (FAO, 2014). March (1999) presents the four areas: *Labour* refers to changes in tasks and labour capacity in the household; *time* refers to the amount of time it takes to carry out project activity and possible changes in this; *resources* refers to whether the project changes resource access and control; *socio-cultural factors* look at whether the project can inflict changes in e.g. gender roles or status.

The framework is flexible. It can be adapted to fit specific contexts and purposes, and can be used by different actors, such as community members, policy makers, development researchers and workers (March et al., 1999). Although the framework aims to investigate impacts on four levels, for the purpose of this paper, the level of women will be the main subject of research. This paper will adapt the GAM Framework and use it as a guide throughout the research to better understand how contexts shape relationships and the dynamics between men and women (March et al., 1999).

2.1.3 The Current Situation

The increased focus on the roles of women in development has put gender issues on the agenda of most major development organisations (Cecelski, 2000). Over the past five to six decades, there has been a significant improvement in gender equality in developing countries. The number

of girls enrolled in primary education have doubled in South Asia and Sub-Saharan Africa, reducing the gender gap in schools (World Bank, 2001). The investment in girls and women's health care have increased women's life expectancy, and the gender gap in employment is greatly reduced with an increase in women entering the labour force (World Bank, 2001). However, despite a major improvement in girl's and women's conditions, human development is strongly hindered by gender inequality so women still face problems today – simply for being women.

Millions of women all over the world, still lack access to education, sexual and reproductive rights, health care and access to political influence and financial stability. According to the UN, only 23.7 per cent of parliamentary seats are occupied by women, 15 million girls under the age of 18 are victims of child marriage every year, and female genital mutilation is inflicted on 1 in 3 girls ages 15 to 19 years old in 30 countries with representative data (UN Economic and Social Council, 2017; UN Women, n/d).

Although the focus on women in a development context has continued to increase, their interests, contributions and needs are to some degree still overlooked. Despite great variations between cultures, a common trend is found all over the world where boys and men are favoured in education, politics and the workplace, while women lack basic rights. Women face discrimination and unequal chances, in most spheres outside the home as well as inside (Kevane, 2014). Even though women were set on the development agenda, there has been a lack of progress when it comes to promoting gender equality and female empowerment in practice (Hoare, 2007). Today, gender equality is goal number five in the UN Sustainable Development Goals.

2.1.4 The Position of Women in Kenya

The patriarchal nature of many societies and cultures in Kenya affect different areas and sectors and have negative implications for women. In Africa, boys and men are often favoured in education, inheritance and asset ownership, employment and politics (Kevane, 2014). From early on, boys and girls are brought up differently and the differences in opportunities, rights and expectations affect women throughout their lives. Inequality between boys and girls can be found

within the school system, when already from an early age boys' education is prioritised over girls. In Kenya, many women are affected by discrimination in land tenure systems. It is a common trend in many African countries that women are not legally allowed to own land, or they lose land areas due to patriarchal inheritance traditions (Kevane, 2014). Although women's property rights are protected in Kenya under the Kenyan Constitution of 2010, they still face discrimination and unequal inheritance rights (Musangi, 2017). The lack of access to land can have devastating effects, such as food insecurity, poverty and loss of their homes. Exclusion is not limited to land ownership, but in politics as well. Despite a two-third gender rule (no more than two thirds of the elected body can be of the same gender) introduced by the 2010 Constitution to create equal gender representation in Parliament there is still serious inequality in the Kenyan parliament (Anyango et al., 2018). After the 2017 election, out of the 1835 elected individuals, only 9.2% were women (NDI & FIDA-K, 2018). The two-third bill have not passed and today only 22% of the Kenyan parliament is represented by women, which is less than their East African counterparts (BBC, 2018). This means that Kenya has a long way to go to reach gender parity in political institutions.

In her chapter "The Impact of Cultural Perceptions on Gender Issues", Orchardson-Mazrui (2006) describes how language and visual images can be used as tools to perpetuate cultural values and perceptions that often have had negative consequences for women. Such perpetuations have been traditional cultural views on women as child bearers and carriers of firewood and water, which are stereotypical images that might have kept women from gender parity (Orchardson-Mazrui, 2006). She further describes women's struggle within politics, and female politicians' subjection to violence, verbal abuse, and lack of moral and economical support when involved in the 2002 elections (Orchardson-Mazrui, 2006). A lack of support to female political candidates, including exclusion and discrimination to sabotage their campaigns and political work was directed towards women's political participation during the 2017 election (NDI & FIDA-K, 2018). The resentment to women's participation in politics is explained by cultural socialisation and negative images built around female politicians (Orchardson-Mazrui, 2006). A traditional view on men as being the main leader, common in most patriarchal societies, can harm women's rights and opportunities. Lack of education and illiteracy is likely to make it harder for women to participate in politics and gain knowledge of their own legal rights.

2.2 A Shift from Fossil Fuels to Renewable Energy

We can classify energy resources into two main categories, non-renewable resources and renewable resources (Roopnarain & Adeleke, 2017). The utilisation of non-renewable resources has been an essential contributing factor to the industrial development and economic growth in the western world the past 300 years. Since the late 1800s, fossil fuels such as coal, oil and natural gas have been the main source of energy (IPCC, 2011). The average global surface temperature has increased by approximately 0.8°C, compared to the end of 1800s, and is estimated to increase at 0.2°C every decade if emissions continue at the current rate (IPCC, 2018). The GHG emissions, such as methane and carbon dioxide, traps heat in the atmosphere to the extent that the composition of the atmosphere is changing (Trenberth, 2018). High concentrations of GHG in the atmosphere caused by human activities is considered to be one of the main causes of global warming which is changing the climate (Moomaw et al., 2011; Weiland, 2010). The trapped heat is referred to as ‘global warming’ and the negative effects of this has started to appear in the form of extreme weather events, such as drought, heatwaves, flood, loss of Arctic sea ice and land glaciers which have huge negative consequences for human societies and biodiversity (Trenberth, 2018). These effects are also described as human-induced climate change. The greenhouse gas emissions caused by the burning of fossil fuels are expected to increase along with the global energy demand (Weiland, 2010). A growing global energy demand enhances the need for a cleaner alternative to fossil fuels. As fossil fuels are not renewable energy sources, at some point these energy sources are expected to cease, which puts pressure on establishing alternative energy technologies (Chynowetha et al., 2001). Investments in the development of clean renewable energy sources continues to evolve and a large part of the countries’ action plans consists of renewable energy and energy efficiency measures (Scarlat et al., 2018).

Renewable energy is a term that encompass a wide variety of different forms of technologies that can produce electricity, energy and fuels to cover different types of energy needs such as cooking, heating, lighting and transportation (IPCC, 2011). It is characterised by utilising natural resources that are renewable, i.e. solar, wind, hydropower or biomass, and emitting less GHGs when utilised compared to fossil fuels (Eia, 2018). The potential of renewable energy technology is high enough to cover the world’s energy demand , yet, only approximately 15-20% of the

world's energy demand is produced from renewable energy resources (IPCC, 2011; Painuly, 2001). Replacing energy from fossil fuels with renewable energy technology is considered an important and efficient method to reduce GHG emissions (Chynowetha et al., 2001; Eia, 2018). The diversity of renewable energy technology enables several ways to provide energy while reducing or eliminating emissions and can be suited to different areas (IPCC, 2011).

The largest contributor to renewable energy is biomass. Biomass accounts for approximately 60% of the renewable energy sector and 10% of the world's total energy consumption (see figure 1, Moomaw et al., 2011) (Moomaw et al., 2011). The versatility of biomass production technology is suitable and adaptable to people and areas all over the world. It is therefore considered an efficient replacement of fossil fuels and an important contribution to a green low carbon economy (Scarlat et al., 2018). Biomass absorbs and stores CO₂ from the atmosphere during growth and releases CO₂ when the biomass is burned (Akella et al., 2009). Using biomass to produce energy can solve a waste problem by effectively treating and disposing of organic waste and this has important environmental benefits (Chynowetha et al., 2001; Roopnarain & Adeleke, 2017).

In addition to environmental improvement, bioenergy has other potentials. In rural areas, particularly in developing countries, bioenergy can contribute to development and improve lives by supplying energy that is accessible and affordable with little side effects (Scarlat et al., 2018). Access to efficient, affordable and sustainable energy is important for poverty alleviation and development in poorer regions. Committing to renewable energy will not only benefit the global climate but has great direct benefits for millions of people, especially in rural areas in developing countries, with expensive or inaccessible energy sources.

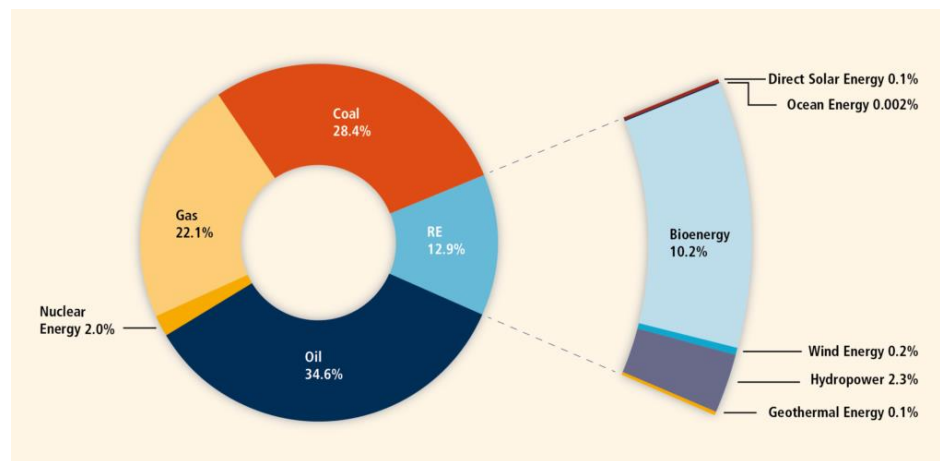


Figure 1: Pie chart of the distribution of non-renewable and renewable energy sources. (Moomaw, W. et al. 2011.)

The three main energy sources in Kenya are biomass (74.6%), petroleum (19.1%) and electricity (5.9%) (Kiplagat et al., 2011). According to the Renewables 2018 Global Status Report, Kenya ranks number 9 in the world when it comes to geothermal power capacity, which they have invested heavily in, and is among the top countries in Africa for cumulative non-hydropower renewable energy capacity (REN21, 2018; Wood, 2008). Eighty per cent of the electricity in Kenya comes from renewable resources with hydropower, geothermal and thermal being the main sources, making it among the world's most sustainable (Kiplagat et al., 2011). However, only 18% of households on the national level have access to grid electricity and in rural areas, the number decreases to only 4% (Kiplagat et al., 2011). A dedication to renewable energy in Kenya is motivated by ensuring reliable energy to the population as well as increasing job opportunities (Wood, 2008). Despite important progress and implementation of energy policies to promote renewable energy by the Ministry of Energy, their renewable energy resources still remains largely unexploited (Kiplagat et al., 2011).

2.3 Biogas

Biogas is a gas produced from anaerobic digestion of biodegradable material (Roopnarain & Adeleke, 2017). The gas is composed of 50-70% methane (CH₄), 30-45% carbon dioxide (CO₂), and small amounts of hydrogen sulphide (H₂S), oxygen (O₂), ammonia (NH₃) and water (H₂O) (Chynowetha et al., 2001; Rupf et al., 2017; Wilken et al., 2017). A wide range of different materials that can be utilised in biogas production, provided they mainly consist of carbohydrates, proteins, fats, cellulose and hemicellulose (Weiland, 2010). Examples are animal

manure, industrial and agricultural waste, crops, food waste, sewage sludge or algae (Roopnarain & Adeleke, 2017; Rupf et al., 2017). The gas is captured and can be connected to a gas burner and be used for cooking and lighting. There are several benefits of implementing biogas, both during the production stage and during the utilisation which will be discussed further.

The availability of resources, as well as low production costs makes biogas suitable for many different households all over the world as the size and scale of the production can be adjusted to individual needs (Weiland, 2010). Because of its versatility, availability and renewability, biogas is considered an alternative to fossil fuels for heating and energy production, as well as providing vehicle fuel (Weiland, 2010). When the biogas is burned, it is not poisonous, and it is less flammable than other gases commonly used for cooking and lighting (Gitonga, 1997). It is an effective way to utilise resources that would have become waste anyway, for example cow dung or agricultural waste. This makes biogas production suitable in developing countries and rural areas.

2.3.1 Production of Biogas in a Fixed Dome

To make biogas, a biodigester is fed a mix of biomass, e.g. cow dung, and water in 1:1 ratio (Heegde & Sonder, 2007). The mix is blended and then released into the digester. The airtight digester eliminates oxygen which causes biological gasification where the bacteria break down the biomass and releases gases, mainly methane and carbon dioxide (Chynowetha et al., 2001; Gitonga, 1997; Wilken et al., 2017). The gases are captured and transferred through pipes from the digester and into the kitchen, where it is connected to a biogas burner stove (Brown, 2006). The gas is most commonly used for cooking but can also be used for producing heat or light. Biogas digesters can look different depending on the type and context. Little maintenance is required when the digester is operated properly, and it can last 20-30 years (Brown, 2006). The daily job of feeding the digester with dung and water is estimated to take about 20-30 minutes, with livestock on site according to an information brochure by the African Initiative Biogas for Better Life (n.d.). To meet the daily cooking and lighting needs of a household, a minimum amount of 0.8-1m³ should be produced daily, which requires 20-30 kg of fresh dung every day (Nes & Nhete, 2007). An estimation of at least 2 cows or 7 pigs is required for gas production on

average to cover this, however this depends on the size and health of the animals. In areas with small and undernourished cattle, at least 3-4 cows might be necessary in one household (Heegde & Sonder, 2007). The capacity of the digesters can be adjusted based on the size, need and available livestock of a family.

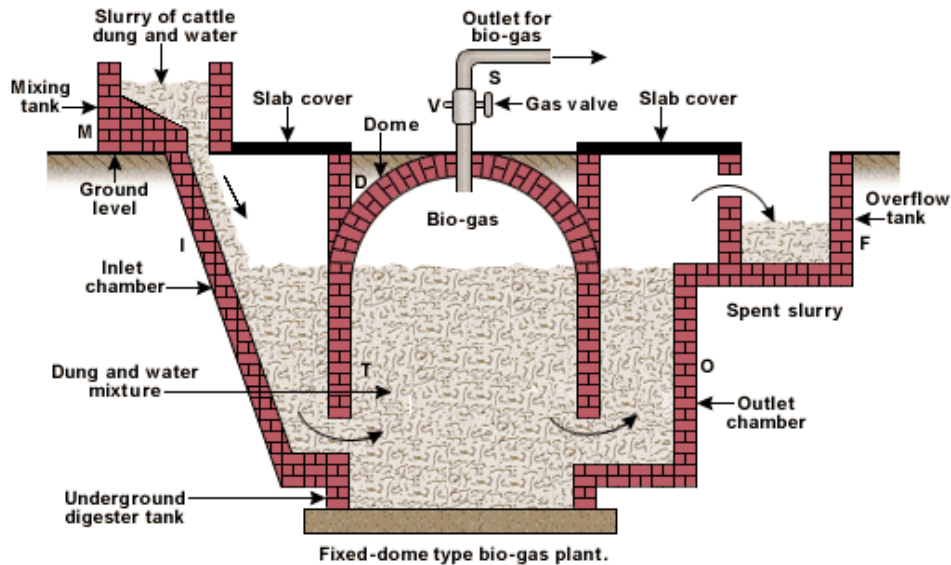


Figure 2: Illustration of a fixed-dome type biogas plant. (Saleh, 2012)

There are four main biogas plant designs in Kenya, and the size of most household digesters varies from 4 to 16m³ (Wilkes & Dijk, 2017). The fixed dome figure 2. Saleh, 2012) and floating drum are the most commonly used designs (Roopnarain & Adeleke, 2017). Figures 3 and 5 show the mixing tank that is a part of the fixed dome digester.

- The fixed dome
- The floating drum
- Prefabricated plastic tube
- The flexible bag



Figure 3: A part of the digester: the mixing tank. The cow shed can be seen in the background. (Source: Heidi Hustad Gleditsch)

2.3.2 Environmental Benefits

Biogas has several environmental benefits and can be important in reducing fossil fuel consumption and to mitigate global warming (Paolini et al., 2018). The use of organic biodegradable waste to produce biogas is a carbon neutral process and is considered an important mitigation act to reduce GHG emissions (Paolini et al., 2018). The decomposition of organic material to make biogas is a natural process (Wilken et al., 2017). Biomass, such as manure, household waste or agricultural crops release gases, such as methane, when decomposing. Methane is an important GHG and contributor to emissions with an estimation of 25-36 times higher global warming power than CO₂ over 100 years (Paolini et al., 2018). Methane therefore has major negative impacts on the global climate when released in the atmosphere. When decomposed through anaerobic decomposing in a biogas digester, the gases are stored and not released into the atmosphere, which reduces GHG emissions (Scarlat et al., 2018). Through combustion of biogas, the methane is converted into carbon dioxide which causes less global warming than methane (Bond & Templeton, 2011; Paolini et al., 2018).

As the use of biogas can replace fuel wood and charcoal for cooking, it can preserve areas of forests and vegetation (Brown, 2006). Eliminating the use of fuel wood is an important method to mitigate deforestation (Bond & Templeton, 2011). Forest conservation is considered an important contributing factor towards reducing global warming because forests work as carbon storage which is essential in the reduction of the amount of GHG in the atmosphere (Karsenty et al., 2003). Biogas production can also benefit agricultural production. The left-over waste is discharged automatically after the production into an overflow tank. This can be used as fertiliser for crops and can replace mineral fertiliser in agricultural production (Weiland, 2010). The digestate that is left over from the production contains phosphorous and nitrogen and is therefore an excellent organic fertiliser (Brown, 2006). This can be especially important for farmers in developing countries or areas where soil nutrient depletion and soil erosion is a problem. This can both help farmers save money on commercial fertiliser as well as increase crop yields (Gitonga, 1997). It can also have a positive environmental impact by eliminating soil, air and water pollution and contamination from manure and reducing the use of chemical fertilisers (Scarlat et al., 2018).

2.3.3 Health Benefits

In addition to environmental benefits, the use of biogas has proved to have major health benefits compared to traditional energy sources (IPCC, 2011). The burning of traditional biomass fuels, such as firewood and charcoal, produce smoke that can cause health issues, such as respiratory and eye diseases. Biogas, on the other hand, releases no smoke or soot when burned and therefore eliminates these health issues (see figure 4). As women on average spend more time cooking, they are exposed to these health issues more than men (Brown, 2006). A shift from traditional fuels to biogas can eliminate these issues and improve the quality of life for millions of people. A study from Kenya shows that women with biogas plants installed had less breathing problems and less chest pain compared to those that did not have biogas installed (Wilkes & Dijk, 2017).

Further health benefits are the improvement of outdoor hygiene and reduction in pathogenic contents from animal manure, which can improve the health of the users (Bond & Templeton, 2011). By connecting a toilet to the digester, it can further improve sanitary conditions. Time consumption is also likely to change with the introduction of biogas. When less time and effort is required for fuel wood collection, the workload for women is reduced.



Figure 4: A biogas stove burning biogas. (Source: Heidi Hustad Gleditsch)

2.4 Biogas Around the World

The production of biogas is increasing worldwide, and there are great variations in how biogas is produced in industrialised and developing countries. In developing countries, biogas is mainly produced on a smaller household scale using cattle dung (Rupf et al., 2017). Here, decentralised domestic production in small digesters, where the biogas is predominately used for cooking and lighting within a household, is the most common (Scarlat et al., 2018). In industrialised countries, biogas production is usually farm-based or centralised commercially, produced for electricity, heat and transportation (Roopnarain & Adeleke, 2017; Scarlat et al., 2018).

Within the European Union (EU), due to renewable energy policies, the use of renewable energy has increased from 8.5% in 2005 to almost 17% in 2015 (Scarlat et al., 2018). The United States and Europe produce the highest share of biogas in the world and Europe had more than 17 400 biogas plants in 2015 (Scarlat et al., 2018). The United States mainly uses biogas for power generation produced from landfill gas (REN21, 2018). In Europe, biogas is mainly produced from agricultural waste, including animal manure, and food waste (REN21, 2018). Germany alone accounts for 50% of all biogas production in the EU (Scarlat et al., 2018). The *Energy and Climate Change Package* was proposed by the European Commission in 2007 and the commitment consisted of an at least 20% reduction of GHG emissions by 2020 compared to 1990 level (Scarlat et al., 2018). The commitment also requires the member states to increase their share of renewable energy to at least 20% (Scarlat et al., 2018).

In South America, Bolivia is the leading country regarding biogas digesters, with more than 1000 domestic plants installed (Scarlat et al., 2018). Several Asian countries are exploiting their potential for domestic biogas with the help of national programmes, such as Nepal, Vietnam, Cambodia and Bangladesh (Heegde & Sonder, 2007). In 2004, the number of domestic biogas installations in India grew to 3.67 million (Heegde & Sonder, 2007). By the end of 2010, the total number of operational biogas units in China were 40 million (Mwirigi et al., 2014).

Approximately 60% of the population in Africa live in rural areas where access to electricity is very limited (Roopnarain & Adeleke, 2017). The most common energy needs for rural African households are cooking and lighting, and for about 75% of households, wood fuel is the main

energy source to cover these needs (Wilkes & Dijk, 2017). The traditional use of biomass for cooking, e.g. firewood, is usually unsustainable, contribute in some cases to deforestation and a major driver for negative health impacts and is time consuming (Mwirigi et al., 2014; REN21, 2018). Due to large amounts of energy resources as well as a suitable climate for production, biogas holds a lot of potential as an alternative energy source in Africa (Roopnarain & Adeleke, 2017). However, despite large amounts of available organic waste, Africa is the region that has the least developed biogas production in the world (Scarlat et al., 2018). Looking to success stories in Asia, it brings hope that the same can be accomplished in Africa, however, the technology is still in early stages (Roopnarain & Adeleke, 2017). Currently, several African countries are installing biogas digesters with the help of national programs (Scarlat et al., 2018). An increase in the involvement of NGOs in biogas programmes in Africa have contributed to a drastic improvement in the biogas sector in Africa since 2008 (Roopnarain & Adeleke, 2017). An African initiative, Biogas for Better Life, aims to install biogas diesters in 2 million households as a way to reduce deforestation, improve health and provide clean energy (Scarlat et al., 2018).

2.4.1 Biogas in Kenya

European farmers introduced biogas technology in Kenya in the mid-1950s as one of the first countries in Africa to use this technology (Mwirigi et al., 2009). Through awareness raising and the aim to reduce the use of firewood, biogas was promoted in the 1980s and 90s and during this growth in the development of biogas technology, about 300 plants were installed (Gitonga, 1997; Kiplagat et al., 2011). Despite the efforts and potentials of biogas, the spread of biogas technology has been slow (Kiplagat et al., 2011). By 2004, only approximately 800 plants had been installed in Kenya (MOE, 2004 as cited in Mwirigi et al., 2009).

The Kenyan National Domestic Biogas Program (KENDBIP) revolutionised the biogas sector in 2009 (Kenya Biogas Program, 2019; Roopnarain & Adeleke, 2017). Initiated by the African Biogas Partnership Program (ABPP), a partnership between Humanist Institute for Development Cooperation (Hivos) and the Netherlands Development Organization (SNV) that supports domestic biogas programs in Ethiopia, Kenya, Tanzania, Burkina Faso and Uganda, KENDBIP has installed 16 000 biogas plants in Kenya by 2015 (Kenya Biogas Program, 2019). The

ongoing programs have had an important positive impact on and improved living conditions for thousands of Kenyans (Roopnarain & Adeleke, 2017).

There is currently a major lack of energy access in Kenya and the majority of rural households relies on traditional fuels to cover their energy needs (Gitonga, 1997; Roopnarain & Adeleke, 2017). Based on the household availability of dung and water, it is estimated that 1.25 million households in Kenya have the technical potential for biogas technology (Kiplagat et al., 2011; Roopnarain & Adeleke, 2017). Hindrance to the spread of biogas technology in Kenya are believed to revolve around lack of information about the production and benefits, high installation and maintenance costs, and lack of access to water (Kiplagat et al., 2011).



Figure 5: Women mixing water and cow dung in preparation. (Source: Heidi Hustad Gleditsch)

2.4.2 Limitations and Challenges Related to Biogas Installation and Production in Kenya

Despite the great possibilities and benefits of biogas in Kenya, the potential is still largely unused and the adoption of biogas technology is lagging behind compared to other places in the world (Roopnarain & Adeleke, 2017; Scarlat et al., 2018). There are several reasons for this. To ensure the sustainability and social, economic and environmental benefits of bioenergy, proper production design, implementation and monitoring is essential (IPCC, 2011). For renewable energy to replace fossil fuels, it must be available, efficient and economically attractive. Although the cost of renewable energy production has decreased significantly in the past 30 years (Akella et al., 2009), high installation cost is a major hindrance to the expansion of biogas technology in Kenya. Although, when installed, biogas is more or less free, the upfront investment cost of installation is unaffordable for many people. Without financial support, or no direct immediate economic gain, few rural households can afford the high investment cost. Several national and international development agencies offer financial support to households for biogas installations in Kenya, either through loans or sponsorships.

With proper construction, operation and sufficient maintenance of biogas plants, biogas technology can be very cost-effective and contribute to a sustainable source of energy (Gitonga, 1997). Lack of access to water is an important restricting factor to successful operation of biogas plants (Mwirigi et al., 2014). Many areas in Kenya lack sufficient water quality and access (FN-Sambandet, 2018). Failing to use the digester properly or perform adequate maintenance, can cause issues. Methane emission during production and utilisation might occur and can both contribute to global warming as well as pose a significant safety risk (Liebetrau et al., 2017). Other causes can be improper maintenance and damage to the construction (Wilkes & Dijk, 2017). Land tenure security can be in issue, especially for women (Mwirigi et al., 2014).

3. Methodology

Methodology is the meeting point of epistemology, the theory about knowledge, and methods, the technique used to gather data and analyse the information (Sprague 2005 as cited in Hoare, 2007). The following chapter will give an overview of how data in this research were collected, researched and interpreted.

3.1 Qualitative Methods

This research study was conducted using a qualitative research strategy. Bryman (2016) describes qualitative research as emphasising words as opposed to quantification of data. This approach to research is common within social studies where the aim is to understand and explain the human experience and collecting data in a natural setting (Stewart-Withers et al., 2014). This can be done in a number of ways, but it is often conducted through in-depth interviews, using inductive analysis, and by focusing on specific groups, rather than large groups of people (Stewart-Withers et al., 2014). A qualitative research approach was chosen for this study because the aim was to create an understanding of women's views and experiences regarding production and use of biogas. Through a qualitative approach, this study researches women's experiences using in-depth interviews in rural villages in Kenya and seeks to understand relationships and dynamics between people and their surroundings.

3.1.1 Feminist Methodology – Research from a Gender Perspective

The purpose of this research project was to understand and convey women's experiences regarding biogas and how they are affected by the implementation of this technology. To accomplish this, I used a feminist research method for data collection to investigate women and renewable energy in rural Kenya. A bias towards male perspectives in traditional methodologies and the lack of objectivity in research have generally ignored women's perspectives and knowledge (Beetham & Demetriades, 2007). Feminist research methods emerged throughout the 1970s and 80s, as women's studies departments grew along with women's involvement in post-secondary education (Dankoski, 2000). This has been described as a 'second wave feminism', where the first wave occurred in the early 1900s along with the suffragette movement (Landman, 2006). Doing research from a gender perspective is important to recognise gender specific issues and constraints and acknowledging the different roles and needs of men and women. According to Bryman (2016, p. 403), 'the goals of feminist research should be to conduct research specifically for women'. Feminist research aims to understand women's experiences and needs (Landman, 2006). In addition to this, feminist research will acknowledge the wide diversity between women's experiences, and do not assume that all women's needs, thoughts and experiences are the same (Harding, 1987 as cited in Landman, 2006).

Critique of feminist methods as a research tool involves the use of women as "research objectives" (Landman, 2006). Oakley (2016) addresses the researcher-researched relationship during interviews. She uses the term 'reciprocal relationship' to describe the power dynamics between the interviewer and interviewee. She claims that a one-way information flow in interviews is not a reciprocal relationship and can make the interviewee powerless. By using her own experience of interviewing women transitioning from pregnancy to motherhood, she claims that answering the participant's questions during the interviews strengthened the trust and honesty as well as providing the interviewees with something (useful information) in return for their time and participation. This is important to avoid exploitations of interviewees. Letherby (2004b as cited in Landman, 2006), on the other hand, claims that the power balance shifts between the researcher and participant during the interview. She points out that the participants cannot be considered powerless, but rather the opposite, as she is the one holding the data. Further critique, is that by the interviewer offering their own point of views or comments, this

might influence the responses of the participants, which might cause error and bias in the data (Bryman, 2016). The way this research study has undertaken a feminist research approach is by reflecting on my own roles as researcher, listening to women's views and experiences through a two-way interview process, and not considering the participants as a homogenous group.

3.2 Reflexivity

An important part of feminist research is to address one's position and role in the research. As I approached the field, it was important to reflect on how my personal background, experiences and perceptions would influence my research and writing of the thesis. Throughout the research process, my role in the research was constantly reflected on. By using a feminist methodology, the aim is to eliminate power issues and imbalance in the relationship between me, the researcher, and the participants (Bryman, 2016). To do this, it was important to be aware of my role as a white western researcher doing research on women in a developing country. By addressing my inherited perceptions and being aware of how they could and would affect my work, the aim was to remain as objective as possible. By leaving assumptions behind and entering the field with an open mind knowing that we cannot assume things about people, societies and their relationships with one another I aimed to remain objective throughout the research process.

The GAM Framework addresses unequal power relations between participants and researcher as something that might influence the research and cause misleading outcomes. The risk of this is described as community members withholding information fearing that it might negatively impact the funding or benefits (March et al., 1999). I believe having an honest and open dialogue with the participants about my role, was helpful to avoid this.

3.3 Contextual Background

3.3.1 Kenya

Kenya is located on the East coast of Africa, bordering to the Indian Ocean and Somalia in the East, Ethiopia and South Sudan in the North, Uganda in the West and Tanzania in the South (figure 6. CIA, 2019). The country has a population of approximately 49 million and the official languages are English and Swahili. The climate is tropical, with a lot of sunshine year-round. Areas around the coast are hot and humid, with a more temperate climate inland, while the northern parts of the country are very dry (Kiplagat et al., 2011).



Figure 6: Map of Kenya (CIA, 2019. *The world Factbook. Kenya.* <<https://www.cia.gov/library/publications/the-world-factbook/geos/ke.html>>. Accessed 30.04.19)

Arabic merchants settled along the coast in the 700s and the Islamic religion and the Swahili language influenced the inland habitants as it spread along the Arabic trade routes (Commonwealth Secretariat, 2019). Invaded by the Portuguese in the 1500s, the Kenyan coast became an important slave and commodity trade route to India. During the Berlin Conference in 1884-1885, Kenya came under British rule, and the British colony Kenya was formally formed in 1920 (FN-Sambandet, 2018). Trading stations and plantations were quickly established. With the British colonial rule, the local population was strongly suppressed, and as British and Europeans settlers occupied bigger areas in the country, issues such as land distribution arose (FN-Sambandet, 2018). Conflicts related to the distribution of land are still prevalent in Kenya today.

Oppression of Kenyans, marginalisation and lack of land-owning rights eventually led to the Mau Mau uprising. What started as a peaceful campaign demanding land ownership rights for Kenyans after being marginalised by white settlers for years, developed into armed rebellion from the Kenyans. The British declared a state of emergency in 1952 and for the next eight years, thousands of Kenyans were captured and placed in prison camps (McDonough, 2018). Thousands of rebels were killed. Kenya gained independence in 1963 and became a republic the year after. A combination of western involvement through foreign investors and citizens remaining in the country during independence, and foreign teachers and aid workers, supported

the economy after independence (Hornsby, 2013). This proved to be important for the survival of the government (Hornsby, 2013).

Despite a rising economy, obstacles such as corruption and lack of modernisation have delayed economic development (FN-Sambandet, 2018). Despite this, Kenya had a GDP of USD 74.9 billion in 2017, which is among the highest in Africa, and the most developed in East Africa (Kiplagat et al., 2011; World Bank, 2018), and is classified as a lower middle income country (Kimenyi et al., 2016). Agriculture accounts for approximately 24% of the GDP, and the most important cash crops are coffee, tea, wheat and corn (Kiplagat et al., 2011). Small-scale farming, rain-fed farming and livestock production account for 75% of the agricultural output (CIA, 2019).

3.3.2 Areas of Research

Interviews took place in three rural locations in Kenya. Kangundo in Machakos county where 13 participants were interviewed. Kitui, a town and the capital of Kitui county, approximately 160 km east of Nairobi. The climate in this area is mostly hot and dry, which has caused some issues related to biogas production. 3 participants were interviewed. The last locations were rural areas in Nairobi, the capital of Kenya, where 28 participants were interviewed. The areas have slightly different climate and environment which I believe have an impact on the production of biogas. The findings from the three different areas will be presented and analysed collectively.

3.4 Data Collection and Fieldwork

To answer the research questions, this study uses both primary and secondary data. Primary data are personal interviews conducted to collect people's experiences and perspectives. The primary data collection consisted of visits to households with installed biogas plants. The secondary data were research articles to get an overview of the information on previous research done on the topics. A lot of background information was collected about the country and areas of research before the fieldwork.

3.4.1 Selection of Study Site

The study areas were selected based on where Help to Self-help in Africa (HSA) work in Kenya. HSA is a Norwegian NGO that has financially supported installations of over 50 biogas plants in Kenya. The organisation worked as a gatekeeper and provided access to relevant respondents for my data collection. Having a gatekeeper was necessary to get in touch with participants. Their connection to the areas, the county officials and local communities provided me easy access. Prior to my arrival, representatives from HSA had been in contact with possible participants to inform them of my visit and purpose. I was accompanied by a local driver in the field who assisted with interpretations and general practical knowledge regarding customs, traditions and everyday life. In some areas, due to the infrastructure and the locations of the households, an extra person involved with HSA's biogas projects joined us in the field for navigation purposes. I believe being joined by people familiar to the areas and the participants was essential to my data collection. It not only helped gaining access to respondents but also to gain trust and credibility among the participants.

3.4.2 Selection of Respondents

This research conducted purposive sampling of respondents. According to Bryman (2016) purposive sampling is when units of research are chosen intentionally, rather than randomly. This approach is often used in interview-based research (Bryman, 2016). Because the aim of this study is to determine the consequences of the implementation of biogas plants for women, the sampling criterium was women with functioning biogas plants on their properties. The sampling procedure was purposive sampling because all the participants were selected based on their relevance to the research; being women and having a biogas plant. The fieldwork included visits to several households with non-working biogas plants. This allowed for a better understanding of the issues people can face when trying to produce biogas and learned about the different reasons why some plants are out of function.

3.4.3 Sample Size

Before the data collection began, the aim was to conduct a minimum of 40 one-on-one interviews with women. The final sample size after data collection was 45 personal interviews, consisting of 41 women and 4 men. I am pleased with the number of interviews I conducted with

women and feel like I was able to collect a sufficient amount of information. The reason why I did 4 interviews with men is because in some cases when arriving at a house to do the interview, the women were not present or available. In those cases, I chose to interview the men instead. As this sample size is limited it cannot be generalised and applied to the whole of Kenya, and the findings from the interviews in the results chapter is solely from the interviews with the women. Nevertheless, they did provide me with useful insight and interesting information, and their contributions are valued.

3.4.4 Interviews

For this study I used in-depth and semi-structured interviews. The interviews took place either in the participant's houses or in their gardens and lasted between 30-90 minutes. The first part of the interviews followed an interview guide with questions about their biogas production. This included practical background information, such as how long they have been making biogas, how much time they spend and the number of cows they have. It also included questions about their experiences and possible benefits as well as challenges they might have endured. This was to establish some background information and to get a clear understanding of the status on biogas in their home. The second half of the interview was in-depth interviews where I asked their views and opinions on certain topics. This part of the interview did not follow an interview guide but was rather a conversation that the participants lead freely towards what they wished to talk about. The topics that were discussed were mainly gender roles, gender equality, decision-making within the household and the surrounding natural environment. I conducted the research using a feminist approach, and this was reflected in the interviewing process. I initiated a conversation on some of the topics by giving my own point of view. This encouraged the participants to share their own perspectives on the topics.

3.5 Data Analysis

The primary data is analysed using a thematic approach. This approach to the data analysis consists of search for themes, also called codes or categories, which can be sorted into central themes and subthemes (Bryman, 2016). While investigating the data and looking for themes, I will look for any repetitions, categories, metaphors, similarities and differences that are relevant to the research questions (Bryman, 2016). During the interviews I chose to use manual noting

instead of a recorder. The reason for this was that I worried that using a recorder would create a barrier between me and the respondent and that they would be reluctant to share information. This led to a large workload after each interview, which was transcribed and sorted every day. The analysis will aim to clearly present the personal experiences of the women, and their views on the topics discussed during the interviews.

3.5.1 Reliability and Validity in Qualitative Research

Reliability and validity are ways to assess the quality of the research by looking at whether it measures the concepts that we wanted to measure and if another researcher could perform the very same study and get the same results. Due to the naturalistic approach and often limited samples of qualitative research, the aim is not to derive results through quantification that can be generalised (Golafshani, 2003). Rather, the aim is to understand and enlighten social situations and phenomena. Cuba and Lincoln in Bryman (2016) propose two alternative criteria to assess the quality of qualitative research: trustworthiness and authenticity. Trustworthiness is composed of four criteria: Credibility, transferability, dependability and confirmability. The criteria of authenticity entail what the research has contributed within the research field, such as creating better understanding of the social environment and empowered members to engage themselves to make desired changes in their community. The criteria also address whether the research can contribute with a fair representation of the different perspectives of the participants. Considering these criteria is important to achieve a high-quality research paper. Reliability and validity are ensured in this paper by sampling participants that are relevant to the research questions, presenting their experiences and perspectives fully to ensure that the paper actually reflects their realities. By using relevant, acknowledged and peer-reviewed information sources, the quality of the information is strengthened. The research has followed ethical guidelines before, throughout and after the fieldwork and the context of and approach to the research has been explained. This includes a thorough and conscientious assessment of limitations of the study.

3.6 Challenges and Limitations During and After Fieldwork

When doing any kind of research, and especially when doing fieldwork, it is common to encounter some problems underway. One of the main challenges I encountered during this research was using a translator during the interviews. The majority of the respondents were

fluent in English, and in those cases the interview was conducted in English. In the cases where the respondents did not speak English, I used an interpreter. The interpreter was Kenyan with great knowledge of the country, local culture and traditions and experience with biogas. The issues of information being lost in translation is always a possibility. However, I believe this is a result of not only speaking different languages, but our different backgrounds and perceptions can also influence how we understand each other. When possible, I aimed to have no one else besides the respondent present during the interview, but while using a translator I worried that a man's presence would have an influence on the answers given by the respondent. Since asking questions regarding gender roles and decision-making in the household, I worried some people might have inhibitions talking about these topics, not only with a man present, but also having such a conversation with a foreigner.

Feminist research will aim to employ several methods when doing research. As this research study used mostly interviews, this might have limited the feminist perspective of the research. A mixed methods approach to triangulate the results would have strengthened the results and enriched the research by providing a more nuanced analysis of the situation on gender relations (Hoare, 2007). However, being alone and limited by time, I believe this was the appropriate choice of methods for this research study based on the context. Some will argue that men and women should be represented equally in the study, as well as including different social classes in the interviews (Dankoski, 2000). The reason for choosing to interview only women was limited time and resources, as well as an intention to completely focus on women's view and experiences.

With qualitative methods, generalising the findings to apply to other areas is usually not possible, due to a small number of respondents. I can therefore not assume that the views, perspectives and thoughts of the women I interviewed are representative to other women within their communities or in other communities in Kenya. The aim is not to speak on behalf of all women. However, the research might contribute in presenting different perspectives, opinions and needs, that can be useful when implementing development projects.

As this research paper is investigating possible changes after implementing biogas, ideally the interviews should be done both before and after the biogas was installed. This, I believe, might provide a more accurate documentation of possible changes over a longer time period. Since the fieldwork based on interviews took place *after* the implementation, it relies on participants providing an accurate picture of previous conditions. Nevertheless, the research investigates women's experiences and opinions on this matter, and through interviews, I believe the conditions have been described sufficiently.

3.7 Ethical Considerations

While working with this research project, ethics related to informants and writing have been carefully considered. Ethics are important during the fieldwork, but also afterwards during transcribing, data analysis and writing of the thesis. Thagaard (2013) discusses three main principles for ethical guidelines in research that all have been followed during the production of this thesis. The principle of informed consent means that you must have informed consent from the participants before the research can start (Thagaard, 2013). As well as agreeing to the research, it also entails the ongoing right to withdraw from the research at any times, both during and after the research has finished. Before each interview, the participants were informed about my reason of visit, the purpose of the study and what it meant for them to participate. This included their rights to not participate or right to withdraw at a later point, without any questions asked or consequences for them. They were ensured full anonymity throughout the entire research project and beyond, that participation was voluntary and that not partaking would not have any negative consequences for them. The information was given in both English and their native language. All participants gave written consent prior to the interviews.

The principle of confidentiality protects the participants personal information. This demands special precautions in handling data at all times during and after the data collection to ensure that the privacy of the participants is protected (Thagaard, 2013). This was done by using reference numbers rather than names to make it impossible to track the information back to each participant. Thirdly, protecting the integrity of the participants must be done by considering the consequences for them to participate in the study (Thagaard, 2013). This entails respecting their answers and behaviour, not analysing the interviews out of context, or causing any negative

consequences for the participants (Thagaard, 2013). This research study is approved by and follows the ethical guidelines of NSD – Norwegian Centre for Research Data. This entails collecting written informed consent from participants and storing personal information according to the requirements.

4. Results and Discussion

This chapter will present and discuss the findings from the research. I am using the Gender-Analysis Matrix Framework to analyse and discuss the four kinds of impacts: labour, time, resources and socio-cultural factors. Other impacts of significance will also be included. During the thematic analysis and sorting of the collected data, the information from the interviews was sorted into a table based on the Gender-Analysis Matrix Framework. Table 1 is an excerpt of this. The reference number of the participant is in the column to the left, and information from the interviews are filled in under each impact. The purpose of this was to create a clear overview of the impacts and to identify the views and experience of the participants, which will be presented in this chapter. Further, this chapter will present and discuss changes in gender roles and labour distribution followed by the implementation of biogas in the households.

Table 1: Data from fieldwork sorted in the GAM Framework. The descriptions of each impact in the top row in the table are from March (1999).

Participant	Labour <i>-Changes in tasks. -Level of skill required. -Labour capacity</i>	Time <i>-Changes in the amount of time it takes to carry out activities related to the project.</i>	Resources <i>-Changes in access to resources caused by the project. -Women's control over resources changes</i>	Socio-cultural factors <i>-Changes in social aspects of the participants lives as a result of the project. -Changes in gender roles or status as a result of the project.</i>	Benefits/challenges <i>-Positive outcomes for the participants as a result of the project. - Issues related to the project for the participants.</i>
1	She does it herself, it is more economical	Spends about 5-10 minutes a day	She does not have to buy anything to produce the biogas, as she already has all the resources available	Before biogas, her husband did not cook, now he will cook.	More freedom: you can cook at any time, even during night. More efficient than charcoal Safer for the children Can cook inside when it rains and does not have to worry about wet fuelwood

					Saves times and money
2	Herself	Spends 20 minutes once a day. Before she would spend 2-3 hours collecting firewood.	She has the resources readily available, and does not have to buy anything extra	No changes in the household	Cooks fast Time saving The manure is good for the crops Sometimes not enough fire/gas (if you don't fill the tank every morning) Easier and faster to use than firewood and charcoal
4	She got training and is using it herself	Half an hour	Her problems related to getting firewood is now gone.	Her husband can go in the kitchen and cook, which she is happy about.	Health: she no longer needs glasses, due to no smoke Economy: saves money. Uses fertiliser Eliminates problem with firewood
5	Herself	She spends about 15 minutes every day, which is less than when she was using firewood.	Sometimes lack of water, not enough to make the biogas.	Her child can cook as well	When she goes away, there is no gas when she comes back, because she didn't prepare it.
8	Herself	She does not spend much time, only about 20 minutes. It is very fast and makes work easier.	You have to have the waste to make the gas. Also have to feed to cows properly.	Her children can cook as well.	No smoke, she is allergic to smoke. It reduced her expenses. Can cook when it rains Have to make sure you have the gas
11	Herself	Spends 10 minutes	Have to supplement with gas and firewood, as there is often not enough cow dung (2 cows).	Her husband would cook before they had biogas, and also continues to cook now.	Cheap and accessible – she already had cows.
15	Finding workers to do it can be challenging. When you can't do it yourself, you have to hire help. She hires somebody to do it, but when they leave, she has to do it.	30-40 minutes daily.	Free access to resources when using biogas. When she used firewood, it was hard to access, due to economy, and that she needed help from men to help her get it.	No gender roles, everyone cooks, washes etc. They make decisions together. There have been no changes in gender roles.	Economical

17	She has workmen who help her do it.	30-40 minutes every day.	Access to water can sometimes be challenging. There are a lot of different needs for the water (people, digester etc), and sometimes there is not to make biogas.	She doesn't think there should be specific roles, in reality, African women are overworked. Decision-making: if she does not agree with the decision made by her husband, she'll "go behind his back" and try to change his mind without his knowledge 'be clever'. Boys and girls are told different things. No changes in gender roles after biogas.	Getting enough water is a challenge. Sometimes she is busy or tired and does not want to make the biogas, but she has to otherwise she will not have any gas.
20	Herself	Spends half an hour	They have cows and access to dung.	They distinguish between gender roles and tasks. Her= cook, him=outside work. There have been some changes: Now the husband can make tea and coffee. Before, when they used firewood, he could not do that. Now he prepares food because it's easy, clean and fast.	Fast, clean and cheap. They save a lot of time and money. Problems when it is raining or cold, then the quality of the biogas is not so good.

4.1 The Use of Biogas in the Visited Households

Through the interviews I began to investigate when, how and to what extent biogas was being used in the visited households. The aim was to establish some technical background information about biogas use among the participants, then further address more specific changes and attitudes regarding economy, time management, health and gender roles. The time range the participants have been using biogas ranges from six months to 11 years. All the participants have received funding to support the installation of their biogas digesters, and many pointed out that they would not have been able to afford the plant otherwise. The following sections will explore more in depth the women's experiences with biogas.

4.1.1 Motivations to Get Biogas and How it Was Introduced

To better understand the attitudes toward biogas, I sought out to understand what had motivated the women to get biogas. Most of the participants learned about biogas by either seeing or hearing about it through neighbours or relatives. Other people's positive experiences and the benefits they gained were important contributing factors for people to express their own interest in installing the technology.

Access to fuel resources, or lack thereof, was an important motivator to get biogas among many of the participants. Increase in prices of charcoal and firewood, as well as a government ban on cutting trees, have made traditional energy sources more difficult to obtain, which can threaten food and energy security. The necessary resources for biogas production (cow dung and water) are already available for many people which makes producing and using biogas more convenient and affordable. One participant explains that she does not have the space to grow firewood on her property, but she has the space to have cows. All the participants use cow dung, while one uses pig manure.

Simpler and safer cooking conditions were also major contributing factors. The elimination of smoke when cooking with biogas was an important motivator for many women. Additionally, faster and more efficient cooking stove was a driving factor. The simplicity and efficiency of the production and utilisation of biogas was emphasised by several participants. As little technical skills are required to operate the plant, they were all eligible and they were trained in using it.

Few people were motivated by the environmental aspects of biogas. Being environmentally friendly did not seem like a concern for most people but is rather viewed as a positive side effect. It seems like many people have increased their interest in clean renewable energy after getting biogas and look for ways to expand environmental conservation into other areas of their lives.

Results imply that there was a strong motivation among the participants to implement the technology. There was an overall positive attitude towards the installation of biogas, and many of the participants expressed their gratitude towards HSA for help with funding. Their interest and engagement are important for a successful and sustainable development intervention. Knowing

what motivates the women to install biogas digesters can be important in understanding their needs, and then later assess how these are met. This is important to determine the success of the project and to solve possible issues and limitations.

4.1.2 Benefits from Biogas Production and Use

When discussing the use of biogas and interviewing the participants about their experiences, the respondent often began by explaining all the positive changes that have followed the installation of biogas. Several of the same benefits repeated themselves throughout the interviews, which will be presented and discussed. The most reported benefits of biogas adaptation for the women are as following:

4.1.2.1 Economy

Improved financial situation was an important and frequently mentioned benefit from the implementation of biogas. The low expenses linked to the production of biogas is an important contributing factor to keeping rural small-scale biogas productions sustainable. Many people already have all the necessary resources to produce the gas, such as cows and water, available, which makes the production cost-effective. By utilising these resources that are already available, there are no extra expenses related to biogas production. In addition to this is the economic benefit of not buying fuels, such as firewood, charcoal and gas cylinders. Producing biogas will in most cases eliminate the need for external fuel sources, which in the past have been extra expenditure. Reducing these expenses allows the biogas user to save money or spend money on other things. However, findings did show that some of the participants still to some degree rely on alternative energy sources, which means that extra expenses still remain in some households.

In addition to the reduction of expenses for fuels, many participants save money on fertiliser for their crops by using the slurry left over from biogas production. In many cases, the cow dung was already being used as fertiliser, but according to several participants it is now of higher quality. Some women have been able to increase crop yields as a result of the slurry and this has allowed them to sell the surplus output, which provides extra income. As their work within the home is to a large extent unpaid, selling crops can give them needed income.

Economic freedom and opportunities are important for women, who often will experience poor job opportunities and less income than men. Reducing economic expenses related to energy production can be an important step towards economic empowerment and extended freedom of choice for women. Some participants expressed frustration related to the increase in the price of charcoal, but having biogas removes this extra expense and frustration. In areas with low income levels and high expenses of fuel, biogas can provide energy security which is important for the wellbeing of the households.

4.1.2.2 Health

In low-income developing countries, 80% of household fuel consumption is covered by the use of biomass fuels (Cecelski, 2000). As the primary managers of household energy, women bear the main burdens connected to the production and use of energy (Wilkes & Dijk, 2017). The use of biomass fuels as an energy source for household cooking can have major health implications. There are many reports of health issues, such as back pain and respiratory problems (Cecelski, 2000; Wilkes & Dijk, 2017). A woman using fuelwood for cooking is continuously exposed to indoor air pollution, caused by soot and smoke from the burning of firewood or charcoal, which can cause severe health issues, such as respiratory infections and eye diseases. Respiratory disease, such as infections and asthma was estimated to cause 1-2 million deaths in year 2000 (Brown, 2006). As biogas burns clean without harmful emissions or smoke, it eliminates toxic pollution in the kitchen. This is an important health improvement which benefits women as well as their children.

Some of the participants or their children have previously been struggling with health issues such as respiratory problems or eye problems, that have completely gone away after transitioning to biogas. One of the participants no longer needs glasses as her vision has improved after switching to biogas. Another participant mentions that her son's breathing problems caused by smoke is gone. Better health also reduces expenses related to medicines. Having safe and clean cooking conditions have major positive health benefits and is important for well-being. Hospitals might not be accessible to many people and consulting a doctor might not always be possible. Health problems can keep women from achieving their goals, and it can affect other aspects of their and their children's lives.

4.1.2.3 Time

The impact on time is an important part of gender analysis according to the GAM Framework. High time consumption is one of the consequences of traditional energy use that have been characterised as a burden to women. The time intensive collection of traditional fuel can prevent women and children from participating in education and other important activities (Heegde & Sonder, 2007). The time women spend in and around the household are important economic contributions, but their effort is often unrecognised and unpaid.

Time consumption was brought up several times during the interviews. Both in terms of the time spent preparing and producing the biogas, and the amount of time spent cooking on biogas stoves. Reducing the time spent on producing energy and cooking, appeared to be an important motivating factor for many participants to install biogas, and it was a frequently mentioned benefit from the technology. As previously mentioned, collecting firewood, and buying charcoal and gas is time consuming and expensive, and this was confirmed by the participants. Having all the necessary resources for biogas and the digester readily available on the property allows them to produce the energy on-site which makes the production more time efficient. Many participants explain that faster energy production saves them time, which can further increase their time management options. The time spent on producing the biogas, meaning the time spent collecting dung, mixing it with water and feeding it to the digester, ranged from 10 minutes daily to 2 hours, from every day to twice a week. On average, the participants who produced biogas every day, spent approximately 30 minutes every day. Many of the participants expressed happiness that the energy production is less time consuming, compared to traditional fuels where some women reported spending 2-3 hours every day on collection.

“I save a lot of time that I spend on reading and researching, visiting friends and work on my business.”

The following tables give an overview of how much time participants spend on making biogas. Table 2 presents the participants that make biogas every day while table 3 presents the participants that make biogas 1 day to 4 days per week. The time specified under ‘time spent’ in table 3 indicate each session, not all days combined.

Table 2: The number of participants that make biogas every day.

Participants making biogas every day	
Time spent:	Number of participants:
5-10 minutes	2
10 minutes	2
15 minutes	2
10-20 minutes	1
20 minutes	4
30 minutes	7
30-40 minutes	1
30 minutes-1 hour	2
45 minutes-1 hour	2
1 hour	2
1-2 hours	1
Unspecified	3
Total:	29

Table 3: The number of participants that make biogas less than every day.

Participants making biogas less than every day		
Frequency:	Time spent:	Number of participants:
Every other day	Un-specified	1
Three times per week	15 min	1
	30 min	1
	1 hour	2
Twice per week	2 hours	1
	Un-specified	1
Once per week	30-45 min	2
	1 – 2.5 hours	2
	Un-specified	1
Total	12	

Some participants mentioned that the biogas stove is more efficient because it cooks faster compared to traditional energy fuels, which has reduced the time they spend cooking. For some, this meant being able to cook in the morning before school, which increases her freedom. For many of the participants, extra available time means more time to spend on other household chores. For others, it meant spending time on hobbies, their children, women’s groups and work outside of the house.

Kevane (2014) addresses people’s perceptions about men and women’s workloads in Africa, and states that the differences in workloads are not as significant as many people tend to assume, as the number of hours they spend on average are nearly the same between men and women. According to World Bank (2001), this is only the case in high income countries, while in low-income countries, the difference in men and women’s average time consumption is more significant. Women’s work hours will usually decrease as household income increases (World Bank, 2001).

Whether the hours of labour between men and women are unequal, labour-saving technology might improve people's physical and mental well-being. Kevane (2014) emphasises that rather than merely looking at hours spent working, we should aim to understand the reason behind how people choose to allocate their labour. He addresses the issues of restrictions on women's labour in many places in Sub-Saharan Africa (Kevane, 2014). 'Freedom to choose what kind of work to do, and for whom, is a basic human right, and should be considered one of the goals of development' (Kevane 2014, p. 116). To understand labour choices made by men and women, we can look at allocation of time and their options related to this. Expectations related to our genders are culturally bound and inequalities in time distribution can leave women spending more time doing household work, due to intrinsic power relations. There is also more time consumption than only hours spent working, and comparing hours does not tell much about people's well-being (Kevane, 2014). Differences in access to land, capital, investment rights and human capital between men and women, are some things that restrict women's labour choices. Greater investments in boys than girls are likely to reduce girl's education opportunities and further impact their possibilities for work.

One of the respondents explained how women often feel more obligated to take care of the home and family, while her husband doesn't feel that obligation to the same extent. Through the interviews, culture is explained by many participants as decisive in what roles and work is allocated men and women, and boys and girls. The fact that women spent more time on household chores than men, might indicate that most of the responsibility related to the home lies on her. Because of this, it is easier for men to leave home while women stay to take care of the home and children. Women's responsibility to unpaid household chores might deny her economic opportunities and restrict her options.

On the other hand, making assumptions that women don't have any options when it comes to labour and that they are constrained in their choices, can be harmful. Men and women spend their time differently, partly due to gender roles and norms, but in many cases their tasks will alternate. Biogas can contribute to liberating time, that has previously been spent collecting firewood and cooking, allowing women to spend that time in other ways. Nevertheless, liberating

women's time will not automatically achieve gender equality, but it can be a step towards enhancing women's wellbeing, and increase their options and opportunities for other activities, as well as ensuring their right to choose what work to do.

4.1.2.4 Safety and Convenience

Important benefit of biogas, as told by respondents, are the convenience and practicality. Firstly, cooking with biogas is fast and efficient. Presuming that the biogas is available in the pipes, using the biogas burner is easy and cooks the food very fast. It is a more comfortable way to cook and can reduce cooking time. Secondly, it is easy to use. All the participants were trained in how to make and use biogas. According to most of the participants, learning the technical skills to produce and burn biogas was uncomplicated for them, and this has made the switch to biogas manageable. Remaining in contact with the biogas installer who assists with technical issues or difficulties increases their sense of comfort and safety. Because of the technology being very user-friendly and easy to master, all the participants had positive experiences when it came to the implementation and training. Thirdly, the risk of explosion and fires linked to user errors or accidents are reduced. This is often a concern related to the use of cylinder gas and firewood.

A somewhat less mentioned benefit, but still essential to women's wellbeing, is safety. When cooking with biogas stoves, rather than open fires or charcoal, it allows people to move their cooking area into their main house. This means that, with gas readily available, cooking can be done anytime during the day and night, without having to leave their houses. Due to safety reasons, cooking late or at night-time is often not an option for women with kitchens in an external building. Therefore, being able to cook and heat water at any time of the day increases freedom of choice. Having this freedom and flexibility is important for many women.

“Biogas is helpful, because at night-time I can cook inside, which is safer, and I can cook any time of day”.

The convenience, safety and flexibility that comes with biogas technology shows that biogas can be an important tool towards empowering women, by putting them in charge of their time management and expanding their options. Increasing their safety can also increase their

wellbeing, both physically and mentally, by providing them the possibility to cook securely whenever they wish.

4.1.2.5 Fertiliser

Another benefit of biogas is not only the gas itself, but also the residue of biogas production: fertiliser. The slurry from biogas production is automatically discharged from the digester and readily available as fertiliser. This fertiliser contains nutrients and for most of the participants, this by-product of biogas production is an important fertiliser. Many participants have seen a significant increase in crops, and the surplus is sometimes sold at market for extra income. One participant that utilises the slurry experienced an increase in potato crops that she struggled to dispose of. This has also had economic benefits, as it reduces the expenses of purchasing external fertiliser.

4.1.2.6 Environmental Benefits

Some important negative implications from using wood fuel, are deforestation and soil erosion. As only 2% of Kenya's land areas is forested, a strong dependence on biomass for fuel in rural areas have put pressure on forests and contributed to land degradation (Kiplagat et al., 2011). Forests are important for biodiversity and for the overall climate, and deforestation has therefore several serious negative environmental repercussions. An increasing wood fuel demand, due to population growth, increasing poverty and lack of other alternatives to biomass energy, is putting a major pressure on forested areas. A contributing factor to deforestation is the use of charcoal, which is used in approximately 34% of rural households in Kenya (Kiplagat et al., 2011).

During the interviews, some participants pointed out the increase in tree growth that has occurred surrounding their villages after starting to use biogas. This can be linked to the reduced use of firewood, thus less cutting of trees. This is not necessarily solely due to the implementation of biogas, as the logging ban enforced by the government could be a contributing factor. Most of the women were not motivated by environmental concerns when implementing biogas. However, most respondents acknowledged the importance of environmental conservation, although admitting it is not a priority for them.

“We have other problems than caring about the environment”. (Participant talking about their concern for the environment).

Considering that the emissions of these rural households were not significantly high in the first place compared to households in the industrialised countries, the changes in total emissions might be minor. It is likely that the environmental benefits of small-scale domestic biogas production are primarily prevalent locally rather than globally. Reduction in deforestation might not be a direct benefit for women but can have several long-term benefits that are important for the community and climate. This can indicate the importance of renewable energy for sustainable development. Logging bans enforced by the Kenyan government in certain areas increase the focus on environmental conservation and rehabilitation of forests. On the other hand, it can reduce energy fuel options of many people that depend on traditional fuelwood and may have devastating consequences for their families. Due to lack of data on deforestation I cannot conclude that there has been a significant reduction in deforestation that can be directly linked to biogas implementation. Nevertheless, providing people with other sustainable energy sources is also an important part of sustainable environmental development and can ensure reliable energy access to a growing population.

4.2 Does Biogas Meet the Energy Needs of the Women?

So far, the implementation of biogas has been portrayed highly positive and beneficial for women. Although this portrayal to a large extent reflects the attitudes towards the biogas technology among the participants, many women expressed concerns and issues related to the biogas technology. Energy access is important for a country’s social and economic progress and insufficient or lack of energy access prevents development. It is also important for people on the household level as everyone depends on energy to some extent. As men and women have different needs, through the interviews I aimed to map out whether biogas covers the needs of the women. I asked the women if they feel that biogas sufficiently covers their energy needs or if they supplement biogas with other energy sources. This information is also important in development work as part of assessing the success of the project, because we should not assume that women automatically benefit from new technology.

For 29 of the participants, biogas covers their energy needs when it comes to cooking. This means that traditional biomass fuel, such as firewood and charcoal, have been completely replaced by biogas in their homes. The remaining households will still use firewood, charcoal or gas for cooking, in those instances where biogas is not sufficient. In their experience, biogas is not always sufficient, and they will in some cases rely on traditional fuels to complement the biogas, rather than replacing it with biogas completely. This can be during colder periods, when biogas production is especially low, or if the gas produced does not last long enough, e.g. when cooking large amounts of food for gatherings. Some participants will use traditional energy sources in addition to biogas for bigger events and food preparation. Having a backup of other fuel sources seemed necessary for some people, and one participant explained this as part of the mentality, especially among the older generations. This might imply that biogas is still a new technology that needs to gain some more trust among the users. It could also imply that the biogas is not sufficient for their needs, which will be discussed further.

Many of the households use additional energy sources, such as electricity, solar, and traditional fuels to cover other energy needs besides cooking. For lighting, electricity is common in some areas, while others use solar driven lamps. Only one household had connected their biogas to a lamp to produce light, and this was something many of the participants were interested in implementing. They wish to expand the biogas use and look for other ways to use biogas. Although biogas in the majority of cases is sufficient when it comes to cooking, women's needs extend beyond this. Broadening the use of renewable energy into these areas can be an important step towards energy security and sustainable development, and to ensure that people's needs are met.

4.2.1 Limitations and Challenges Linked to Biogas Use for Women

Knowing how women use biogas and to what extent it covers their needs is important to evaluate the success and sustainability of the technology. It cannot be automatically assumed that women will benefit from the project and it is important to remember that the implementation of biogas in Kenya is ongoing and the technology is still being developed. An important part of reviewing the success of development projects is analysing issues and possible solutions to these. This is also an important way to understand how biogas impacts women. As women are the main users of the

household energy, they should be consulted on matters related to changes and improvements of the biogas technology, and addressing the limitations and challenges as experienced by women is an important part of this.

As opposed to benefits, when asked about problems, not many people had a lot of challenges or problems to share. However, some of the same challenges were repeated. Although biogas is considered a safe, easily accessible alternative to traditional fuels, there are still certain requirements that must be in place for the technology to function. Even though biogas is very user friendly, it still requires an investment of time to be produced. As these are domestic biogas plants, the production takes place on the property of the owners. Each digester is individual and independent from other digesters. To have sufficient biogas to cover the needs of everyday cooking of a household, the biogas should be produced every day. In a few cases, the participants produced biogas less than every day. If this is not done, no biogas is produced. There are different reasons why some people are not able to do this as often as required, which causes them to not have biogas available at all times. The participants reported several different reasons why biogas production could be inconsistent for them, and they will be discussed further.

4.2.1.1 Water and Climate

In cases of drought, the lack of water can have negative impacts on biogas production, as it is an important part of the mix to produce biogas. Water is also important for the health of the cows. Some participants have experienced low quality dung caused by the lack of water which can cause reduced quality or inadequate feed. Low quality dung produces poor quality biogas. A lack of water can therefore impede several steps of the biogas production.

“Water is a big challenge (...) People and animals both use water, and sometimes there is not enough water left to feed the digester. When I lack water, I am not able to make biogas”
(Participant in Kitui).

As sufficient water is necessary to produce biogas, it may be unsuitable in dry areas. The research areas that were visited in the town of Kitui, will sometimes suffer from drought, and because of this, several biogas projects have been unsuccessful. According to some participants,

during colder periods, less biogas is produced because the production is less effective at low temperatures.

4.2.1.2 Cow Dung

Having free access to resources is an important motivating factor to implement biogas. One of the participants experienced that one of her cows died, and then she was not able to produce a sufficient amount of biogas because there was not enough dung. Satisfactory cow dung does not only mean having enough cows, but to feed them sufficiently so that enough dung is produced to produce biogas.

4.2.1.3 Lack of Manpower

The present construction of the biogas digester requires manual labour to produce the gas. Although less labour is required compared to collection of firewood, if the digester is not filled, no biogas is produced. Among elderly women that rely on help, there were some instances of lack of manpower to produce biogas. This means that some people depend on hired help, which can be expensive and unreliable. In these cases, despite having a well-functioning biogas digester, it could not be fully utilised.

4.2.1.4 Economic Constraints

I take into consideration the fact that without funding, many of the participants would most likely not afford biogas technology. The price of a digester depends on the size, ranging from 6m³ to 12m³ for households. The price of the smallest unit is KES 70 000 (approx. NOK 6000) including kitchen equipment, such as gas purifier and burner. This price also presupposes that the household themselves conduct digging, collect sand and gravel as well as providing general assistance during the construction, which accounts for approximately KES 22 000. Help to Self-help in Africa has supported the households with between KES 35 000 - 60 000, while 5 pilot projects were funded 100%. Estimated payback period is 2-4 years. Financial support to pay for installation costs is necessary for many people. Due to the economic constraints, biogas technology in Kenya is not widely available. Many participants point out the high installation costs as a main hindrance for many people to get biogas. Expanding funding would make it available to more people.

Despite the challenges linked to biogas installation and production, the participants are overall very pleased with biogas. They are thankful for it, and some express that they wish everyone to have the opportunity to have it. A few people express that they think it is either too much work, or not possible to achieve an adequate amount of biogas in their current situation.

4.2.2 Resource Access

It's important to take into account possible changes in access to resources as a result of the new technology, to ensure sustainability and to minimise negative impacts from the project. When implementing new projects that impact how important resources are used, secondary effects must be evaluated. There have been cases where development projects have implemented new technology that have reduced energy access for people outside the target group, and rather than increasing and improving energy access, it has unintentionally removed people's crucial energy sources out of reach (Cecelski, 2000). The GAM Framework aims to investigate impacts on resources caused by new project interventions on women, which includes both their access to and control over resources.

My research implies that the biogas technology has improved women's access to energy, as traditional biomass fuel is sometimes impossible to obtain due to logging bans and high costs. The reduction in access to necessary resources for cooking have increased the need for alternative energy access. As the households already had cows, their access to cow dung is not affected, and they have free access to and control over this necessary resource. At the same time, some of the challenges related to biogas production are linked to reduced access to resources, such as lack of water in some instances. In most of the households, this was not a problem, but the need for water to produce biogas entails that the production will not be suitable everywhere.

4.3 Socio-Cultural Factors: Gender Roles and Labour Distribution - Views, Attitudes and Perceived Changes in the Visited Households

This research paper asked the question of how gender roles and labour distribution are affected by the implementation of biogas, with the aim of further understanding the impacts on women. The GAM Framework emphasises that the research participants themselves hold all the

necessary information for gender-analysis (March et al., 1999). The following section will present the findings from the interviews and investigate changes in gender roles and labour distribution after the implementation of biogas. This section will look closer at the two areas of impact: socio-cultural factors and labour distribution. The two concepts will be explored in relation to each other by using gender-analysis to understand the different roles of men and women within the household.

A gender-analysis study is useful in exploring and mapping out men's and women's relationships in society, including possible existing inequalities (March et al., 1999). An important part of successful development interventions, is understanding the underlying causes of the gender gap and dynamics between men and women (FAO, 2014). This is because gender dynamics are important integrated parts of people's everyday lives, and it impacts the different roles, needs and priorities of men and women (FAO, 2014).

Table 4 presents a thematic analysis of the data, dividing the data into themes, codes and sub-codes that will be discussed further. The table (4) highlights the different thoughts and ideas about gender equality and gender roles that appeared from the interviews. This is a way to consider the women's different experiences with gender equality, how they view it within their households and their experiences of possible changes on this topic over the years. By using these perspectives on the relationship between men and women and their roles within a household, it can provide us with a better understanding of the causes of labour division and changes. As different people have different interests, we cannot assume that all women wish the same things. All the women I interviewed were very different, with various views, opinions and experiences and provided varied and nuanced perspectives. The aim of this research is not to generalise the views of the participating women, but rather to represent the different perspectives among the different participants.

Table 4: Thematic analysis: themes and codes.

Theme: Gender roles				
Codes:	Traditional gender roles	No distinctions in roles	Changes in gender roles	Discussing gender roles in the home
Sub-codes:	<p><i>Distinguish between men's and women's roles</i></p> <p><i>Some traditional gender roles are very bad and women are over-worked.</i></p> <p><i>According to African culture, men don't cook</i></p> <p><i>Women and men have different tasks</i></p>	<p><i>"I don't think there should be specific roles"</i></p> <p><i>It is a part of how they have been raised.</i></p> <p><i>"There are no such things as gender roles"</i></p>	<p><i>Gender roles will not change much</i></p> <p><i>Both men and women can work and make money</i></p> <p><i>Some changes: before biogas, the husband would not go in the kitchen, now he can go into the kitchen</i></p>	<p><i>It depends on the culture, some places it is a sensitive topic. Some cultures are very strict, and women do not talk about it. In other cultures, it is different, and women have more opportunities.</i></p> <p><i>Do sometimes discuss it with friends</i></p> <p><i>Discussing with other people make you see things in a different perspective</i></p>
Theme: Gender equality				
Codes:	Men and women are equal	Men's work is more valuable than a woman's		There is not gender equality
Sub-codes:	<p><i>There are no distinctions in equality between men and women</i></p> <p><i>Talks about and teaches her children about gender equality</i></p>	<p><i>"A woman who is doing a man's job, is a super woman"</i></p> <p><i>The man:</i></p> <ul style="list-style-type: none"> - brings the money - brings the food - provide the school fee 		<p><i>We need gender equality</i></p> <p><i>Men view women as weaker</i></p> <p><i>"Men are men and women are women"</i></p>
Theme: The work of women				
Codes:	Few jobs available for women outside the home	African set up		The work women do
Sub-codes:	<p><i>Discrimination against women. Discriminated in everyday life, and hard to get a job.</i></p> <p><i>Culture. Culture impacts peoples' attitudes.</i></p> <p><i>"Women suffer". Quote by a woman speaking about women's work loads and situations</i></p> <p><i>African women are overworked</i></p>	<p><i>Mom takes care of the house</i></p> <p><i>Cooking is for women</i></p> <p><i>Women feed and take care of the children</i></p> <p><i>Make sure husband is sober</i></p>		<p><i>She does work that the man cannot do</i></p> <p><i>Men cannot cook with firewood, but he can cook with biogas</i></p> <p><i>A woman</i></p> <ul style="list-style-type: none"> - cares for the family - looks after the animals - cleans - cooks
Theme: Masculinities				
Codes:	The roles of men	Views on men	The work men do	Less of a man

Sub-codes:	<i>The consulter</i> <i>Dad is the provider</i> <i>Men earn money, breadwinner</i> <i>“You don’t expect the man to do anything (housework) because we work all day”</i> <i>African men do not cook</i> <i>He is the manager</i>	<i>Men do hard work, women do easy work</i> <i>“A man doing laundry is crazy”</i> <i>“Men are lazy”</i> <i>Men cannot cook</i> <i>“Men should be men”</i>	<i>“A man doing a woman’s job is demeaning”</i> <i>Economic responsibility</i> <i>Paid work</i>	<i>An expression used by participants</i> <i>A man is less of a man if he cooks</i> <i>It is because of cultural values and traditions</i>
Theme:	Decision-making			
Codes:	Mutual	Man makes the decisions	Woman makes the decisions	
Sub-codes:	<i>Not just one person who decides</i> <i>Sit down and solve problems together</i> <i>Consult each other</i> <i>Come up with solution together</i>	<i>“We must be equal, but not in decision-making”</i> <i>Many women are okay with this.</i> <i>Husband is the head of the family and he makes the decisions</i>	<i>“I make the decisions” (woman)</i> <i>She first suggests a solution/possibility</i> <i>After the man makes the decisions, she can make him change his mind without him knowing it</i>	

4.3.1 Participants’ Views on Gender Equality

To understand how views and attitudes towards gender equality might affect women’s positions within the energy sector, the research first aimed to investigate the participants’ personal views on gender equality. By using a gender-analysis framework and methodology, the aim is to obtain an in-depth understanding of the norms and cultural traditions that place men and women in certain parts and roles within a society. This paper does this by not only looking at possible benefits and challenges of biogas, but also investigating common views on gender equality among the participants. The aim is to understand how attitudes towards gender equality affect women’s positions within the energy sector, today and in the future.

Gender equality was described by the respondents as men and women having equal opportunities and being able to do the same domestic work. Some explained that the government has implemented measures to ensure gender equality, such as same pay for the same work. However,

some express that what the government is doing is not affecting them on the household level, and that changes towards a more equal society must take place in the home.

Some participants shared their experience with changes in gender equality over time. Many of them believed that a combination of globalisation and education have caused a gradual change in attitudes towards the positions of girls and women. Increasing equality in education among boys and girls can be a contributing factor to a more gender equal society. By allowing girls access to education on the same level as boys, it can improve her living conditions later in life by increasing her chances of getting a job and not having to rely on a husband for support. Viewing girls and boys equally is also an important part of gender equality, regardless of a woman's job status and income, as gender equality is a human right.

“Nowadays, there is gender equality. It is equal. What a man can do, a woman can do better. There are no distinctions, all are equal. Even my daughter (5) knows that what boys can do, she can do better”. (A single mother talking about raising her daughter in a gender equal community).

Gender equality is not automatically achieved through interviews with women about their realities and experiences or by using a gender-analysis framework. It is a long-term process, and some participants point out that the change must come from within the household. For many of the participants, gender equality is considered desirable. For others, gender equality is considered unattainable because men and women are different and that is how it should remain. Nevertheless, providing women with more options, simplifying chores and ensuring a safe and stable energy source can hopefully provide them with various options and help reach their full potentials, regardless of where they are born.

4.3.2 Gender Roles in the Visited Households

The following section will present and discuss the views on gender roles among the participants and how this is practiced within the households as well as possible changes that have occurred. There were considerably different viewpoints on gender roles among the participants. Re-visiting the definition of gender in chapter 2.1, the interviews revealed clearly a distinction of roles, activities and responsibilities between men and women in most of the households. Women were

mainly pointed out as responsible for housework and children, while men are mainly the ones providing income for the household to cover expenses such as food and school fees. For many of the participants, this is a natural part of life that is not open to question. Cultural values and traditions were used by some to explain why they separate between men and women's roles. It is the way it has been for a long time, and this is the way they are used to and prefer. Religion and messages in the bible were also pointed out as a part of the reasons for labour division.

The expression "less of a man" was mentioned several times by different participants. This came up when we were discussing gender roles and whether they separate tasks for men and women. This included questions regarding whether and how their household is organised in terms of labour distribution, and why they separate their roles. Being "less of a man" was described as men doing household chores that are traditionally managed by women, e.g. cooking or washing clothes. These are traditionally a woman's job. Such work is considered demeaning to a man because it makes him look weaker. At the same time, a woman doing a man's chores would be considered more of a woman and some used the expression "super woman" about a woman in this position. One respondent who disagreed with this viewpoint, linked this attitude to illiteracy and lack of education in many rural areas. She explains that some people are very traditional, but this is likely to change over time.

While some respondents had clear distinctions between the roles of men and women, others were of the opposite opinion. 9 out of 41 participants stated that they did not distinguish between the roles and tasks of men and women. Not distinguishing between the tasks of men and women meant that the housework is not separated by gender, and no tasks are specifically dedicated to men or women. In between the two opposites were the respondents claiming that they do not have a strict separation between their roles. Although some separation between the roles in the everyday lives did occur, they will sometimes change roles if there is a need for it, e.g. in cases of illness or absence.

The interviews show that men and women in many households distinguish between their tasks, while some households share their tasks. As we know, women's work within the household is not only unpaid, but to a large extent overlooked and unacknowledged. However, the work

conducted by these women are vital for the function of and to sustain the households. Many of the participants mentioned that their work is not something that their husbands would or could do, such as gathering firewood, cooking with firewood and doing laundry. In some cases, these were also tasks that the participants did not wish the men to do. The roles of women in the home might be an important part of her identity or it could be that he does not know how to do it properly. Improving her working conditions and alleviating hard and hazardous labour through safe and reliable renewable energy, can enhance her freedom and opportunities.

4.3.2.1 Changes After the Implementation of Biogas Digesters

Gender roles do not just vary between societies, cultures and within households. They also vary over time (March et al., 1999). As research have shown, women's positions, not only within the energy sector but also in society, have changed over time. Their situations have in many cases improved, and opportunities are expanding in most parts of the world, maybe partly thanks to an increased focus on women's rights within politics and development agencies. To some degree, I could recognise these changes through the interviews, although there were great variations in views and perspectives among participants.

The implementation of biogas seems to have caused changes in gender roles within some of the households that were visited. Many women explained that before the implementation of biogas, it was their job to collect firewood and cook. Several respondents inform that after installing biogas in their homes, their husbands have started cooking as well. This was explained by it being more convenient, comfortable and faster to cook. The participants explained that men do not like to cook with firewood, because there is too much smoke, difficult to obtain and takes too long. In the households where men started to cook, the respondents welcomed this change, and appreciated their men's involvement in the kitchen.

“Men mainly earn money to take care of the family, especially before, today they are a bit more equal (...) After implementing biogas my husband said, ‘now I can help you’. With biogas, he could make and prepare drinks for himself” (Participant whose biogas digester is currently out of order).

One participant explains how biogas changed dynamics in their house because her husband has started cooking. Her husband who was present during the interview states that this is not normal among Africans. Several respondents expressed gratitude that their husbands are finally able to make their own drinks. The reason for this is that it has reduced her workload and she has gained more power over her time management. One participant welcomes the changes from traditional gender roles and claims that education has played a big part in this change. She says that this has allowed women to get jobs, and she now feels less restricted and is able to do what she wants to a larger extent. Changes in gender roles also means men being more involved in domestic activities and will help more with raising the children. Some women appreciate men's participation in the kitchen because it means more time for them to spend together as husband and wife. In the household where there were no changes, the women are still benefiting from the technology in other ways.

The Gender Analysis Matrix Framework emphasises that transformation must be promoted by the people being analysed themselves. This approach aims to challenge community members about their views on their own gender roles (March et al., 1999). My aim was not necessarily to challenge their views, but rather understand the different views that are present within the different communities.

4.4 Women's Role in Biogas Technology in the Visited Areas

By using the GAM Framework, this paper has investigated impacts on different aspects of women's lives as a result of biogas implementation. Displaying the various benefits and limitations is important to give a picture of the complex reality (March et al., 1999). The GAM Framework warns against over-simplifying the presentation of the effects of the intervention (March et al., 1999). Gender-sensitive research is an important tool to understand and document the constraints and issues women face within the energy sector and possible causes of these issues. At the same time, it is also an important tool to highlight and accentuate the skills and knowledges of women. With an understanding of how the participants describe and view gender roles and knowing how their households separate between the tasks of men and women, the next section will discuss women's positions in the biogas technology in their households that were visited.

Throughout the interviews with women, it was clear that they play significant roles in the biogas technology as producers, users and managers. Because of traditional gender roles that to a large extent places women within the household and in charge of domestic work, such as cooking, this means that they utilise the biogas technology every day and this makes them the main users of biogas. The participants have extensive knowledge and experience with household energy and therefore know what works and does not work within biogas production.

Despite some changes in gender roles in some of the participating households where the men have started partaking in cooking, women remain the main users of the household energy and are therefore important actors in the development of this technology. Through their positions as users, they have first-hand experience with issues, limitations and how the technology works. As we can see in table 1, many women produce the biogas themselves, which might imply that it is likely that any challenges related to the production falls on them. This increases their experience regarding issues and possible solutions to limitations.

It is likely that targeting women in energy projects, will not only improve their energy security, but further improve their well-being, and expand their opportunities through more options and better economy. Enhancing women's roles in energy projects and development interventions might help enhance their role and influence of energy decision-making. Providing all girls and women the opportunities to reach their full potentials can not only benefit communities, but the country as well. Nevertheless, as freedom of choice is a human right, women have the right to choose to be responsible for their household, as many might find value and meaning in this. Paying attention to women's needs and interests in development projects is important due to their important part in biogas technology as producers and consumers.

4.4.1 How Might the Views and Attitudes Towards Gender Equality Affect Women's Positions Within Biogas Technology?

To have a gender perspective in the energy sector is important to recognise gender specific issues and constraints (Cecelski, 2000). The patriarchal nature of many cultures in Kenya, including the ones who were visited, is expected to have a negative influence on women's positions,

opportunities and access to resources and capital. Common attitudes toward boys that they are going to grow up and become men and must provide for their family, enforce stereotypes that place men and women into different systems. These attitudes emerge from early on through the prioritising of boys over girls in primary education. There was a widespread view among several of the participants that men and women should remain responsible for their separate tasks and roles. The following section will provide some examples of how gender inequality is prevalent several places within and outside the households, before discussing how this might impact women's roles in biogas technology.

Among many of the participants there seems to be a conception that the work men do is more valuable than the work that women do, and according to some participants, men often view women as weaker than men. The research has revealed other issues in the households, such as domestic violence and alcohol abuse among men. Men's attitudes towards women is an important contributor to domestic violence towards women that I believe can be related to traditional gender roles and women's lack of income and land-owning rights. Several participants describe African women as being overworked, because of their domestic workloads and lack of involvement from their husbands. One participant explains her and her husband's roles and says that women have many problems because of traditional gender roles. She feels like traditional gender roles put women at a disadvantage and limit her options compared to men's.

“If a woman dies, man cries for 3 days, then on the 4th day, he goes out and find himself a new wife. If my husband dies, I stay with my family. Women care a lot about family, women support their family”. (An elderly woman talking about the different attitudes towards family among men and women).

During an interview with three young women, who strongly believe that the roles of men and women should be separate, they point out that many girls do not know their own rights. Consequently, because of lack of other options, they get married early. They link this to girl's disadvantage in the school system from an early age. The exclusion of girls from education is likely to have a negative impact on her life in the future, and these limitations to women's

options often make them dependent on men. One participant explains that the lack of work and income among many women forces her to be dependent on her husband and that she is taught to listen to him. The same participant runs a women's group where women get together to discuss issues, help and encourage each other and educate themselves on their rights. Her aim is to support women that are being abused by their husbands and by teaching her about her rights and support her financially to empower her.

One participant explains that a gradual shift in traditional gender roles has increased the chances of women undertaking jobs outside of the home nowadays. In her opinion, these changes are caused by education, and today, boys and girls are more likely to receive the same education. Previously, a lack of money in the family would allow only the boys to go to school, but today the child with the best results can go to school regardless of their gender. Personally, she enjoys these changes because they make her feel less restricted and it opens more opportunities for girls especially. However, she emphasises that this is to a large extent determined by the views and attitudes within the household.

Due to a limited sample of participants it is difficult to draw any clear conclusion to this research question. These findings might imply that the widespread perceptions that girls and women belong in the households might limit their opportunities in life, especially if they miss out on education. Based on the information from the participants, girls are likely to face disadvantages within education early on. This combined with a widespread attitude that women belong in the household regardless of her own ambitions might hinder her in several areas in life, including her influence over household energy. The widespread views on women as being weak and their work being less valuable might undermine women's positions and reduce attention towards renewable household energy technology. These attitudes might enforce the view on women as beneficiaries, rather than active participants in development work.

In some of the households, the husbands were the main decision-makers, which might imply that decisions regarding the biogas technology rely on them. This might suggest a risk of women being excluded from decision-making about energy in some of the households. This can imply that despite being the main users of biogas technology, they might lack influence and control

over how the technology is improved, developed or adjusted to their individual needs. However, most common among the participants was a mutual decision-making process which was prevalent in approximately half of the households. Changes in gender roles might change the systematic categorisation of women as homemakers and view girls' potentials on the same level as boys. Changing traditional gender roles might be a necessary step towards improving women's access to resources and capital. However, in that case, the change should come from within and must be promoted by the participants themselves rather than external development interventions. (March et al., 1999).

4.4.2 Women's Views on Changes, Opportunities and the Future Development of Biogas Technology

As reported by the majority of the participants, biogas is highly valued and has brought many benefits to the women. This might signify that the implementation has to a large extent been successful and biogas will continue to be an important positive change within many households. As previous research has showed, women should not only be included in, but also considered active participants in the implementation of renewable energy. Women are important actors in renewable energy projects and their input on design and further improvements are important and valuable. Due to their expertise, listening to their knowledge and experiences is crucial to ensure successful and sustainable project implementation. FAO (2014) claims that a project can fail if it does not recognise the important contributions of women. It is important to not only recognise their contributions, but to also use their knowledge and experience to further develop and improve the project.

Despite the benefits and positive impacts, many of the participants had strong opinions on changes, improvements and further developments of the technology. I believe this emphasises the participants involvement in the technology, as they know what works and what can be done to improve it. They are directly involved because they depend on the technology in their everyday lives. Based on the participants' attitudes and views on biogas, this technology has great potential in these communities in rural Kenya. The following section will present different suggestions of improvements and development of biogas technology proposed by the participants, based on their own experiences and needs.

- A way to expand the utilisation of biogas is to install biogas driven lamps. Connecting biogas to lights can be an important facilitator towards development as it can expand households' activities to after sunset. This can be suitable in areas where electricity is not stable and accessible. It can also contribute to lower expenses in households that use electricity.
- Developing energy storage through technology advancement to enable storage and selling of biogas. This can make biogas accessible to people that do not have cows or do not have the ability to produce biogas themselves. It can also provide an increase in income for biogas producers, and further improve waste management.
- Increase sufficient access to suitable resources to ensure a satisfactory production of gas that can sustain the needs of the households. This way the need for traditional biomass fuel is reduced, which can eliminate expenses and emissions and deforestation in areas where the traditional use of fuelwood is widespread. This can for example be achieved by relying on other types of biomass for biogas production, rather than only animal manure as principal feedstock. Better utilisation of waste, e.g. human waste or crop residues might have the potential to expand the biogas production.
- Expansion of funding is important for more people to be able to receive and utilise the technology. The high up-front cost of biogas is an obstacle for many people to access the technology. More investment in biogas technology from either NGOs, women's groups or the government can help more households to obtain the technology in the future.

4.5 Further Research

Lastly, I will address some limitations to my research that I discovered during the writing process that inspired suggestions to further research that can help expand our knowledge on this subject.

Although the GAM Framework aims to include and combine the views of men and women, for this research study, women were the main focus. The reason for this choice is a limited amount of time and resources. The research also does not target the entire community but is limited to

the household-level use of biogas. A further study could include more levels in the research and possibly do a comparative research paper to investigate consequences on multiple levels.

Several benefits and limitations for the women implementing biogas have been mentioned. However, the effects and significance of biogas implementation might extend beyond households. Seeing that biogas technology to a large extent has replaced other energy sources, it is important to evaluate the consequences for people providing other energy sources, e.g. firewood or charcoal. A shift from the demand of traditional energy sources, such as firewood, might affect the income or livelihoods of someone else. A further research project could investigate the impacts of biogas implementation on providers of traditional energy sources.

Due to a limited time frame of this research study, long term changes resulting from the use of biogas have been difficult to identify. A further study could be conducted in the future, exploring the research questions on an even deeper level by looking at a case study over a longer time period, and possibly conduct fieldwork before and after the implementation to register the changes more accurately.

5. Conclusion

By looking at the use of biogas in rural Kenya, the purpose of this paper was to investigate how women are affected by the implementation of this technology. Women's personal experiences regarding the implementation of biogas as expressed through in-depth interviews have been presented and discussed. As research has shown, the implementation of biogas in Kenya has been a challenging process, where missteps and complications have been – and still are – a part of the path. The issues of economic constraints, lack of manpower and limited necessary resources are things that have had negative impacts on the development and production of biogas in some areas. On the other hand, results also show that there have been several positive consequences following the implementation of biogas for the women that were interviewed. They have seen major improvements in areas such as financial situations, time, health and personal safety as a result of biogas technology. An overall positive attitude towards biogas

among the participants suggest that the implementation of biogas has a positive impact on the participants' lives.

The multiple environmental benefits of biogas production, such as waste management, providing nutrient-rich fertiliser and reduction in emissions are important for sustainable development in rural areas in Kenya. Biogas can be important to ensure reliable and affordable energy access to a growing population, while at the same time limiting GHG emissions and conserving the environment. Although I am not able to draw any conclusions with certainty regarding direct environmental improvements in the researched areas, a reduction in logging among the participants might contribute to a decline in deforestation in these areas.

By combining the subjects of women, gender equality and biogas production, this paper has attempted to explain how these elements are connected and investigates how gender roles are affected by the implementation of biogas. Findings show some changes in gender roles after the implementation of biogas in some of the households that were visited. This means that in certain cases, the men have started to take on work that are traditionally undertaken by women. In the households where this was the case, the women saw this as a positive change that is beneficial to their household. These changes seemed to be motivated by the simple, fast and clean qualities of biogas, which made it more comfortable for the men to participate in cooking. However, in other households, gender roles remained the same after implementing biogas. Findings also suggest that traditional views on gender have an influence on women's positions within the households and in society. Many participants believe that girls' disadvantages in education from an early age have a negative impact on her later in life by limiting her work opportunities, which is likely to make her dependent on her husband. A change in attitudes towards girls and women over time have, according to some participants, increased equality in elementary education. Equality in education opportunities for both genders is important for girls and women to contribute and participate in society to the same extent as men and be viewed as equal contributors.

Further, the paper discusses women's role in shaping the future of biogas, by combining previous research on women's roles in the renewable energy sector with personal one on one interviews with rural women in Kenya using biogas. It also emphasises the importance of using gender-

sensitive research to acknowledge and include women's expertise and experiences in development interventions. Findings suggest that the participants have great knowledge and experience in using biogas and this makes them important actors in the development of biogas technology now and in the future. Suggestions from the participants to improve and expand the technology were presented, such as connecting the biogas to lamps. This study has highlighted the importance of focusing on women in development projects, because interventions are likely to have a direct impact on them. By researching these implications on women in rural areas, it can contribute positively to development interventions by taking into consideration how women are affected. Although women have a lot of experience of what works and what does not, the limitations also show that biogas production might not be possible everywhere. Nevertheless, in the areas with the right conditions for biogas production, this technology has great potential to make a positive change, both for the environment and for women.

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Norges miljø- og biovitenskapelige universitet
Noregs miljø- og biovitenskapelige universitet
Norwegian University of Life Sciences

Postboks 5003
NO-1432 Ås
Norway