AN ANALYSIS OF PV SOLAR ELECTRIFICATION ON RURAL LIVELIHOOD TRANSFORMATION

A case of Kisiju-Pwani in Mkuranga District, Tanzania

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Thesis submitted in partial fulfillment of the requirements for the Degree of Master of Philosophy in Culture, Environment and Sustainability

Centre for Development and the Environment

University of Oslo

Blindern, Norway

December, 2014

DECLARATION AND COPYRIGHT

I, **Bernard Matungwa**, declare that this Thesis is my own work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature_____

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List of Abreviations

AFREPREN	Africa Energy Policy Research Network
CCM	Chama Cha Mapinduzi
CUF	Civic United Front
EC:	European Commission
ESMAP	Energy Assessment and Strategy Programme
FAO	Food and Agriculture Organisation
FUAS	Federation of Universities of Applied Sciences
GNSD	Global Network for Sustainable Development
GNESD	Global Network on Energy for Sustainable Development.
IEA	International Energy Agency
IEG:	International Evaluation Group
MDG	Millennium Development Goals
MEYSU	Ministry of Education, Youth and Sport of Ukrain
PV	Photovoltaic
PITRO:	Programme for Institutional Transformation, Research and Outreach
RET:	Renewable Energy Technology
RCHC	Roman Catholic Health Centre
TANESCO	Tanzania Electricity Supply Company
TASEA	Tanzania Solar Energy Association
TAZARA,	Tanzania Zambia Railway Authority
TRC	Tanzania Railway Corporation

TEP	Tanzania Energy Policy
TV	Television
WHO	World Health Organization
UDSM:	University of Dar es Salaam
UNDP	United Nations Development Program
URT-MEM:	United Republic of Tanzania – Ministry of Energy and Minerals
MWEM	Ministry of Water, Energy and Minerals
VEO	Village Executive Officer
WEO	Ward Executive Office
WEO	World Energy Outlook
WSP	World Solar Program

Aknowledgement

Writing this thesis has never been an easy task. Its completion is a result of a collective work; as many parties were involved in contributing and supporting this project. I would like to thank God for always being there for me and guiding me throughout. His love has been awesome for me throughout this long, tough and traumatic journey I went through having lost my father in the very beginning of this study.

I would like to express my earnest gratitude to my supervisor Prof Harold Longford Wilhite for his great support and supervision he gave me throughout to the completion of this study. His reviews, comments, support, love and encouragement were really important, impressive and were immensely felt throughout. “Thank you” may not be enough to express my appreciation for your tireless kindness and support. So in the lack of better words; I say thank you and God bless you.

My mother Augustina Nestory, I thank you for your love and care throughout my education journey. My grandmother Yustina Andrea, who always wanted to see me succeeding in my education. My guardian mother, Emmy Msowoya Matovu, I thank you for your amazing love. You accepted me as your child from the day you saw me and took care of me and always wished the best for me not to

mention the material support you have given me. Thank you for your love and care.

I am indebted to my lovely friend Risala Khalifa for her support and information concerning case study and baseline survey. Your support was helpful in the entire process of writing this thesis. No better words can equal your kindness and the help you gave me. May you stay blessed. Special thanks also goes to Dr. Colman Msoka, of the University of Dar es Salaam for his tips concerning the project together with his introduction which simplified my work in the study area.

To my family, I thank you for your amazing support during the whole process of my education. My wife, Odetha Robert, I wouldn't have completed this work without your support. You have continued supporting me, by taking care of our children; Dorine, Delbert and Ian in my absence without complaints. They have missed me, but the support you have given has been amazing.

I am grateful to my friends: Nelson Matovu, Raymond Matovu, Joyce Nelson Matovu, and Happiness Raymond Matovu for always being there for me in hard, trying and joyful times. Many thanks goes to my uncle, Mwemezi Rwiza and my friend, Frank Theodory for proofreading and editing this work. Many people supported me to accomplish this study; and though their names do not appear here, I am grateful to them for their very invaluable support. May God bless you all!

ABSTRACT

This study aimed at analysing the contribution of Rural Photovoltaic solar energy electrification in the livelihood transformation process in the rural areas, based on Kisiju-Pwani village in Mkuranga District, Tanzania. Understanding the people's perceptions, attitude and sense of ownership over the project installed in the village was another aim of this study, together with the reasons or bases of such attitude. It also wanted to take a closure look and understand the people's electricity consumption behaviour in the rural areas.

In the collection of information for this study, different interviews were conducted in Kisiju-Pwani from different households which are beneficiaries and non-beneficiaries households, three Focus Group Discussions data from the village leaders, women group and fishermen, and direct observation on what was happening in the village which could provide more information on the study.

This study was conducted in Kisiju-Pwani due to the presence (on going) of the Photovoltaic solar electricity project implemented under Programme for Institutional Transformation, Research and Outreach (PITRO). This project as given under this study, intend to reach at least 68 households. Already people in the village have started to benefit direct and indirect from the project.

The study reveals that PV solar electricity has proven to be a reliable source of energy in the rural areas which are far from the national or main grid. It is a perfect way of promoting development activities and creating opportunities for the rural area dwellers. The people's livelihood have been transformed in terms of lighting their homesteads, creating opportunities such as employment for them and enabling them to live the way they would like to live instead of relying in limited options.

This study revealed the positive attitude people have over the PV solar electricity installed in their village. This attitude has the reason mostly basing on the preconditions before the implementation of the project together with the benefits they have got so far from the project. Purchasing and socialization time for most of the people in the village was improved and people can have more time to exchange ideas during the evening and night hours, while businessmen and women could continue with their business for a longer time than it was before the project.

However, the study show some discontent from some village members who seemed frustrated over how the project benefit (electricity) have been distributed despite having participated in the decision making process. Much of the discontent seems to be based on the political differences as the villager have divisions based on their political ideologies.

PV solar electricity is no longer doubtful in its effectiveness in the process of rural communities' livelihood transformation. It is the best alternative for electrifying the rural areas as they struggle to participate in development process. Photovoltaic solar energy can no longer be ignored by the energy stakeholders as it provide an alternative source of energy which can benefit a number of people in the marginalised areas due to its availability, affordability, cleanliness and safety. Therefore, local enterprises as well as other stakeholders should be encouraged to further reach out to a wider part of the rural poor communities

1. INTRODUCTION

1.1 Background of the study

Energy is arguably an important element in the development process. It has been argued that without energy, it is almost impossible to attain sustainable development. “Since access to modern energy lies at the heart of human development, it is evident that in order to meet the MDGs (Millennium Development Goals), substantial improvements are needed in the type of energy services that the poor have access to”, GNESD (2007). The WHO and UNDP, asserts that the Millennium Development Goals (MDGs) can be attained if energy issue is well addressed in terms of the quantity and quality. It provides that; “The global target date for achieving the Millennium Development Goals is only 6 years away. While there is no MDG on energy, the global aspirations embodied in the goals will not become a reality without massive increases in the quantity and quality of energy services” (WHO and UNDP, 2009).

Energy is surely an important aspect of socio-economic development that touches almost every sphere of human life, and an essential requirement for human development. Improved household energy technologies for the very poor can prevent almost 2 million deaths a year attributed to indoor air pollution from solid fuel use WHO and UNDP (2009). The argument that energy is essential for

human development and livelihood transformation is also given by FAO, (2000) which see energy as a catalyst which can spur peoples' livelihood transformation in the sense that it improves different socio-economic activities at household level such as agriculture, health care and education. Toman and Jemelkova (2003) provided energy as an integral part of enhanced economic development. The fact that expanded provision and use of energy services strongly associated with economic development reveals how important energy is an essential factor in socio-economic development. It is believed therefore that modern standard of welfare, education and health cannot be maintained without sufficient energy; Baston et al (2013).

Tarujyot, (2012) stresses modern energy not only as important, but a basic human need in the same category of water and food for development of societies. He provides this by looking at rural electrification. "Rural electrification was not considered a basic human need like water and food in the past. A number of recent studies provide insight into how rural electrification helps in the betterment of rural society in various ways." Tarujyot, (2012). The same argument is stressed by the ESMAP report which view modern energy as important as the likes of education, health, and water; ESMAP (2002). The Tanzania Energy Policy (TEP) sees and recognises energy as important for development and an element which can determine either success or failure of any society depending on the status of availability and quality; MWEM, (1992).

Manas and Satyabrat (2013) perceive energy to be a driving force to foster economic, social and health conditions and that it affects all the dimensions and support pillars of sustainability.

Photovoltaic solar energy is a renewable source that is generated from the sunlight. Various studies have indicated different advantages solar energy has over other sources. Photovoltaic solar energy is provided as free, needs no fuel and produces no waste or pollution Virendra et al (2013). Photovoltaic solar electricity seems and has proved to be the alternative way of electrification to the off-grid rural areas where there is a limited supply of modern energy (electricity) hence hinder development efforts in such communities.

Sasikumar and Jayasubramaniam (2013) have attempted to show the difference solar energy has over the other sources of energy like conventional energy such as coal, oil, natural gas, and shown that conventional energy sources are limited in quantity and that if they continue to be depleted at the present rate they will be exhausted in the coming decades. Solar energy offers a different dimension as it is clean, climate friendly, with abundant and inexhaustible energy source of mankind and that it is even cheap as the solar panels price has fallen rapidly. Gajare et al (2013) provides that the use solar energy is attractive because it is abundant and offers a solution to fossil fuel emission and global climate change.

Photovoltaic Solar energy distinguishes itself from other sources of energy in that it is abundant, and cheap while the others are limited. Mahmood et al (2012) sees solar energy as cheap, eternal and achievable in many parts of the world. Renewable energy, in this case Photovoltaic solar energy system, is important for rural livelihood transformation due to its reliability, cost effectiveness, and achievability. Photovoltaic solar system gives an alternative way in which people can enjoy electricity they cannot get from the national grid due to the distance available and prices involved in it. According to the (GNSD, 2007) without supply of affordable energy, it is impossible to improve health, education, and poverty reduction. This is also stressed by Mkunda (2008) who argues that Photovoltaic solar energy (solar electricity) is an efficient and cost effective energy as it has transformed socio-economic lives in villages, cities and countries in Africa. The program of giving poor people access to modern energy services transformed their lives and broke the poverty cycle.

Tanzania like many other developing countries and African countries in particular, still suffers from the lack of reliable, effective and sufficient electricity in many parts of the country. Rural areas and other off-grid areas in particular suffers the most, something that has mired development in the rural off grid areas and the country at large. Tanzania and the rest of Sub-Saharan Africa mostly depend on traditional biomass. North Africa is heavily dependent on oil and South Africa depends on coal, Karekezi et al (2002). Tanzania’s total area of

945,000 km² was only partially served by the 220kV transmission network and covered only 2,605 kilometres in the year 2000; Mwihava (2004). Energy sources in Tanzania include hydro, coal, natural gas, biomass and imported petroleum. Electrification level in the urban areas is about 37% of the population while for the rural areas it is less than 2%; (AFREPREN 2004; IEA 2004). This estimate proves that there is a huge and urgent need of encouraging and promoting the supply of reliable and affordable energy sources in rural areas where 75% of the national population lives Shuma (2009). The answer for this challenge can probably be attained through the promotion of renewable energy particularly Photovoltaic solar energy.

It is also thought that the supply of electricity in the rural Tanzania through the national grid could not be attained in the near future, the major challenges associated to this problem being the nature of rural settlement, the cost for transmission of grid electricity which is believed to be too expensive and the affordability of the grid electricity by the rural population seems to be a challenge of its own nature (MEM, 2003). Again, it is renewable energy, particularly solar energy that can give the rural population a relief from social and economic marginalization as the transmission of the grid electricity seems will take a long time to be realised.

Photovoltaic solar energy can be a catalyst for different activities and can create a room for which education and health can be improved hence support the efforts of poverty eradication. Studies shows solar electricity is important in bringing about development in the marginalized areas particularly the rural areas. It plays a more substantial role in supporting the use of electric light for evening studies, electrical appliances usage such as TVs, radios, and cellular phone charging, and most of all it support income generating activities Tarujyot (2012). It is therefore not only important but also necessary to look at the other alternative sources of energy e.g. renewable energy, more especially solar energy if the rural community livelihood is to be transformed instead of keeping tabs on sources which seems to have countless challenges.

1.2 Study area

This study was conducted in Kisiju-Pwani village in Mkuranga District, Coastal region in Tanzania between 25thNovember, 2013 to 16thDecember 2013. Mkuranga district is located 50 km from Tanzania commercial capital, Dar es Salaam, along Dar es Salaam – Kibiti road, (Torell and Mmochi, 2006, p. 4; Torell, et al., 2007). Mkuranga is one of the six districts which forms the Coastal (Pwani) region of Tanzania. Other districts are Bagamoyo, Kisarawe, Rufiji, Mafia, and Kibaha. The district is comparatively small and it has a total area of 2,432 km^2 which is about a quarter of Bagamoyo district.

Mkuranga district is administratively divided into 4 divisions which are further divided into 15 wards and 101 villages. The divisions are run by the division officers commonly known as k*atibu tarafa*, wards run by the ward executive officers (WEO) commonly known as *katibu kata* and the villages run by the village executive officers (VEO) commonly known as *Mtendaji*. Politically, each village is headed by a village chairperson who represent a particular political party. While the village chairpersons are political figures and elected by the people, the village officers are professionally employed by the district council and perform their duties under the office of the district executive director. However, despite their professionalism, the village officers' selection mostly base on the political affiliation, and most of them are CCM members; the ruling party in Tanzania. Mkuranga district has two major political parties: CCM and CUF.

1.2.1 Socio-political and economic profile of the study area

Kisiju-Pwani is one of the seven coastal villages in Mkuranga district with a population of 3966, where as females are are believed to be 2000 and 1966 are male as per village records. Other coastal villages are Shungubweni, Kerekese, Mpafu, Mdimni, Magawa and Kufumangao. There are also near–shore islands villages. These are Boza, Kuruti (URT, 2002c, Torell and Mmoch, 2006 and Torell et al, 2007). Most of these villages are remote and are not connected to the national electricity grid which ends up in Mkuranga town. Unlike Kisiju-Pwani,

the remaining villages have no functioning port despite being located at the shore of the Indian Ocean.

According to the local informants, the history of the village dates back in the 19th Century. The village still have the remnants of shops and buildings which are said to have been built by the Indians and Arab traders who settled in the village between the end of the 19th Century and the beginning of the 20th century. A good example of the buildings in this village is the building which was known as *Jamatin*, which was a shop and a resident house for Indians in this village. They also built a market place which is still upright and in a good condition, but not used by the people in Kisiju-Pwani. These traders, traded with the people of Kisiju-Pwani as they sold food and clothes, while at the same time purchasing coconut and sunflower oil from the natives.

Kisiju-Pwani natives are mostly religious people, with a large percentage of the people in the village who are Muslim. Despite having a big and beautiful Roman Catholic Church in Kisiju-Pwani, it is said that the number of native people who are Roman Catholic is even less than 100. Islam became influential in this village not only because of the Arab and Indian traders who settled in this village from the end of the 19th Century, but also the German colonial rule cemented it for administrative purpose and functioning in the beginning of the 20th Century.

Kisiju-Pwani has 2 sub villages (*vitongoji).* These are Pwani and Maputo. The story behind the naming of one sub village *Maputo* is a bit interesting. According to the local informants and the village leaders, that sub village was named after the Capital of Mozambique, *Maputo* and the main reason was that most of the people living in this sub village *kitongoji* are migrants who migrated from the southern part of Tanzania, but more especially from the neighbouring country Mozambique. The remaining sub village is named after its geographical location as it is located close to the shore (coast) and the port in the village which in Kiswahili means *Pwani*.

The political situation and affiliation of the people in Kisiju-Pwani is not far different from that at the district level. Only 2 political parties; CCM and CUF are dominant in this village. According to the people in the village, these two political parties are believed and considered by the people to be the major political entities in this coastal area whereas other parties are deemed as parties of upcountry/mainlanders'. This study found that the village is politically divided; the central section of the village is occupied or dominated by CCM loyalists while the fringes of the village are occupied by CUF followers. This political division in the village is obvious and has negative implications on how developments projects including the PV solar electricity are perceived and implemented across the village. More discussion on how this tensions are

affecting the propagation of PV solar electrification in the village will be given in the later.

As pointed above, Kisiju Pwani has a commercial harbour area where people purchase items like clothes, utensils and food stuffs brought in by merchants from Dar es Salaam, Mafia, Zanzibar, Kilwa, Lindi and Rufiji. Kisiju-Pwani people not only purchase but also sell some products to the mentioned areas. For instance, some people of Kisiju-Pwani sells fresh water to the islands close to the village. The village is therefore connected to all these areas because of the harbour and this increases the interaction between Kisiju-Pwani people and other outsiders on a daily basis. Moreover, this harbour is a major fish–landing site in the Coast region. It is the only place in Mkuranga district where fish landings are recorded (Torell and Mmochi, 2006, p.7–8; Torell et al, 2007). Torell and Mmochi (2006) in Mkuranga Governance Baseline; estimated the number of people visiting the village every day by sea or road to be about 1,500 persons. However, it was found from this study that a number of people visiting this village vary from day to day or season to season depending on fish availability. Some of these people spend few hours in the village, while others migrate to the village depending on their activities. This tells us that most of the economic activities carried out by the people of this village are directly connected to the ocean and the presence of the harbour.

According to the local informants, Kisiju-Pwani harbour was busier in the previous years. This is because it used to handle cargoes and passengers to and from Mafia Island at the same time. Currently Kisiju-Pwani harbour deals mostly with cargoes and fishing activities, while most of the passengers prefer Nyamisati harbour in Rufiji district. This preference shift in harbour usage has its explanation. According to the local informants, Nyamisati harbour is more advantageous to passengers. Among the reasons given by the local informants were; first; Nyamisati near shore has no trenches and so it permits quick docking and taking off from the port. On the contrary, Kisiju-Pwani harbour as a lot of trenches and so it depends on high tides to fill to allow the docking and taking off of the boats. The second reason mentioned was that the distance between Nyamisati (in Rufiji district) and Mafia is shorter when compared to that of Kisiju-Pwani to Mafia. Basically, the change was inevitable according to the local informants. However, there some few passengers who still prefer Kisiju-Pwani harbour because of the possibility of docking at night hours as will be explained in details in the upcoming chapters

Agriculture is another important economic activity carried out by the people of Mkuranga district and Kisiju-Pwani residents in particular. In this village, people grow food and cash crops. The main food crops grown in this village are cassava, rice and beans whereas cashew nuts and coconuts are the major cash crops in the village and the district at large. Fruits such as; water melons, oranges, pineapples

and mangoes, are also grown and sold by some people in the village, but at a small scale. Moreover, in order to get their daily income people also engage in other small business like selling refreshment drinks, selling fried fish, tea, pan cakes commonly known as *chapati* and *andazi* to mention but a few. What is interesting is that pancakes selling is considered as a woman job and so it is carried out by women rather than men in the village. However, some of these small activities and trade have been supplemented by the solar electricity project as I will show in details in the coming chapters.

Social service in the village are relatively poor. It is a village that is connected by the road to Mkuranga Township. It lies 49 km from Mkuranga town. The road become harder to pass during the rainy season. Health services are available in the village. There are health facilities in the village, but there is no health facility owned by the village. Health care services are provided by Roman Catholic Health Centre and the other small dispensary privately owned by a village member. The Roman Catholic Health Centre (RCHC) has advanced equipment needed the health services provision, but the other one owned by a village member has no all required equipment and it is very small. For example; the (RCHC) has had solar electricity even before the PITRO project was introduced and implemented in the village. In fact the (RCHC) is not a beneficiary to PITRO project. The (RCHC) has enough water as it due to the huge underground water tanks which are used to tap water during the rainy season. The service given at

the (RCHC) is of good quality according to the local informants and only for severe cases a person can be referred to go to bigger hospitals of Mkuranga or Dar es Salaam. The (RCHC) serves the people from different areas in the division and other wards from the district. However, it was learned that some of the people in Kisiju-Pwani do not go to this dispensary due to religious differences as most of them are Muslim. The small dispensary of which most of the people depend on has no enough and quality equipment to provide health services

Water scarcity is another problem facing Kisiju-Pwani. The water used by most people and more especially those who cannot afford to buy water every day, is hard water. To get soft water, people have to pay $0.5 for a bucket of 20 litres. According to the local informants in the village, the cost of water has just risen in the recent years. It used to cost $0.03 to get a 20 litres bucket. Water has ultimately become a huge business among the youth and more especially some people with capital who sells beyond the village borders like to the Islands for that matter. This study was able to confirm this in the village as researchers bought water for bathing for all the days of this study.

The village has one primary school and one secondary school. All these schools are functioning. All these schools are day schools and normally students do not use them during the night hours.

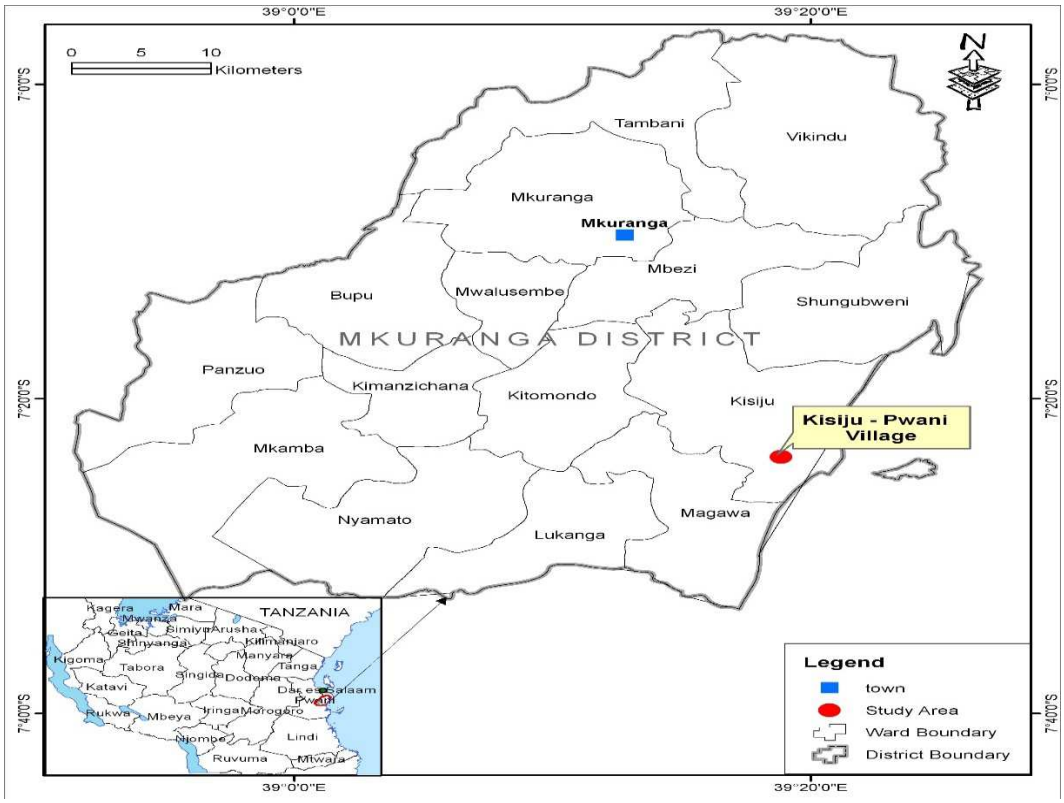

Plate 1: A Map of Kisiju-Pwani Village in Mkuranga District

Source: Cartographic Unit, University of Dar es Salaam

1.2.2 Electricity supply in Kisiju-Pwani

Kisiju-Pwani is a remote village and one among the many disadvantaged villages in Tanzania despite a number of potentials as revealed in this study. It is a village which is far from the national electricity grid line and there seems to be no connection plan from the national grid in the near future. According to the local informants, the distance from Kisiju-Pwani to Mkuranga where the national grid ends is about 50km, and so it is far. However, the village received a small electricity project in 2010, which was facilitated by the Member of Parliament

(MP) representing Mkuranga Constituency of which Kisiju-Pwani is a part. This was a wind electricity project. This small project meant to light up the areas where the shops are located and was distributed in 10 houses in the village. However, it did not last long as it had low power output. Moreover, according to the local informants, this project was sabotaged by some village leaders for personal benefits.

Apart from that project, one person who is believed to be rich in that village had started to supply electricity to different households by using a generator even before the wind project. This electricity supply was more business than service oriented. Under this electricity supply; households were getting only one bulb connection, worth of $0.5 for one lighting per six hours, and $1.0 for two lightings per six hours and so on. The service was for 6 hours every day and people had to pay that amount of money. However, other benefits which were coming from the electricity supply were limited to him and people (customers) were not allowed to utilize them. For example; the phone charging activity was only limited for him; and his customers were not allowed to have access to that service. This means, even those who had connection (his customers) had to take their phones to his centres for charging and pay extra money for that *extra* service. People who wanted to have an access to the TV connection had to give more money for that service too. According to the local informants it was hard

for people to maintain that service. Nevertheless, the project was ineffective and unreliable. This will be explained more under the coming chapters.

1.2.3 Mini grid solar project in Kisiju-Pwani village

Because of electricity problem in this village and the potentials available, Kisiju-Pwani is a beneficiary of a sustainable energy system for the provision of rural electrification services under (PITRO). This project is implemented under the collaboration of the University of Dar es Salaam, Tanzania and The University of Oslo, Norway. The main goal of this project is academic as the overall goal of the project is to research the technical, economic and social challenges associated with bringing solar based mini-grid to rural villages in Tanzania (PITRO III final report 2011/2012). However, Kisiju-Pwani remains the sole beneficiary of this project as it will be explained in details in Chapter Four.

This project is a min-grid built in Kisiju-Pwani, where electricity is produced and distributed to at least 68 households as per plan. It has a peak power of 8.6 kW of installed solar panels, and each of the 32 panels is rated 24V, 8A and has a peak power of 270W. After the solar panels, there is power bank consisting of 120 batteries, each rated 2V, 1000Ah. These batteries are connected in series and parallel to form a DC bus-bar of 48V.

Plate 2. Solar Panels Installed in Kisiju-Pwani to constitute a min grid plant

The array of solar panels charge the battery bank via a charger controller rated 48V, 140A DC. The AC mini-grid supply is obtained by using DC to AC converter (inverter) rated 48V-DC input, 230V-AC at 12.0kVA output. The batteries, DC side switch gears and protection, charger controller, inverter, AC side switch gears and protection are all securely installed in a power house.

Plate 3: A complete setup of the min grid with solar panels and the Battery bank house

Plate 4: The batteries, DC side switch gears and protection, charger controller, inverter, AC side switch gears and protection installed in a power house

1.3 Statement of the problem

Due to the challenges facing the power generation transmission in Tanzania, experts have come up with the alternative sources to foster rural electrification. Different studies such as Kanagawa and Nakata, (2008); Mahmood et al (2012) and Gajare et al (2013) to mention but a few have shown the role played by photovoltaic solar energy in the rural community livelihood transformation by showing the advantages the rural areas have got out of it basing on the material gain, health and social livelihood improvement. However, there are no studies that show peoples' sense of ownership and/or acceptability, interest and readiness on the technology transfer and their understanding of the benefits of such technology in their livelihood transformation process. It is the aim of this study to fill this gap in literature and set the basis upon which the stability of the technology transfer and solar energy project installation can be guaranteed.

1.4 Objectives of the study

1.4.1 Main Objectives

The main objective of this study is to explore and analyse the effectiveness of solar energy electrification in the rural community livelihood transformation and to understand the people's sense of ownership, and acceptability of the photovoltaic solar technology.

1.4.2 Specific objectives

i. To identify the social and economic opportunities in the community which have been created by the functioning of the PV solar electrificity project in the village

ii. To examine people's solar energy consumption behaviour in Kisiju-Pwani community

iii. To examine the peoples views and plans for the PV Solar project stability and the future maintainance of the project

iv. To examine the contribution of solar energy project in Kisiju Pwani on the environmental conservation and protection according to the village members

1.4.3 Research Questions

i. What are the socio economic contributions and opportunities of the Photovoltaic Solar energy project for the rural community livelihood transformation?

ii. How do people in the rural communities use or consume electricity or what areas need electricity in the rural community dwellers?

iii. Is there sense of ownership/ readiness and acceptability over the solar energy project from the community?

1.5 Significance of the study

This study come up with a number of significances. First and foremost the study shows how Photovoltaic Solar Energy Project installed in Kisiju-Pwani village has so far benefited the people and the community at large. Also the findings from this study shows the readiness, acceptance and a sense of ownership of the project installed in the village and more importantly show the acceptance of the people over the PV solar technology to their societies to create a base and assurance on Photovoltaic Solar energy projects stability. This will help both the people as beneficiaries of the projects, academicians and other energy stakeholders in the preparations and implementations of the energy projects. It would however serve as a catalyst in the mind-set change and pave the way for

policy makers to think of the alternative source of energy; and in this case the renewable energy for rural community livelihood transformation.

1.6 Scope and limitations of the study

The study explored the role of Photovoltaic solar energy electrification on the rural community livelihood transformation in Kisiju-Pwani village, Mkuranga District in Tanzania. The village was purposely selected because it is the beneficiary of the functioning min grid solar electricity project under PITRO program. The limitations of this study were on the reluctance of giving relevant information, minimal understanding of the questions asked as most of them have no education, access to women for interviews especially the married women. The remoteness of the area was also a limitation of it its own kind.

To deal with these limitations different solutions were taken; explaining what the study meant and informing them that confidentiality on every information given was to be maintained, restructuring the questions when asking to make them easily understood by the informants. To get women involvement in the study I had to find the households which had women as household heads and in other houses it was informing the husbands the importance of women participation in the study.

2. THEORICAL APPROACH AND LITERATURE REVIEW

2.1 Introduction

This chapter present the review of literature related to the study. It is comprised of Theoretical Framework which guided this study, the state, status and initiatives of solar energy in Tanzania, the benefit of solar energy on rural livelihood transformation, status and limitations of solar adoption in Tanzania and the maintenance ways. Under this chapter, the important and key terms used in this study will be defined and explained.

2.2 Key terms used in the study

2.2.1 Livelihood

Livelihood has been defined in different ways by different scholars and groups. The (WCED 1987a) defines livelihood as stock and flows of food and cash to meet basic needs. This definition seems to focus on materials and leave out other important elements. Conway and Chambers, (1991) defines livelihood as a means of gaining a living. They see capabilities as both an end and a means of livelihood. A livelihood provide the support for the enhancement and exercise of capabilities. However, capabilities enable livelihood to be gained. Livelihood

comprises the capabilities, assets (stories, resources, claims and access) and activities required for a means of living (Chambers and Conway, 1992; Carwell, 1997; Scoones, 1998; and Hussein and Nelson, 1998). The important feature in this livelihood definition is to direct the attention to the links between assets and the options people possess in practice to pursue alternative activities that can generate the income level required for survival (Elis, 2000).

2.2.2 Solar energy

Solar energy is the sunlight energy collected and used to provide electricity, heating, cooling homes, businesses or industry. It is a sustainable source in the sense that it does not provide greenhouse gas emissions and proves to be environmental friendly sources of energy. It is free and maintainable as the sun is here to stay. The United Stated Environmental Protection Agency (EPA), see solar energy as environmentally friendly because the sun is a natural energy source that does not require the burning of fossil fuels and associated air emissions. In addition, it is considered renewable since the energy produced from the sun does not deplete any natural resources, and will never run out.

It should however be kept in mind that although solar energy as a source is free, its conversion is not free as it requires different devices like solar panels, batteries, inverter and different cables and switches to mention but a few which in

the end have costs. The conversion of solar energy to electricity is explained under this study.

Makhijani and Alexander (2013) provides that there are two main categories of solar electricity which are Photovoltaic (PV) modules and Concentrating solar Power systems (CSP) that focus on the sun's heat to drive a steam turbine. For the purpose of this study, my focus is on the Photovoltaic solar energy.

2.2.3 Photovoltaic solar energy

Maycock (1999) defines photovoltaic (PV) as the direct conversion of solar radiation into electricity. This is particularly because photovoltaic energy conversion is based on photovoltaic effect. Photovoltaic solar modules converts the sun light directly into electricity. Solar PV can be used at any scale, from small scale electronic appliances to decentralized household rooftop systems and from installations that power industrial facilities to utility scale PV farms Makhijani and Alexander (2013).

Photovoltaic is regarded as a phenomenon in which solar radiation is converted into electricity without using stimulating mechanisms; and photovoltaic system is regarded to any system using such phenomenon. It is the most usable system of application of modern energies. So far, various systems with different capacities (0.5 watt up to several megawatts) have been installed and run throughout the world; and given their reliability and performance, application for them increases

every day Taraghdari et al (2012). Also Deb et al (2013) sees Photovoltaic as a solid state electrical device that converts sun light into electric current using the photoelectric effect. Materials presently used for photovoltaic solar cells include mono-crystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium selenite/sulphide.

PV technology uses the electrical properties of materials known as semiconductors to produce electricity. When hit by sunlight, a semiconductor material creates an electrical charge which can then be transferred through a circuit to anything that uses electricity. In a PV system, these semiconductors are produced in the form of cells, which are then assembled in a structural panel. Panels can then be assembled into larger groups, or arrays, to produce increasing amounts of electricity, depending on the amount of energy needed. Solar arrays can vary in size to provide the electricity needed for a home, office, or larger facility (EPA).

2.3 Theoretical framework

Theories are very important in research because they provide a way towards tackling the research study undertaken. A theoretical approach adopted in this study will be adopted in future study of the contribution or the effectiveness of solar energy to the livelihood transformation process. This study is therefore

guided by Amartya Sen's Capability Approach which has been used in the studies of human development.

2.3.1 Capability Approach

As pointed out above, Sen's 1980s Capability Approach was applied to guide this study. The term capability refers to the ability of individuals to realize their potentials as human being in the sense both of being which is to be adequately nourished, free of illness, and so on and doings which is to exercise choices, develop skills and experience, participate socially and so on, Ellis (2000). This approach was established in the 1980s and it challenges the use of gross national product, individual personal incomes, industrialization and social modernization levels as the determinants of human development. According to Sen, development should be conceptualized in terms of people's capabilities to function, effective opportunities to undertake the action, the activities that they want to engage in and be whom the people want to be, Sen, (1989). In his own writing, Sen continues to define development as a process of *expanding* freedoms that people enjoy. Focusing on human freedoms contrast with narrower views of development, such as identifying development with the growth of gross national product or with a rise in person incomes or with industrialization or with technological advance or social modernization (Sen, 1999). However, Sen sees these elements being important as the means to expanding the freedom enjoyed by the members of the society. For him and in accordance with this approach,

freedoms depend also on other determinants such as social and economic arrangements such as facilities for education and health care (Sen, 1999). It is an important approach that focus on people's capability and freedom expansion to live a good life.

Capability approach sees human life as a set of "beings" and "doings" which some time are called *"functionings"* and it relates the evaluation of the quality of life to the assessment of the capability to function (Sen, 1990). The line of reasoning that will is be pursued under capability approach is based on evaluating social change in terms of the richness of human life resulting from it (Sen, 1990). This set the base of argument therefore, that the success of a development project have to be measured in terms of how it impact the people's lives in expanding their freedoms and capabilities which is being and doings.

(Deneulin and McGregor, 2010) points out that capability approach is a framework which accommodates social, economic and political analysis and which holds that the wellbeing of a person ought to assessed in the space of capabilities. In order to develop, people have to be able to expand their capabilities which means their freedom to achieve functioning they value doing or being. Alkire and Deneulin (2009) provide that; Sen's capability approach forms the philosophical base of human development as it is used in the human development index, which was developed by a Pakistan economist Mahbub ul

Haq and used since 1990 in the human development reports. The human development reports for example focuses on human wellbeing and poverty reduction, rather than focusing on income like what World Bank does. Human development reports distinguish human poverty from income poverty by arguing that the purpose of development is to improve people's lives by expanding their choices, freedom and dignity (UNDP, 2003, p. 27)

This theoretical approach entails two core normative claims which are; "Freedom" and "Capabilities". On the first claim; it entails that the "freedom" to achieve well-being is of primary moral importance. On the second claim it entails that freedom to achieve well-being is to be understood in terms of people's capabilities, that is, their real opportunities to do and be what they have reason to value.

2.3.2 Relevance of the Approach to the study

Capability approach was relevant to this study in exploring the role of photovoltaic solar electricity to the rural community livelihood transformation. This approach helped in understanding how photovoltaic solar electricity project in Kisiju-Pwani has impacted the lives of the people at the household level and the community at large in terms of expanding their choices and the way it has helped them to live the kind of life they want to live and be and the way it has helped in expanding people's freedom. Basing on Sen's capability approach,

development requires the removal of major sources of un-freedom, poverty as well as tyranny, poor economic opportunities as well as systematic social deprivation, neglect of public facilities as well as intolerance or over-activity of depressive stated (Sen, 1999)

2.4 Solar energy in Tanzania

2.4.1 The state and initiatives of solar energy electrification in Tanzania

Tanzania like many other African countries still suffers from lack of sufficient energy for its people. To date, an overwhelming share (almost 90%) of current energy use is still met by traditional biomass (wood fuels). In the rural areas this means burning natural wood (mostly scrub and pruning) for domestic use. Small rural industries prune larger quantities of trees for processing agricultural products, and charcoal, which predominantly is sold and used in urban areas. Charcoal is the single largest source of household energy in urban areas and (roughly estimated, assuming primitive kilns) represents 20 % of total energy use, Bauner et al (2012)

Studies shows less than 14% of the Tanzanian populations has access to modern electricity. In its presentation on the Rural Energy Agency and Innovation and Delivery of Modern Energy Services to Rural Areas, the Rural Energy Agency (REA) points out that less than 15% of Tanzania population has electricity

access. It goes further providing that in rural areas energy access is about 2%. The IEA, (2011) reported in their World Energy Outlook 2011 report that only 13.9% of the total Tanzanian population had access to electricity, leaving 37.7 million people without access to electricity in their daily lives. It is further reported that 80% of the country population lives in the rural areas and it is only 2% of the said population which have access to electricity. Similar information has been given in Wilhite, (2012) Energy Dilemma. Suma (2009) sees the challenge on how best to facilitate the availability of an affordable energy for households and commercial activities for the disadvantaged rural areas. Kihedu et al (2006) argues that there is a relationship between energy and the type of building materials used in the village. This is to say that, there is very little chance that a house built from indigenous building materials like grasses and other local materials will be connected to the national power grid.

Thus, the application of solar energy in the rural Tanzania seems unavoidable and it has proved to be the best alternative for lighting and electrifying the rural areas. According to TASEA (2005), solar energy should go to people, especially in the off grid rural areas of Tanzania. Solar energy is believed to be the best alternative because of the abundant availability of sunlight in many parts of the country. Bauner et al (2012) argues that the country's geographical location and available land make it a high potential for solar farms in Tanzania. Sawe et al (2003), Kimambo and Mwakabuta (2005) shows the range average annual solar radiation

levels to be 4.2 - 5 kwh/m^2 per day. Moreover, the FUAS also shows an average daily solar insolation of 4.6 kWh/m^2. Solar energy is said to form a major part of the solution for energy generation in the rural areas because of its availability and easy maintenance, Mosha (2007).

The importance of solar energy in the rural households and communities development is unquestionable. It is the source of energy which is cost effective and affordable by the rural residents, and a source of energy that can be accessed by many people in the village across their economic status. Dauda, (2005) see photovoltaic solar system as important to the rural households because its electricity is cost effective and environmental friendly when compared to other sources of energy. It saves money because the recovery/payback period for this investment can be short depending on how much electricity the household uses; after the initial investment has been recovered, energy from the sun is practically free Varganova (2012). Scenarios show that solar energy will in the long term be the most important energy source, provided that the cost of photovoltaic modules is substantially decreased, EC (2009).

This has witnessed a proliferation of solar energy investment and application. According to Gwang'ombe (2004) in his renewable energy technologies in Tanzania; there has been application of solar energy mainly for heating (water thermal) systems. He goes on to show that solar cooking, pasteurizing and advanced solar crop drying technologies' application is still in its infancy stage.

However, the resent years has witnessed Solar photovoltaic (PV) being applied for telecommunication, lighting, refrigeration, water pumping and powering other electronic equipment at individual residences, schools and health centres, TAZARA, TRC and missionaries. The estimated current installed PV capacity in Tanzania is to the tune of 550kWp with an annual growth rate of about 20%, Gwang'ombe (2004).

The increase of Photovoltaic solar application in Africa and Tanzania in particular, seems to have been contributed by the increase in production of solar modules in the past 2 decades. As Karekezi (2002) argues, the increased production in photovoltaic solar modules has significantly seen the drop in price of PV system hence the increased application of PV solar system in Africa.

Electricity consumption from the commercial sources like the national grid and other sources like fuel seems to be insufficient (inadequate) and expensive to afford for rural areas dwellers, hence a very low consumption. Rural electrification through the national grid seems to be unattainable in the near future due to the dispersed nature of the Tanzania rural settlements in most the Tanzanian regions MEM (2003). The proof of the affordability is seen from the number of the rural dwellers who have access to electricity which is has not exceeded 2% as most of the studies have shown.

The process of rural electrification requires the cooperation across all sectors in the country. This is well given by Karekezi (2005) when he argues that the need for rural energy needs and required investment should be established in which mult and cross-sectoral cooperation is a central component. Different efforts to the application of renewable energy in Tanzania have been undertaken at almost all levels; that is the government level, Organizations' (mostly NGOs) level and at the individual level and the religious institutions to mention but a few. As Mosha (2007) provide that efforts such as those of Tanzania Solar Energy Association (TASEA), (which is a Non - Governmental Organization of solar energy stakeholders in Tanzania composed of individuals and organizations with a common goal of promoting renewable energy applications) are of a great significance.

Kihedu (2006), also shows the efforts in the process of renewable energy application by providing that there are several organizations which have actively engaged themselves in the renewable energy undertakings and the list include 21 governmental organizations, 21 projects and development partners; 73 private companies and 46 non-governmental organizations. The framework formulation for the promotion of Renewable Energy Technology (RETs) promotion in the country seems to be an expression of intent by the Ministry of Energy and Minerals. Moreover, the Tanzania Energy Policy provides more room for the growth and development of renewable energy, solar energy being one of them as

clearly stipulated under articles 25, 39, 45 and 56, of the current Tanzania Energy Policy, URT-MEM (2003). It is interesting however, to note that Tanzania government is implementing a National Solar Program under the World Solar Program (WSP). The WSP is an open- ended attempt through broad Partnerships and cooperation of governments and NGO to promote a wider utilization of renewable energy sources. So far the government has declared two of its five project proposals submitted to UNESCO as being of high national priority. These proposals are (1) village level solar electrification; and (2) small islands solar electrification. With these projects, the penetration level of solar power is expected to increase greatly Kihwele et al (2012).

Tanzania Solar Energy Association (TASEA), and other stakeholders' organizations have all actively engaged in the development of solar energy application in Tanzania. The government moreover has acted on the process by the exemption of all solar powered equipment and specialized accessories from import duty for the aim of promoting and encouraging the application of alternative energy given the energy crisis in the country, Mwandosya (2006). However there has been more steps by the government is terms of attractive financial terms for potential investors to develop the countries renewable energy sources since 1999, URT-VPO (2003). Procedures for investment in solar, wind, and micro hydro projects have been simplified and include 100% depreciation allowance in the first year of operation, exemption from exercise duty and sales

tax and concessionary custom duty on the first import of materials used in renewable energy projects, Mwihava and Mbise (2005). The establishment of the Rural Energy Agency (REA) by the government is another evidence to prove the government commitment in the rural areas lighting and encouraging the development of renewable energy in the country. REA's one of the objectives among others is to mobilize, coordinate and facilitate private and public renewable energy development in rural Tanzania.

Mwingira (2006) provide an example of the international donation on the application of solar energy in Tanzania by citing the examples of promises made by the former US president Bill Clinton when The President of Tanzania visited the United States. He made a promise that all Health Centres and Dispensaries that had no electricity would be supplied with solar powered generators. However, this is a promise that has not been realized in many parts of the country.

2.4.2 Socio-economic impacts of solar energy on Rural Livelihood transformation

Different studies on renewable energy, solar energy in particular, sees the system as a channel to development and livelihood transformation in the rural areas. It has been proved with no doubt that Photovoltaic solar energy can and has positively impacted the rural livelihoods. There are notable transformational signs in many spheres of human development notably in the rural areas. Education,

health, employment status, electric devises application, information and communication to mention but a few have all proved the capacity of solar energy is the livelihood transformation process in the rural areas. Studies shows the system to have positively impacted the socio-economic development of the people in most of the areas where different solar projects have been implemented.

Education improvement

There has been a notable significance of solar energy in the improvement of education in most of households and communities at large. Buragohain (2012) in her Impact of Solar Energy in Rural Development in India; provides that getting light for children to study at night might results in major improvement in their education performance. This has been argued a lot more in a number of studies. Nolens (2010) also argues that solar electricity allows children in the rural areas to have more time to study at night with better quality of light, hence improvement. ESMAP (2002) see village electrification as important for lighting up schools for better education attainment, whereas the ESMAP (2003) report shows the lack of electricity in Peru resulted into diminished quality of life and poor education. According to the ESMAP reports, village electrification enables the application of ICT for better education as the examples drawn from Honduras explain, ESMAP (2002). For example children in electrified households have higher education levels than those without electricity as revealed in the ESMAP Philippines ESMAP (2003). Electrification is believed to have a direct impact on

education improvement in a sense that it can impact education by improving the quality of schools, either through the provision of electricity dependent equipment, or increasing teachers quantity and quality (teachers attraction to the electrified villages); and study time allocation at home, with increased study time, though the availability of TV may decrease that time (but at the same time it may also possibly provide educational benefits) IEG – WB (2008).

Health improvement

The impact of solar energy on health improvement in the off grid areas has been pointed out. Health improvement can remain a myth if the issue of reliable energy is not addressed. Energy is essential in improving people health in the peripheral and disadvantaged areas which are not connected to the main electricity grid. Solar energy in such areas is very important and has proved to be very helpful in most of the areas where it has been applied. Studies over the impact of solar energy in rural development in India shows that solar lighting has helped different households to overcome health problems which results from kerosene use and candle burning in the closed rooms, Buragohain (2012). It is argued that solar energy has an important health benefit as it reduces in house air pollution and the danger of fire as it substitute the use of kerosene (Modi, 2004; World Bank, 2008a). Dieudonné and Evariste (unpublished) provide that the min solar power plant that was installed in the Ngan-ha locality in Cameroon improved the health services in that village in a span of only two years. Solar electricity

moreover contribute to the improvement of health awareness by providing people with access to media as the source of information, (Braden,2012). PV solar technology has proven success in high-technology applications of communication. It is also an ideal alternative for powering vaccine refrigeration in rural remote clinics. Vaccines can dramatically improve the health of the rural poor and in this respect, Kerekezi et al (2005). The IEA (2008) provide that access to better medical facilities, vaccine refrigeration, equipment sterilization, operating theatres and lighting for local health centres are essential in the improvement of health service in the rural areas. For instance solar PV installed at Lugala Lutheran Hospital (3000Wp) in Ulanga, Morogoro improved health services by powering low energy equipment and lighting for infusion unit, theatre, outpatient department, administration block, in patients wards, medical cooling in the pharmacy and security lights TASEA (2005). The same on health service improvement is documented by WHO (2000)

Economic development

PV solar electricity's contribution to economic growth is evident and has been given in a number of studies. Modern energy has a direct relationship to economic growth. Braden (2012) views the contribution of solar energy by looking on its contribution to generating employments and allowing people to work for long hours at night in Rema, Ethiopia. The World Bank (2009) reveals that Solar Home Systems (SHS) increases economic activities inside and outside

households because business activities operate long hours in the evening. The contribution of solar energy to economic growth is also viewed in terms of the role it plays to lower the cost of energy to the rural dwellers, resulting to the consumer surplus and the way it helps to spur the growth of home business hence a boost to the household's income growth IEG-WB (2008). The study by Braden (2012) on solar energy and rural development which was conducted in Rema, Ethiopia, proves the creation of the growth of home business which lead to the strengthening of the households' income in Rema. Hussain et al (2013) in their study on the cost analysis of concentrated solar power plant with thermal energy storage system in Bangladesh, asserts that concentrating solar power plants with thermal storage system can lead to economic benefits for the developing countries because of its low operating cost. This sort of power plant is not adversely affected from fuel price fluctuation.

PV solar energy and the environment

Literature available on the impact of solar energy on environment is remarkable. A lot of scholars have written a lot concerning the contribution of PV solar energy on environmental conservation. Hussain et al (2013) on their study of cost analysis of concentrated solar power plant with thermal energy storage system in Bangladesh argues that concentrated solar power plant have no hidden social cost in the form of environmental solution. It is also argued here that solar energy have potentials in the country particularly in various sectors it is applied by

reducing traditional fossil fuel based power consumption and ensuring a green environment for the future generation (Deb et al, 2013; Ahmad et al, 2013)

Hasnat and Anisuzzaman (2012) in their study on the role of solar energy in reducing GHG from the residential sector in Bangladesh, they found that in residential sector, emissions of greenhouse gases are mainly emitted from gas oil (kerosene) and biomass. Here they estimated the total amounts of carbon-di-oxide gas the base year 2004 and it is 3410000 metric tons and points out that within five years this will increase up to emissions in 29% and this will be 35989682 metric tons in 2033, which will increase up to 90% of the base year. In their study, they points out that, if there is an increase in the share of solar energy to 12% in Bangladesh within 30 years, the greenhouse gas will be reduced considerably. It is pointed out that by taking 10%-12% contribution of solar energy, it is estimated that the emission of the carbon-di-oxide gas will be 22821679 metric tons which will reduce up to 21% in the year 2033.

Eric Zencey (2013) in his topic named Energy as a master plan, sees renewable energy notably wind energy and solar energy as the solutions to the environmental problems. He provide that there are plenty of reasons to move to solar and away from oil; climate change being among the reasons. Also Makhijani and Alexander (2013) speaks of the environmental problems available in relying on fossils fuels and provide that the reliance on unsustainable energy sources is no longer necessary. They provide the solution over fossil fuels being

the transition to a sustainable energy system based on a high efficiency and renewable sources as well as smart grid and storage solutions. They support their claim by looking at the growth of renewable energy investment by 2011 in which renewable energy technologies toped those of conventional in some countries, US and German investment in wind energy and solar energy respectively being among them.

Jagoo (2013) views the importance of solar energy by looking at the risks and the danger posed by fuel burning that increases the already greenhouse gases which lead into global warming. He sees Photovoltaic and solar concentrator energy as a solution and that it is predestined to a bright future because of its ability to power the globe. However, he provide that harnessing this free energy at high efficiencies is considered as a challenge even to the engineers. (Sen, 2008) also provide that the key atmospheric energy sources such as solar and wind power should be harnessed more effectively and turned directly into heat energy to meet the growing demand for cheaper power supplies to meet the challenges posed by the unprecedented increase in the population and industrial products and the development of technology, human beings search for ways of using more and more energy without harming or, perhaps, even destroying the natural environment.

2.4.3 Limitations of solar energy adoption in Tanzania

For the purpose of this study, limitations have been viewed as challenges facing the development and growth of solar energy in Tanzania. A number of studies have documented on the limitations facing photovoltaic solar energy. This study provide some of the limitations which have been documented under different literature as they are given hereunder;

Minimal Institutional Support

Despite the growth and development of solar energy in Tanzania, this energy sector still faces inadequate institutional support for its prosperity. The promotion and development of solar energy seems to have been left to the private sector alone which hinders its development. It is argued that the development and promotion of solar energy requires support from efficient institutional framework Laing and Rosseli (1999). The promotional of solar energy can therefore be attained if the government, the donors and the private sector can work together in undertaking a number of programs of which aim is harnessing renewable energy potentials in the country.

Financial Limitations

Like in many other development projects, the growth of solar energy also encounters financial problem. This is the major problem for the development of solar energy in Tanzania. Despite being hailed as a cheap energy and even

sometimes free, the initial costs involved in buying the materials and the installation devices makes it difficult for the technology to grow to the required standards hence inadequate supply of energy in rural Tanzania Dauda (2005)**.**

Mwihava (2002) argues that the major target for rural electrification are the majority of poor rural households and they could only afford the renewable energy technology expenses if they could have financial support because they cannot afford the cost by depending on their income. EC, (2009) also sees financial problem as the major problem for solar energy technology development and believe solar energy can only develop if the cost of photovoltaic volume is reduced. Studies shows that the main obstacle in the implementation of renewable energy practices is often not due to their technical feasibility, but to the absence of long term financing resources, Karekezi et al (2005) and Bauner D et al (2012). In the Sub-Sahara Africa solar energy technology is believed to have benefited the high income segments of population given the high cost of solar photovoltaic. Solar PV is unaffordable to majority of the population in sub-Saharan Africa, given the high levels of poverty, Karekezi and Kithyoma (2002).

Muhamad et al (2002) conducted a research on solar energy in Bangladesh. The focus of this study seems to be installation of new technology demonstration and adaptability of the technology in Bangladesh. They found that there was a problem with the adaptability due to the price of solar panels and technology itself. The focus was on the technology adaptability and other technical issues.

Policy and Ligal Challenges

The success of any development project depend primarily on the policy guiding the process. Likewise, the promotion and development of solar energy technologies is to a large extent depending on the existing government policies. Government policies are important tools and factors in terms of their ability to create an enabling environment for RETs dissemination and mobilising resources, as well as encouraging private sector investment Sampa and Sichone (1995).

The promotion and development of solar energy suffers from the lack of clear cut policies and legal framework which gives the direction towards the growth and implementation of different projects. Like Karekezi et al (2003) argues that most governments do not have clear cut policy on the development and promotional of RETs which continue to be undertaken within an energy planning vacuum. This lead to the lack of clear link between the RETs and the national power master plan Karekezi (1998).

2.5 PV solar system stability

This is important for the aim of safeguarding the reliability and long term operation of the PV solar system projects. For it to happen, a well-designed maintenance system must be in place. This may be from the quality of devices used in the project to the functioning maintenance of the running project, capacity

building and long term financing of the projects. As Olivia (2006**)** puts it, reliable and long-term operation photovoltaic solar energy system requires well-designed and installed systems, the use of sound quality equipment and uninterrupted continuing funding for maintenance, repairs, component replacements, and spare parts. The REN21 (2010) proves the importance of the long term financing of the project by providing that financing mechanisms after-sales services for operation and maintenance are key to the successful development of a long-term project. As it was earlier pointed out, this has been one of the main reason for the failure of different solar energy and other renewable energy projects in a many countries, Tanzania in particular.

Technical knowhow and maintenance services are other areas believed to be important in the PV solar energy systems stability. It is well put by Kawambwa and Kimambo (1999) who found that many solar projects which were installed in Tanzania were not stable because of improper installation and insufficient maintenance services. Mwihava (2002) stresses on the importance of the maintenance and local capacity building for the project stability. Project security also is important in the stability of the PV solar projects as most of the projects suffer from vandalism and theft of the solar systems equipment TASEA (2005).

2.6 Application of PV solar energy

Different literature have studied the applicability of PV solar energy in different areas and households in the urban and rural areas. Jacobson (2006) studied solar energy electrification in Kenya, with the focus on the connectivity of the technology and the social change or advantages. He found that in Kenya there were tremendous rise of renewable energy technology due to the growing market for solar PV system among the rural households. He shows to have been a large number of people in rural areas who have adopted the technology and that there has been a tremendous ascend of solar market in Kenya. Data from the year 2000 survey conducted by Tegemeo Institute indicated that 4.2% of rural Kenyan households owned a solar system and that solar electricity had emerged in Kenya as a key alternative to grid base rural electrification, Jacobson (2004)

The work of Kirumbi et al (2009) in Kenya looks on the community based electric micro grids and see if that can contribute to rural development. It clarifies the mechanism through which the rural electrification could promote rural development. Through this research, it was demonstrated that access to electricity enables the use of electric equipment and tools by small and micro enterprises resulting into significant improvement in productivity.

2.7 Knowledge gap

From the above empirical studies, the role of solar energy as an important aspect for social change and development in both developed and developing countries is evident. The above literature review, shows a lot have been said and studied from a different angles of the globe on the development of solar energy utilization Tanzania being among them. From the literature available; the role played by different stakeholders in the development of solar energy technology, advantages and challenges have been studied and put well.

However, the literature doesn't show the community members' acceptance and sense of ownership of the PV solar energy systems nor do they explore the community members' views on the effectiveness of the PV solar energy projects in different areas. This study has therefore addressed this gap focussing on addressing the community members' acceptability and sense of ownership of the PV solar energy project and the basis for the same. Moreover, the community members' perceptions on the effectiveness of the PV solar energy projects together with the energy consumption behaviour has been addressed.

3. RESEARCH METHODOLOGY

3.1 Introduction

This chapter shows and explain the research procedures which were applied in carrying out this study. It describe how the intended research objectives were reached and achieved under this study. The chapter covers; Research Design, Research Approaches, Study Area, Sampling Procedures and Techniques, Data Generating Methods, Data Analysis, Ethical issues and Limitations to the study .

3.2 Research design

This is a roadmap in the process of conducting a research. It is a plan for conducting scientific investigation on what questions are to be answered, how participants are to be selected, how data are to be collected and interpreted, and how valid conclusion can be drawn. It is a fundamental and integral part of actually doing research as given in Murray and Overton (2003) article on designing development research. It is a roadmap and a conceptual structure through which the research is to be conducted. It facilitates a research to be as efficient as possible yielding maximal information Kothari (2004) on research methodology. As a road map, it helps to determine the best way to reach the

destination Loudon *et al* (2007), and it gives the guidelines or specific steps that have to be followed so as to get evidence in relation to the questions of the study.

A descriptive design was employed in this study. According to Kombo and Tromp (2006) on the proposal and thesis writing, a research design focuses on information about people's attitudes, opinions, habits or any of the various educational or social issues of the study. It was employed in order to have a chance of getting enough information concerning the research problem. As (Bryman, 2004) in social research methods puts it, it helps the researcher to deeply describe the views and peoples insights about the research topic.

3.3 Research Approaches

This study applied qualitative approach throughout the study. This approach was applied because it is the most appropriate approach to studying the social realities. As Bryman (2004) in his social research methods, clarifies that qualitative approach is most appropriate in studying social realities through multiple tools of data collection that are qualitative in nature. According to Bryman and Burgess, (1999), qualitative methods are used to explore the meaning of people's world. It intends to collecting data in natural settings rather than artificial and it works inductively building up theory from observations. As descriptive design was adopted in this study, qualitative approach was found to be the best way into which this study was to be administered. Moreover, the

application of descriptive research design provide the possibility for researchers to discover causes of the research problem (Kothari, 2004).

3.4 Sampling Methods

To get respondents suitable for my study, a Purposive sampling technique was applied (Bernard, 1990; Huberman, 1994; Devine and Heath, 1999). In two stages purposive sampling was done. The first one was the selection of the village where this study was to be conducted. The main criteria was that there should be an ongoing implementation of the solar electricity program or project or that there has been such a project recently. In that regard, Kisiju-Pwani was purposively selected as it is the village which has the ongoing implementation of the min grid solar energy project. Again it is a village which is remote that have had no access to reliable modern energy for all the time. However, it is a village endowed with natural resources but with limited opportunities and high rate of poverty.

In the second stage, purposive selection of the respondents of this this study was made. On this stage again, several criteria were used. This study moreover, concentrated on two areas in the village which are; the solar electricity project beneficiary households and the solar electricity non-beneficiary households. In all these households I targeted the most resourceful people; that is people with knowledge and enough information who could provide valid and reliable information for this study. In that regard however, not all households were

interviewed, but few of them which were purposively selected. The village leaders and in this case the V.E.O and the project committee secretary helped in identifying potential households and respondents for this study. This was first to identify all households which were already connected with PV solar electricity. A pre visit to all households which were selected by the village leaders was made and from that list households for interviews to avoid bias from the village leader's selection were reselected. This means not every household that was selected by the village leaders was interviewed. They also helped in identifying and organising the people who participated in the F.G.D. On this, they worked on the qualities of the people needed for that purpose. Moreover the V.E.O and The Village chairman together with the solar project secretary, were among the people who participated in one of the F.G.D.

Three (3) focus group discussions were conducted in the village. These in general; targeted the village members understanding of the village history, understanding different matters in the village and the ongoing project process, village members groups believed to have benefited or benefiting from the project like women groups and fishermen; and different social servants in the social settings of the village.

A total of 20 interviews were conducted at the household level from 20 different households. On this, 10 households were the already connected with solar electricity while the other 10 households were yet not connected with the

electricity. The main reason for this kind of selection; was to get a picture and understanding the views of the people concerning the min grid solar project in the village depending on how they are benefiting from the project, and their experience on the presence of the project in the village.

3.5 Data generationg methods

In this study, Qualitative method was applied in generating valid and reliable data. In particular; In-depth interviews and Focus Group Discussion were applied. In the whole process and all interviews, Kiswahili language was used throughout to generate the data. There was no application of other languages like local (tribal languages) language because Kisiju-Pwani residents are Kiswahili speakers and so the use of this language simplified the interviews to both the researcher and respondents.

3.5.1 Primary Data

The data were collected through in-depth interviews, focus group discussion and direct observation. These data mainly focused on the historical background of the village before the implementation of the min grid solar electricity project; the situation after the implementation of the project; people's understanding, feelings, and perception over the project implemented in the village; and new potentials and opportunities generated by the presence of the solar electricity

project; and the feelings on the administration and management of the project and their views on the adoption of the new technology (solar energy)

3.5.2 Data collection instruments

In the process of data collection, different instruments were employed. To get enough data for this study, recording instruments and note books were used. Moreover, the camera was used and this helped in capturing different events and activities together with people's treatment of the PV solar electricity project which were observed as will be expressed through the pictures in the upcoming chapters.

Direct Observation

This was important and it proved to be helpful in the research village. Through direct observation, different events and activities people were engaged in and the way they were utilizing solar electricity within and outside their households were capture. It moreover helped in capturing different activities people were doing during the night under the street lights. The socialization level in the village in different ways was also observed. One way was the gaming activities which were done at all levels across the age and gender. For example, elders were playing their favourite game known as *Bao*. Youth were playing different types of games such as playing cards know in Kiswahili as *Karata.* Draft was another game that was favoured by youths in Kisiju-Pwani. While children were happy enjoying in

the streets by using the light from the street lights installed in the village, women were meeting in some households to watch video (movies) especially Swahili movies commonly known in Tanzania as *Bongo Movie.* Different developments in the village by seeing different services which have been established or even strengthened after the introduction of solar electricity project were among the observed under this study. For example; Kisiju-Pwani people can now enjoy the European leagues from different countries as they have DSTV connection in the village; a service which is provided by one young person in the village. All these observations prompted further questions and the need of asking and understand from the people concerned.

In-depth Interviews

In-depth interviews were applied to create an enabling environment under which information on the real situation, feelings and perception of the people concerning the project implemented in Kisiju-Pwani could be generated. Through these interviews people's sense of ownership of the project, the basis for such feelings and perception were captured. It is a way that created a friendly environment with respondents as they felt free to speak out whatever they thought and wanted to air out about the project. Therefore; 20 in-depth interviews were conducted at the household level. 10 households were those households which are beneficiary of the project in a sense that they were already connected with solar electricity. These were from *Pwani* sub village as it is the only sub village in

which households are able to connect electricity due to a short distance from the min grid location. The other 10 households were from the households which are not beneficiary in a sense that they have not connected their households with electricity and there is no way they could do so due the existing distance from the min grid location. 8 out of 10 household (not connected) were taken from Maputo sub village which is not a beneficiary of the project; and 2 were taken from *Pwani;* though people have benefited in some ways as will be explained in details in Chapter four.

S/N	**HH Inter**	**Conn. Status**	**Gender**	**Age and household combination**
1	10	Yes	3 Female 7 Male	- 1 Woman was between 20 – 40 years of age - 2 Women were between 40 - 60 years of age. - 2 Men were between 20 – 40 years of age - 5 Men were between 40 – 60 years of age.
2	10	No	4 Female 6 Male	1 Woman was between 20 – 40 years of age 3 Women were between 40 – 60 years of age 2 Men were between 20 – 30 years of age 4 Men were between 40 - 60 years of age

Plate 5: Household interviews Composition

Focus Group Discusions

In collecting enough information for this study, Focus Group Discussions were conducted. The participants in this FGDs were purposively selected basing on village history understanding and special field expertize. Three FGD were conducted. The first group discussion consisted of village leaders; and in this regard; the village chairperson, the Village Executive Office (V.E.O), the village council members and the former village chairman; solar project committee secretary, education officer (teacher) and health officer. The second focus group discussion consisted of fishermen, and the third one was for small trade venders' women. The FGDs were necessary for the purpose of testing and confirming the validity of information which came up from the in-depth interviews in the households but also to get more information on how the project had helped different fields in the village. Moreover, they were meant to capture more information concerning the feeling of the people on the project.

FGD. int	Description of the participants	No. Partic
1	Village leaders, 2 Council members, 1 Project committee members 1 Health Officer 1 Education Officer 1 Former Village chairman 1	7
1	Small trader venders – women: This was a group of women who were selling different items in the village such as fried fish, *andazi, food, tea (ginger tea).* Their main customer are fishermen and other people in the village	6
1	Fishermen: This is a group that involved mainly the boat operators and other fishermen	4

Plate 6: Group Discussions Composition

3.5.3 Secondary Data

Various documents on rural solar electrification and other information about Mkuranga District and Kisiju-Pwani were reviewed. Some of them were obtained from Mkuranga District office, Kisiju-Pwani village, The University of Dar es Salaam, and from other individual researchers. These documents provided information which perfected the data collected in the primary data.

3.6 Data processing and analysis

Qualitative methods were employed in the data processing and analysis. Information captured by recording (using the recorder) from in-depth interviews, focus group discussions were carefully transcribed, and translated from Kiswahili; a language which was used in the data collection to English language as a standard language for this study. This helped to understand the meaning, understanding, experiences, attitudes and sense of project ownership and feelings of community members towards the effectiveness of the solar electricity project in their community livelihood transformation. Most importantly, it helped in capturing the basis for the attitudes, feelings and sense of project ownership by the community members. Data coding was performed for the aim of identifying the themes related to the solar electricity project implementation process, transformational changes and its relation to the community members' feelings and perception. This was also important in determining the basis for the feelings, attitudes and perception of people towards the project implemented in their community. The conclusion making was preceded by a detailed description of data.

3.7 Ethical Issues

Ethics is a matter of principled sensitivity to the rights of others. Being ethical, limits the choices we can make in the pursuit of truth. Ethics says that, while truth

is good, human dignity is better, even if in the extreme case, the respect of human dignity leaves one ignorant of human nature. This is and was important to consider during this study (Bulmer 2001). The research process must ensure the participants' dignity, privacy, and safety Scheyvens, et al (2003). In this study, social research ethics were assured. To be able to conduct this study, the permission and the introduction letter from the PITRO research team based at the University of Dar es Salaam was processed. After getting in the research village which in this case is Kisiju-Pwani, self-introduction to the village authorities was done and the introduction latter from the University of Dar as Salaam was handed in. Another introduction was made to the Project committee members by the Village Executive Officer. After identifying the households and the groups which were involved in the study, the information were sent prior the visit. They were all assured of confidentiality, dignity and safety during and after the study.

3.8 Limitations to the study

This study faced some limitations. The big limitation was to not be able to work on the collected data for a long time as the house I was based had no electricity and it was not a good environment to do extra job after the data collection. Another limitation was the inability to have enough female (household head wives) to discuss at the household level. Even those who were available to speak in their families could not give enough information especially when their

husbands were around while others were busy and were rushing to take care of other activities. They lacked freedom

To overcome these limitations, immediate action was important. On the first limitation, the decision to collect the data and deal with data processing at the end was made. On the second limitation, getting the households whose household heads were women and could have enough time and freedom to speak was important. On this also, it was important to elaborate thoroughly the objectives of this study to create a friendly environment for interview.

4. FINDINGS AND DISCUSSIONS

4.1 Introduction

This chapter presents, interpret and analyse the finding on the effectiveness of PV solar electrification to the livelihood transformation in Tanzania, a study based in Kisiju-Pwani, Mkuranga district. Under this chapter, explanations on how the implementation of PV solar electricity project in Kisiju-Pwani has impacted the people's lives and the community at large basing on the positive changes in the village which have either resulted from the project or have been strengthened by the presence of the project are given. The impacts of the PV solar electrification project in Kisiju-Pwani are obvious at the household and the community level. Moreover, the sense of ownership of the PV solar electrification project, community members' attitude and perception on the effectiveness of the PV solar energy project and the basis for such attitude has been explained.

Kisiju-Pwani community members considers the PV solar electricity project implemented in the village as a catalyst for their community's development and that it has created opportunities and many community members sees that as a turning point of their community's poverty and backward life standard.

4.2 Effectiveness of photovoltaic solar energy in livelihood transformation

Despite Kisiju-Pwani village being among the villages in Tanzania to have been denied with the access of modern energy for their development, people in this village understands the contribution of energy (electricity) to their development efforts. The only knowledge people did not have was the possibility of getting modern energy from the sun. Few people in this village who have travelled outside their village could have this idea. However many people could not understand the effectiveness of PV solar electricity before the project was implemented in the village. It was therefore the intention of this study to understand the perceptions and attitudes of the community members on the effectiveness of the photovoltaic solar electricity in livelihood transformation. Photovoltaic solar electricity project is an ongoing project installed in Kisiju-Pwani village. The community members understand the strength of the national grid electricity. Their views and perceptions on the strength and effectiveness of solar electricity therefore were important to get under this study. This study needed these questions to be answered; what is the understanding of people on solar energy? What are the peoples' perceptions on the effectiveness of solar energy? Do people consider solar electricity as a catalyst to their community development?

According to the informants; solar energy is a new technology that was not known to many before. However, some people who had seen solar electricity systems had no idea if electricity could be produced at the scale it is produced under one min-grid and distributed to different houses like the ongoing project. During the interviews one respondent had the following remarks concerning the solar energy understanding and its effectiveness;

> "I should admit that it is my first time to see such a big solar electricity project. I have seen those small solar which I also had one and it was not effective at all. If you get in the village during the night without being informed of the presence of solar electricity project in this village, it is very hard to believe this electricity is not provided by TANESCO. It is very strong and I never thought solar electricity could be that strong to be honest. You can light up, watch TV, radio, and charge your phone without any problem. You could not do all these with electricity from the generator which was very expensive." (Remarks from a 51 years respondent, who also own a small dispensary in the village)

From the experience of his life in the village, and other different sources of electricity from different projects the village has seen, people in this village were able to experience and recognise the effectiveness of the PV solar electricity. Despite being connected to the generator electricity which is believed to have been very expensive and unreliable, this village member had the following experience to tell;

> "I have had this business for 12 years ago in this village without electricity. I was using the kerosene lamp. In 2007 I bought a small solar panel which was used to at least get light but it was not effective and I had to stop using it. After that I was forced to use the generator electricity. Again it was not efficient and effective. It was too expensive and I had to stop because I could not afford $1 for 3 bulbs per day, and I did not see the point of paying for something that was not efficient at all. When the system of this electricity was completed, I was

> connected and it is a very good electricity. It is strong and it is there all the time day and night."

People's view and perception on the effectiveness of solar electricity is evident from the statements above. They admitted of being the first time for them to see solar electricity system in such a huge project. However, some of them had no idea how it works till the time the PV solar project was set up. Despite their praise on the effectiveness and strength of solar electricity, they were able to also point out the problem that they could not use some electric devices like fridge, subwoofer, and freezers which could widen up the chance for more opportunities. However; most of the community members were optimistic of the possibility of solar energy to have that capacity if they make the addition of the solar panels and batteries. The statement from one respondent explain this optimism as given hereunder;

> "This electricity is strong and I can see it is effective in helping us to develop our community. It would have been better had they allowed us to use some of the electric devices we have. We were told the intention of the project is to reach over sixty houses, and they said if we use devices like fridge, subwoofer, freezers and other devices that consume a lot of electricity, it would not reach all the said houses and we would like to see at least more people having it. We haven't lost the hope though as I believe if we make the addition of the solar panels and batteries we can have enough electricity and we can use them. If the money we are paying should aim at strengthening the project, I believe it is possible, isn't it?" (Statement made by a 49 years aged respondent)

PV solar electricity project has contributed effectively to the people's lives transformation in Kisiju-Pwani. It was interesting that most of the people viewed this by referring on the time used in the phone charging process compared with

how it used to be during the generator time. For example; one respondent in the village when asked about the way she sees the effectiveness of solar energy she responded by considering not only the time spent now in charging the phones but also the assurance one have when taking phones for charging. Here is what she had to say.

> "Solar electricity has helped all of us in this village. Take the example of charging the phones. You could take the phone for charging, wait for about two days, but then you get it back not fully charged. So you see, you spend two days without the assurance of getting it fully charged. It is different now as we have a lot of places to charge, with assurance of getting a fully charged phone. People with phones have increased because they are sure of charging them when they run out of charge. This is development and it has helped in a lot more other areas." (Remarks from a 46 years aged woman and a household head in Kisiju-Pwani)

4.3 Community members' sense of ownership and technology acceptability

Understanding people's sense of project ownership and their attitude on the PV solar electricity project was the aim of this study. This was to be studied given that there are no literatures which have shown in details the acceptance of this type of technology transfer, the sense of ownership of the projects, and the basis at which the acceptance could be measured from. The availability of the sense of ownership together with the basis at which that emanate will be revealed.

First of all it should be made clear that, the acceptance of PV solar electricity project among others is obvious in Kisiju-Pwani village. It is obvious in a sense

that it could be seen even without asking people. In direct observation which was done every day after the whole day of interviews for data collection, different events and action which could tell the peoples' feelings over the project were observed. Some of the actions coincidentally happened right in the presence of the researcher, but some others were actions which people had created or put in place even without being told so by the village authorities or the special project committee, but their own creativity in the cause of the project protection.

There are lots of examples of the events which happened while in the village. There are different connection boxes in the village, but most of them being right outside the houses of either beneficiaries or non-beneficiaries. The idea among others, is said to have been making it easy for people to connect their houses. One evening while going around with the secretary of the project committee, one connection box was nocked (hit) by one guy with a motor bike which is one of the main modes of transport and commonly known as *bodaboda*. There came one lady who was complaining that someone had hit the box and it was not in a good condition. It was so interesting to see how she was demanding for that person to be arrested and pay for the damage he had caused. The box was outside her house which was not connected to electricity. This action revealed one important observation and feelings, that not only those people who had the connection could care much about the project, but also even the people whose houses were not connected yet.

Another important observation was the one of the street lights which was observed while in a program of going around the village and seeing how people were benefiting from the solar electricity project. While going around, and reaching at a house which had no electricity, but it had the advantage of having the street lights right outside. The household members were using that street light for their night activities like having dinner under the light. Looking under the street light, it was realised there were the protection wire. When the household head was asked of what that meant, he explained that the idea was to protect the light sensor. Children were most of the time during the day and night playing around that area and they could end up damaging it. In order to protect it and ensure its safety, he had to find the protection wires and round the whole area, to discourage children from tempering with it. He then said, as a member of the village which has been privileged to have such a project, it was his responsibility to do everything he could to protect the whole project. To make his point understood, here is what he had to say;

> "It is our project and every one of us in this village has the responsibility to protect it. I am already benefiting from it through this light, but in future I might also need to get the whole house connected. Now we have the light in all our streets where the lights have been placed"

Plate 7: The connection box which was hit by the motor bike.

Plate 8: The street light with a protection wire

4.3.1 Basis for technology acceptance and sense of ownership

Having studied the sense of ownership of the project and their acceptance of the technology, it was important to find the factors at which their affection to the project were based. That is; what was the main cause or reason for them to have the sense of ownership of the project itself, but also their technology acceptance. It should be understood that PV solar electricity is still a new technology to most of the Tanzanians.

Prio information and preparation

One of the factors which were mentioned by many respondents in the households and in the focus group discussions was the prior information and the preparation the village authority gave them. It was said that the fact that they were informed over the project and that their village was among the three villages of which one was going to win, made it for them to feel privileged and so they are not ready to see it failing. One respondent said;

> "I think you have been told that this project was to be implemented in one of the three villages. So when we were informed over the selection of our village, it

> was something for us to be proud of and we find we have the responsibility of loving and protecting this project as much as we can" (Remarks from a 34 years aged man, who is a businessman in the village)

The information people were given over the then expected project have an important role to the people and on how people views the project. They view it as theirs, and see it is up to them to see it succeeding as the way of honouring the privilege that was given to them.

Peoples' participation in decision making

This is an important factor for the betterment of the project. As mentioned above, the village members were informed of that benefits their village could have from the installation of solar electricity project, but it was to be seen which village was going to win the project as their village was among the three villages which were considered under the project. Community members had to wait and the information came out that their village had won the project they were informed of.

It was reported that, when the village authorities started the plans of where and how the project was going to be implemented, all people were informed and were urged to participate through the village assemblies, which they did. In this they participated in decision making like; the placement of the project (plant), and areas to be considered for electricity supply (beneficiaries). According to the local respondent; the main decisions in which people were very much involved was the placement or the location where electricity plant would be. It is said that

the initial plan was to place it in the centre of the village so that at least members from both sub villages namely *Pwani* and *Maputo* could benefit on equal basis. However, this decision was forcing the village to buy the land as the area that was said to have been proposed was privately owned by one of the village members. To avoid such unnecessary costs, the village members suggested that because the village had a plot which was not used, located close to the village office; it was suggested that plot to be used for the PV solar electricity plant. Two main reasons are said to have been given by the people and they were agreed by the village authority; one was avoiding unnecessary costs, and the second one was ensuring the project devices safety and security. These suggestions were given by the people from both sub villages. One lady had the following to say;

> "We feel we were not ignored by the village authorities. We participated almost at every level of the project implementation. For example; we are the ones who made the decisions of the placement of the solar electricity plant. The leaders had suggested to buy the land, but we refused and suggested that the area at the village to be used instead and that is what happened. Even this committee was selected by us. Because it also has our decisions, we see it as ours and it is." (Response from a 44 years aged and a long-time resident of Kisiju-Pwani)

The participation of the people also helps the village authorities with less blames from the Maputo sub village which is not supplied with electricity as the people from there participated in deciding where to place the min grid even having been told that electricity from the plant wouldn't go for a long distance. The people also participated in proposing over the payments which are paid as monthly bills.

State of non political interference

It was found during this study that people were informed that the project had no any political interests and would not entertain political interference and that no politician was going to be allowed to use it for gaining political influence. This increased the trust of the people over the project. However some people were divided on this and believed that politics were applied during the distribution. This is because the village seems to be politically divided. But many of the respondents during my interviews and my study at large said that the information they were given is that the project was a not a political one and this increased their trust over the project itself.

> "We love this project and trust it because no politician can come here and tell us that he or she has given us electricity. We love it because we believe we are all united under this project." (Remarks from a 30 years old man in the village and a household head of 4 other members)

In different households which were visited, the focus group discussion conducted, and different people during the direct observation, their praise were directed on the fact that politicians could not use the project for their political agenda. Even those who were complaining of the politicization of the project were insisting that the leaders had gone contrary to the prior information they were given.

The promise of project ownership

The promise that was made to the people in the village had a positive impact on the way people viewed the project. It was reported that when the project started in the village, village members were told the project will at the end be given to them and that they would have a full ownership of 100%. This promise was so impressive to the village members to get. Knowing they are going to own this project for ever, pushes them to have more concern and commitment on its stability and development as their wish is to also benefit the coming generations. When responding to the probing questions on the reason that made them to have the feelings of the project ownership; most of the people pointed ownership promise as one of the factors as the one lady responded;

> "Now they (donor as they called them) are still doing their activities, but they told us when they are done this project will be given to the village and will have 100% ownership. We were all impressed by this information and that is why almost all people in this village love this project" (Response from a 44 years aged woman and a long-time resident of Kisiju-Pwani)

Most of the respondents revealed that it was important to tell the people and let them know what was going on as they did. Village members, everyone at his or her level feel the obligation of loving, and protecting the project because it is deemed to be a community's project. The stories which were given in the households and the focus group discussions were similar to the stories which were given in the streets. For example the women who were selling their products like food, pan cakes, and tea during the night told revealed the same factors and

went further to relating the project with the help in their business. One lady told had the following remarks;

> "I feel to be a part of this project. Look; it is helping me in this business despite that I don't have electricity at home but it is helping me in my business and this is the way am benefiting. We were told it will be given to the village and we all feel happy and love it because we regard it as the entire community's project." (Comments from a 30 years lady who sell food right under the street light during the night)

The village leaders like the V.E.O and the Village Chairman also admitted that this was a reason even on their side as leaders. The love over the project increased more after learning they were going to be the owner and controller of the project as the VEO is quoted as saying;

> "The donors said it will be given to this village. So when we are working every day for this project we know we are working for something which is ours despite that it hasn't been given to us yet, but it will be ours" (Comments from the V.E.O)

The village chairman and project committee secretary all confirmed it. The project committee secretary who works on the day to day activities of the project, said that the promise fuelled the passion and commitments of the people on the project.

4.4 Socio-economic opportunities from PV solar electricity project

The project have contributed in changing people's lives in Kisiju-Pwani through different social and economic opportunities which have either been created or

boosted by the project establishment in the village. Some of the opportunities were already in the village, but the project has just been a catalyst for their functioning. Some other opportunities have been created by the presence of the electricity after the introduction of the PV solar electricity

4.4.1 Fishing and sea transport activies improvement

Fishing is among the main economic activities in Kisiju-Pwani village and Mkuranga district at large. As pointed out in this study, a large number of Kisiju-Pwani and Mkuranga dwellers depend on the fishing activities and other business conducted at the harbour as their main income generating activity, not to forget sea transportation to and from the small islands close to Kisiju-Pwani. According to the local informants, the harbour had started to lose its popularity and favour from the investors in the last couple of years. Boats for fishing and transport had started to divert from Kisiju-Pwani in favour of Nyamisati and Dar es Salaam harbours. However the reasons for this change were far from lack of energy, but the facts underlying all these ports. For example Nyamisati near shore has no trenches and so it permits quick docking and taking off from the port which makes it favourable to passengers, and the distance from Mafia to Nyamisati is shorter as compared to the distance between Kisiju-Pwani and Mafia. So there were more pulling factors at Nyamisati harbour than Kisiju-Pwani.

The installation of solar electric project in Kisiju-Pwani has brought back the early glory of Kisiju-Pwani village and its community members at large. The interviewed community members pointed out that the installation of solar project in Kisiju-Pwani had attracted back the people and investors to invest at their harbour and bring back the busy Kisiju-Pwani harbour as it used to be. As pointed out, most of the passengers from Mafia and other islands had stopped using Kisiju-Pwani harbour in favour of Nyamisati harbour. Things are said to have changed since the introduction of the functioning of the PV solar electricity project. Fishers now believe having electricity at Kisiju-Pwani harbour, allows them to have an easy access to the harbour at any time, something that cannot be done at Nyamisati which is more functioning during the day. They now see Kisiju-Pwani having no difference with Dar es Salaam in terms of accessing the harbour when getting back from fishing especially during the night hours. During the focus group discussion conducted with the fishermen and in other interviews in the households, the appreciation of the project on strengthening the fishing and transport activities were coming out. Some of the respondent's statements explains people's feelings as it is shown under the statement given;

> "This harbour have now turned back to its old days we all know in this village. Now you can see it is busy, but it was not like that in the past two, three years. Most of the boats for fishing had shifted to Dar es Salaam and all other boats from Mafia for example had started to use Nyamisati harbour. But the introduction of this project (solar project) seems to have changed the situation. Those who had started to use Dar es Salaam harbour now are coming back and

> use our harbour as they see it is like Dar es Salaam (ferry) because of the lights but also Dar es Salaam has a lot of boats, and they are running out of that trouble. The boats can get to the harbour at any time because the lights also helps in guiding them. Seeing the lights helps a lot. To be honest, this change has been because of this project" (the contribution from the 32 years fisherman who go for fishing by himself)

Solar electricity in Kisiju-Pwani is believed to have turned the port a business hub again and improved the working condition. People in Kisiju-Pwani believes even the fish for the local people who buy for subsistence have increased in the sense that they have more chances and options of getting fish and making the choices of where (at which seller) they should buy. It has increased their capability to make choices due to the increased options instead of few as it was. It emerged as the interests of this study to understand how that was contributed by the installation of solar electricity project in the village and these were the response which were given;

> "Like I said and am sure you will get the same experience from other people you will visit. Despite the potentials of this port (Kisiju-Pwani harbour), it had lost the market and people had started to use other ports. Very few were coming here and that was making it difficult and they were deciding the price they want. Now if you don't agree with one you can easily move to another one and get a price you want. Had it not been this electricity, I am sure we would have lived with the same experience for a long time. Those who were going to Dar es Salaam are now coming here, and they can get here at any time. Early in the morning you can get fish arrived in the last night because of electricity" (Remarks from the 32 years old man, and a long-time resident of Kisiju-Pwani village)

From the above statement or response, solar energy project has not only helped on encouraging different people to invest in Kisiju-Pwani especially in fishing

but also it has widened the chance for peoples' choices. Their capability has been widened. Now fish business is run on a fair competition base as people who have invested in the business have increased from time to time.

The contribution of solar energy in Kisiju-Pwani is viewed in many angles by the community as pointed out earlier. It is believed that before the start of this project, there were a lot of theft cases at the port whereby the fishing materials and equipment were stolen unnoticed. During the discussion with the V.E.O, it was admitted to have had a lot of theft cases at the port before the project was installed in the village and here is what he had to say;

> "This office was busy solving the port's theft cases. It was easy by that time for people to steal because they could come from the beach unnoticed and take anything they wanted and leave. In the morning you open the office with cases. There are even some of the fishermen who decided to stop their activities and others shifted to other ports like Dar es Salaam where they were assured of the fishing equipment safety. It was terrible". (V.E.O response)

Now things are changing since the installation of the solar project according to the V.E.O and the other community members. Theft cases have decreased from time to time and now the village have been able to combat the problem. According to the community members and the fishermen when interviewed during the group discussions, they were full of praise to the project and that in that it has ensured safety to their fishing materials and it has won back the people who had left the field and those who had shifted.

> "No one can do anything without being noticed by any of the villagers. Now even the work of the security guard has been simplified by this electricity. It is

> different from the time when we had no electricity in this village. These days we can leave our equipment and go home and sleep without having any problem. You could not get a lot of people especially the fishermen and those who own fishing materials like the ones you see now. This has really helped in our fishing sector in this village" (Remarks from the 32 years aged fisherman during the F.G.D)

4.4.2 Small and medium scale trade improvement

As a lot of literatures provides the contribution of energy in the improvement of community activities, solar energy project in Kisiju-Pwani has proved to have a great impact on the improvement of small and medium trade activities in the community. Different activities have been boosted and others have been established. According to the local informants, the project has helped in their everyday business due to the improvement of their activities. Most of them cited the opening hours to have been increased from 06:30pm to 11:00pm. The opening time is believed by the community members to have increased the productivity in their business and services at large. One respondent when asked of whether the project has had contribution to his business, he had the following remarks;

> "This solar electricity has helped me even more than I expected. It was not easy to use lamp in this business, but also it was limiting my operating time. Now that I have electricity, everything seems okay and the opening time has increased. Instead of closing at 08:00pm, now I can work as much as I can depending on the movement of people in the streets". (Remarks from a 49 years old man, and a household head with a restaurant in the village)

Street lights in the village have had a distinguished contribution in the business according the community members and those who run business in the village.

This claim is built on the fact that the movement in the streets have increased compared to the time before solar electricity project was established in the village. The respondent had this to say;

> "If you (the researcher) have gone around this village you have seen the street lights. Those light have helped so much in our business. I used to close at 08:00pm or even before that depending on the darkness time as peoples' movements in the village were ending almost at that time. Now because of the lights, the movements of people are guaranteed and they come here to eat (at his restaurant)" (remarks from a 49 years respondent owning the small restaurant in the village)

From this project, the village is said by the village members to have benefited from the street light as different activities can now be done during the night. According the village members, the street light not only have increased the operation time, and the customers, but also security during the night hours and more especially the operation time has been ensured. This security benefit will be discussed more in the coming sections.

4.4.3 Job creation and new services provision

New activities which did not exist in the village were introduced and more people got activities to do for their development. It was noted that the village had a large number of unemployed people, who spent more time playing *bao* and draft; while others spent time at the port looking for the possibility of getting some activities which could at least give them some income that could help out to run their lives. Now the village is experiencing a new ease of life as many people; women and

men, old and young people are coming up with ideas of having their business. Creativity in the village can now be seen from different activities which have been established.

This study found that the village had started to have the hair cutting saloon (barber shop), a service that never existed in the village and to get such services, people from Kisiju-Pwani had to travel for over 49km to Mkuranga town where the national grid ends. Now the service is available in the village and one new hair cutting salon (barber shop) had started to operate during the time of this study. It is owned by a young person aged 29 years old. When asked as to how the project had contributed to bring about development in the village here is what he had to say;

> "This project (the solar project) came to this village at the right time and I see it as a catalyst to our development efforts. Given a number of young people having nothing to do, it has given a new way of thinking and come up with what a person can do. I had to think of the possibility of having this service as both a service and business. As you can see, it is only yesterday it started to operate. We had no this service in the village, but now we have it. We are no longer forced to go to Mkuranga just for this service. We will go where it is due for other business"

Plate 9: The barbershop in Kisiju-Pwani which started the operation during this study

Lack of electricity in the village is believed to have also limited the people's thinking and creativity capacity. On what they could do for their development, they were forced to think in the areas of possibilities. Despite having electricity from the generator in the village, it was hard for a person to come up with the idea of having a business of which its functioning would depend on electricity. Even if they could come with such ideas, the generator owner could not let the community members to have such business. When asked of whether he had thought of owning such a business before the introduction of electricity, the response was like this;

> "To be honesty no. It was not even in my mind because even if I did it couldn't be possible at that time. But I just thought of this business after we got electricity in one day and the second day I went to buy the equipment needed and now it has started. But this was possible because of electricity." (A 29 years old and the owner of the barber shop)

Solar energy has potentially helped in job creation in different ways. Like what has been revealed in most of the literatures, phone charging now in the areas where there is no grid electricity but having solar electricity has employed a lot of people. Kisiju-Pwani is no different from what has been studied and written. Phone charging in Kisiju-Pwani used to be an activity that was monopolized by one person for years, the person who owns the generator. No community member was allowed to have such business, unless he or she has his/her own source of electricity; not even his customers who had the connection in their house. This generator owner had different charging centres surrounding the village and so it

was made his business. However, because of the demand of that service, it was not efficient as people could wait for a week for their phones to be charged.

The introduction of solar electricity project in Kisiju-Pwani opened up the doors and cut all barriers which had existed for a long time for the community members and hindered them from opening up phone charging service as their business. Now it has been made possible that everyone who is capable of opening such business (service) in the village can do so as it comprise some extra cost as a monthly bill. Phone charging has now employed more people than it was before the introduction of PV solar electricity project in the village. Different people who were interviewed were able to point similar claims and made comparison of the time before and after the project. When asked about the opportunities they thought had emanated from the project and the changes they have seen, here is what they had to say;

> "A lot has been done after the introduction of this project in this village. Most of the young guys in this village with offices like phone charging centres, video centres, and games' centres had nothing to do before this project. Most of them have opened up phone charging centres. They are getting some money. There are a lot more which can be realized from this project" (Response from a 43 years aged respondent and resident of Kisiju-Pwani)

Plate 10: Two of the phone charging centres in Kisiju-Pwani.

Despite phone charging being a service, it is also respected as a business and a source of income that has changed or started to change some people's lives. Collings (2011), in his study of Phone Charging Micro-Businesses in Tanzania and Uganda found that phone charging is a viable economic activity in rural Africa where there no grid electricity or where most of the people cannot afford grid electricity. It was therefore realized that phone charging in Kisiju-Pwani has now become not only a service but also an important economic activity that has employed village members who were ready to invest in it. The solar project has opened up this opportunity for everyone in the village. It was revealed that it is a business that people count to have helped them meet their daily needs. One community member had the following to say;

> "It is a good business. It is a business in which you don't have to beg, but money comes as people will basically need to charge their phones for communication as not all have access to electricity. As per life in this village, it is paying to be honesty. I can get my needs from this business only" (remarks from the community member aged 30 who owns one of the charging centre)

Speaking to most of the people who owns the phone charging centres, it was revealed to be the business one can depend on without having financial constraints. At least there is an assurance of charging an average of 20 cell phones every day. Every phone cost up to 200TSH (equivalent to $0.1171) to be charged. When asked if it has a profit the answer was simple

> "Yes, it has a profit. At least from charging only I can get not less than 250,000 TSH (equivalent to $146.3) per month. This is a good amount of money in this village. Few people who are employed in the government can earn this amount of money in a month" (remarks from the community member aged 30 who owns one of the charging centre)

Moving around the village as a part of direct observation, a lot of video and gaming centres which has been found to be a good business were witnessed. These are not only used by children, but also the old people and so it guarantees the owners with customers. This study had the chance to speak with some of the owners in the households which were interviewed and even when meeting them in the streets the researcher asked some questions to get a good understanding. When asked of their views on this business in relation to the project here are the opinions of most of the people on this area;

> "Without this project we couldn't have even thought of this business. It was formerly limited and monopolized by one person because he had a generator. It is good that we can now have it as electricity is available all time. We got this project as a blessing. We are getting money that can help our families" (Remarks from the 30 years man and owner of one gaming centre and one video centre in the village)

It is said the village had one video centre before the solar electricity project. Like the phone charging business, it was also limited and monopolized by the

generator owner in the village. Other community members could not open such centres because of lack of energy to run them. No generator electricity customer was allowed to have such business.

> "I had generator electricity, but I could not have this business despite that it was in my mind. It is a business was a one man owned in this village. Doors were closed for others. He had a control. Now he doesn't have that control because we don't use his generator anymore. It is open for everybody" (Remarks from a 34 years guy and owner of the video and games centre)

It was so interesting how village members were so much interested in following the European leagues like the Spanish league, English premier league which is basically the most famous leagues not only in Tanzania, but also in the world. Because of this interest, having a place where people could watch different football matches has become a business of its own kind. The passion people have over football and the love they have over their teams were witnessed. One young guy in the village grabbed this opportunity and has constantly provided this service to the community members at his centre known as *"Anfield"* consistently since the introduction of solar electricity in the village. It was realized that this service had started even before the introduction of solar electricity as it started by using electricity from the generator. According to the owner of this business, it was very expensive to run due to different reasons, one of the reasons being lack of reliable energy in the village and because of this problem he even though of closing it. It was however interesting to learn that he decided to keep on doing it after learning that there was a solar electricity plan which was to be implemented in the village. Here is what he had to tell on the matter;

> "I knew people likes football and I thought I could give this service while benefiting. But I could get to the end of the month when am supposed to pay for DSTV (Digital Satellite TV) and I couldn't get enough money for that because the service was not consistent due to lack of reliable electricity. I then thought of closing I was running it with loss. But before closing, is when it was learned from the village leaders that electricity project was going to be implemented in this village. I decided to wait and see. Now it is well running, consistently and am getting enough people and they are paying. Now I can say *Alhamdulillah"* (remarks from a 28 years guy, owner of the TV sports centre)

Plate 11: The board at the centre showing the matches of the day, time, and entrance fee

The computer gaming centres were for the first time introduced in the village after the PV solar electricity project was established in the village in 2013. Some people thought of having this business, but the problem was lack a reliable energy. When asked of how the business was going and whether it was profitable, one respondent and owner of one of the gaming centre responded;

> "It is going well. It is new but it is going well and profitable. Children and other people are coming to play and one has to pay 500 TSH (equivalent to $0.29) for one game. At least I can get at least 20 customers per day. So it is profitable for sure" (remarks from a 34 years guy, owner of the centre)

Plate 12: Some children playing computer game in one of the games centres

4.4.4 Households and community socio-economic improvement

Different studies provide the primary use of solar electricity in the rural areas in most of the places where solar electricity projects have taken place is believed to be lighting. But electrification brings more than light. Its second most common use is believed to be connection to the television and radio which brings both entertainment and information. People who live in rural areas greatly appreciate these benefits and are willing to pay for them at levels more than sufficient to cover the costs (World Bank, 2008). In Kisiju-Pwani it has been the case in that, lighting has been the common use, but also it has given Kisiju-Pwani community members more than lighting. Now they are benefiting from TV and video watching, radio connection and Phone charging which has turned to be an important source of income in the village. PV solar electricity project unlike others which concentrate on in-house lighting and other benefits, this has gone further than that and light the village streets. People are grateful of this as they

say it also benefit the other people whose houses are not connected. For some others whose houses are not connected, have the street lights right outside their houses. According to the local informants, this project has helped the village in bringing more happiness in their families. One of the respondents told me;

> "I am so thankful for this project and I think everybody in this village should be, because it has changed our lives. We are getting light, we can watch the video and TVs for those who have them and we can walk in the streets without fear because of the street light and because it has increased the movements during the night hours. We can charge our phones listen to radio and get information on what is happening in other areas of our country." (Opinion from a 44 years aged woman)

The Village Chairman also added that the people are enjoying the benefit of the project as they can watch the TVs in their houses and those with no TVs or video films have the opportunity to watch them in their neighbour unlike the past when they had to depend on one person service.

> "But now I can say after getting this solar electricity, people have benefited a lot. Now they can charge their cell phones at a very cheap price, enjoy their TVs and different film in their TVs and those who doesn't have TVs goes to their neighbours." (Remarks from the Village Chairman)

It was so interesting for young and other people who have interests in football. Now football matches are well watched in the village without any problem like electricity cut off. Most of the youth who talk to the researcher had a lot to point as entertainment, particularly watching different matches right in the village. One person said;

> "Today's Kisiju-Pwani is not the one most of the people would think it is. Who can believe that we can watch European football in Kisiju-Pwani? We had this

service but it was not reliable. Now we can watch even if it is at 2:00 in the night." (Remarks from the 23 years guys in the village)

The happiness people have in the village was evident and could witnessed during the direct observation. Watching football together with the village members made it possible to understand what was said during the interviews. It was so interesting to realise that having electricity in the village has made some women to develop interests in football especially for the English Premier League and the European Champions League which are the mostly watched matches in Tanzania.

Plate 13: Children enjoying watching movies and Football fans watching a football match

Khandker et al (2012) in their analysis Who Benefits Most from Rural Electrification provide that rural electrification is expected to improve rural people's quality of life and spur growth on a range of socioeconomic fronts. The (World Bank, 2008) in The Welfare Impact of Rural Electrification also provide that small-scale enterprises, including home businesses, are more plausibly influenced by the availability of electricity. Access to solar electricity in Kisiju-

Pwani have created different opportunities to both the households and community levels hence the improvement of socioeconomic condition. Different employment opportunities have been created where not only men now participate in production, but also women. More explanation about women opportunities will be provided when discussing gender relation improvement in the village.

> "The way you see our village today is quite different from how it was before this project. We have advanced at least. You can see different people with different activities more importantly activities which involves electricity. Our lives have improved now you can see different women having their business which helps to run their families" (remarks from a 46 years old lady in the village)

According to the local informants, households and village members with cell phones have also increased in Kisiju-Pwani. The reason for the increase is believed to be the introduction of solar electricity as people have been motivated given the fact it has given the assurance of charging. It is said that some of the people had no cell phones not because they could not afford to but the challenge of how to charge them was a barrier of its own kind despite having a privately owned generator in the village. When village asked of the contribution of solar electricity to their socioeconomic development, most of respondents pointed the increase of communication freedom insisting that solar electricity had increased their communication freedom without charging problems which they had experienced for so long. For example one person among other respondents had the following to say;

> "Phone communication has been made easy in this village. You know our village is very far from where the grid electricity ends. So it was not easy to charge despite having generator electricity. Some people were forced to send

> their phones to Mkuranga or Dar es Salaam for charging which again was very risk as they could get lost. When I thought of all these I just did not see the point of having a cell phone. But now after getting electricity in this village, I have my phone and I can charge at any time". (Contribution from a 33 years man in Kisiju-Pwani)

The PV solar energy in Kisiju-Pwani has promoted and created more chance for people's socialization. It was reported that before the project, the time for socialization in the village was very limited as people could be together up to 05:30 pm in the evening. It gets dark very early in Mkuranga and so in Kisiju-Pwani. People used to play their local and traditional games like *bao,* commonly known to be a traditional game for old people in the coast regions in Tanzania, and draft and playing cards which is mainly played by youth in the village.

Plate 14: People in the village playing bao and draft as a part of socialization

The PV solar electricity increased the socialization and recreation time for the people of Kisiju-Pwani. It increased their choices and freedom to live and do what they want.

4.4.5 Security improvement

Among the benefits which at least all people; i.e those with electricity connection and those whose houses were yet to be connected, were happy of was an improvement of security in the village. It is said security has been a big problem in the history of this village, something that forced the village authorities to establish a program known as *Sungusungu* for ensuring people's security and the village at large. However, due to the lack of light, the task was so hard, and so they had to use normal touch and people had to contribute some money for buying batteries for those touch to make the task easy. The introduction of solar electricity in the village accompanied with street lights not only it simplified the security program, but also it served the community members the burden of contributions.

Kisiju-Pwani village is blessed to have a harbour which operate for fishing and ocean transport activities. This harbour is the main source of income for the village authorities and the community members at large. Different trucks gets in the village for taking fish from Kisiju-Pwani to other areas like Mkuranga, Dar es Salaam and other areas of the region. The tax they pay is divided between the village (in this case the village authority) and investor; and this is what helps in day to day village activities.

The harbour because of darkness due to lack of lights was the victim of theft habits as different equipment were mostly stolen unnoticed. According to the local informers, people and other traders (fishing traders) had threatened to stop using Kisiju-Pwani harbour and move to other harbours. One of the reasons among others is believed to be lack of security at the harbour which was mainly caused by lack of sufficient light.

Kisiju-Pwani community members also had experienced the pangs of theft and robbery in the village during the night. Houses breaking and stealing things left or forgotten outside was common and in the village. It had become the experience that was common and it could not sound as a new habit in the village.

The introduction of the PV solar electricity project in the village turned the situation from worse to better, admired by everyone in the village. It created a new reputation not only for the harbour, but the village at large. Those traders who had shifted their business to other harbours were reported to have come back to Kisiju-Pwani harbour and pursue their activities as usual.

When speaking to different people from the respondents; during the interviews, the FGD to the other people in the village, at least they all pointed the benefit of street lights being their properties security and the village security at large. One respondent; during the interview when asked on the contribution of solar

electricity to the village as a whole, he made it clear on the security benefit the village has got from the project. Here is what he had to tell;

> "I would point security as the first benefit we have got in the village a whole. You possibly have seen that electricity is not only in our houses, but also in the streets. That has helped and simplified the security activities of this village. No more thieves" (Remarks from a 31 years aged man during the household interview)

It was however pointed out that security is the area of benefit which has touched every person in the village. Yes not all people have connected electricity to their houses and those people whose houses are located a bit far from the connection boxes, but all have benefited from the street light at least. When speaking to one lady whose house was not connected, she said her household was not connected but she had some benefit from the project as it had simplified her night walk to and from the village centre as she could walk at night without fear. Here is what she said;

> "This electricity has made it easy for us to walk to and from the village centre during the night. I could not do that before because of darkness. It was not safe back then. Now I can walk because we see each other due to the presence of street lights. This has been the case for almost all people in this village" (Response from a 44 years old woman in the village)

They were of depending on the touch during the night village patrol is believed to have become the history as the lights seems to have made it easy when dealing with Pwani sub village. The village members who take part in the night patrol used to depend on the normal touch but now has been simplified with the existence of the street light. In Maputo sub village the security issues is still a

challenge as there is no electricity because of the distance from the electricity production area (the plant). However, speaking with the village leaders; it was revealed that it is a challenge that can be handled as the sub village is not that much targeted by thieves like Pwani due to its nature and lack of business centres. There is only one shop (kiosk) in the whole sub village and that takes it out of the theft target. The VEO who mostly leads the village patrol said Collective security commonly known as *Ulinzi Shirikishi* is now easy as they can easily see each other and any other person they can doubt; The VEO had the following remarks

> "Collective security *Ulinzi Shirikishi* has been simplified in this village. We are no longer depending on touch when in the process, but we only need them when we are working in Maputo which has no street lights as it is not connected to this electricity. However Maputo doesn't have big security problem because it has no shops which most of thieve would targets."

At the household level, security was said to be the benefit all people have enjoyed. It was said in most of the households in which the interviews were conducted that security in the village has changed from worse to better something that everyone has been pleased of. The reports of waking up in the morning and find properties to have been stolen before the project was installed in the village were the stories of almost every household in Kisiju-Pwani village. Things changed immediately after the installation of solar electricity project. Chicken were stolen which was so disappointing for the people who wanted to do poultry. In two households where the interview was conducted on the presence of the

husbands and wives, it was revealed that the lights in the house and those in the streets had helped their families;

> "In our house for example having lights inside has helped us a lot. Before this electricity, we had a terrible experience. We could wake up in the morning and find our properties to have been stolen. Some are those forgotten outside but in a place which is not easy for outsiders to see, but they were stolen. But now since the introduction of this project, I cannot complain. We haven't experienced it any more" (Remarks from a 48 years lady (a wife) in the village, who was interviewed together with her husband)

In the next household the responses were almost the same but touching on how their chicken used to be stolen.

> "In our house we have chicken. But we had a problem with theft as they were being stolen during the night given that we had no light in the house or even outside. It was simple for thieves to take them unnoticed. Even if you hear their noises, by the time you are up the thieves are gone. It was disappointing. But now, I thank God that we haven't had this problem since house was connected with solar electricity."(Remarks from the 27 years old lady and a spouse of the households head)

However, despite the benefit that was reported in most of the areas from different households in Pwani sub village, the situation was a bit different in Maputo village concerning security of their properties and themselves. According to the respondents in Maputo, security was still a challenge and that it was hard for them to walk around the village. They reported that for them to benefit from the street light; it is until they go to Pwani.

> "In terms of security in this village, I can see the people who are benefiting are those who live in Pwani. For us no, may be if we can consider the time when we go to Pwani. It has helped the village and the harbour, but saying that it has helped the security of our sub village, no! We cannot walk freely in this sub

village like when you are in Pwani. Here you cannot see what can harm you" (Remarks from a 36 years lady who live in Maputo sub village)

The street lights have also helped to provide the car parking space during the night as the areas which are believed to have more security than the dark areas as it used to be as per their experience. Those cars working within the village and the passengers' cars to Dar es Salaam get security at the street lights.

Plate 15: Street lights serving as night parking for cars in the village

The PV solar electricity project has improved the security of major areas in the village and it would have done the same for Maputo sub village had it been connected to that sub village.

4.4.6 Environmental conservation and hygiene improvement

Most of the respondents in Kisiju-Pwani views the contribution of PV solar energy by looking on the impact of the project to their village hygiene improvement. However, very few of the members pointed on the relationship available between energy and environmental conservation. Moreover, a few

number of the respondents tried to relate energy to environmental conservation were basically referring to the in-house pollution which caused different health problems as it is discussed under the health improvement section.

Most of the respondents recognised the contribution of PV solar electricity project and admitted the project had helped in their village environmental conservation efforts by pointing on the improvement of hygiene in the surroundings of their village. According to the respondents, solar electricity project had helped in the cleanliness of their village in the sense that people who used to *defecate* in different areas of the village, and at the harbour during the night had stopped in fear of being seen due to the presence of street lights.

> "It was common in this village to find *excrement* in the streets. People were using the darkness advantage to defecate in the streets during the night. At the harbour you could find excrement at least every day. People did not even care that could lead to the outbreak of dangerous diseases especially when that is done at the harbour where they all know it is a place we get fish we are all eating in this village. But since the project started to work, this changed and you can hardly get excrement in the streets. At least not as it used to be" (Remarks from a 37 years old man, who is also a fisherman in Kisiju-Pwani)

Again, people in Kisiju-Pwani raised the point that the project most importantly the street lights had contributed to stop the habit of throwing garbage everywhere in the streets. It was found that people were not taking garbage where they were supposed to be taken and it was common for a person to open his door and find a lot of garbage in front of his or her door, or in the way. This habit is said to have

stopped since the installation and the functioning of the PV solar electricity project in Kisiju-Pwani.

> "I think it has helped. Our environment now in the village are clean. I said we have no more trash thrown everywhere as it was before. Now people cannot do that as they know they will be seen" (Remarks from the 29 years aged respondent)

It was interesting to see that people in the village could think of the impact of modern energy to the reduction of emissions in the atmosphere. It should be understood however that the matter was not so much related to the presence of the project in their village, but thinking that if the project was strong enough, they could use it for cooking and that could serve them their trees and fuel burning. One woman in the village who owns different income generation activities like shop, CD lending centre, and phone charging pointed on relationship available between solar electricity and the environment. She said all her other income generating activities are outside her house, except the shop in which she sell clothes, communication voucher, and other cosmetics goods. In responding to the question that aimed at understanding the contribution of solar energy towards the environmental conservation in the village, she said that before solar electricity was introduced in the village, she was using a kerosene lamp. This was smoky, but no one could notice that. She could only get the results from the clothes as they were turning black as she named it "*they were getting and black shell*". The idea she got was if this is the case, then lamp are dangerous to the environment

and their health for that matter. Here is what she had to say and it was very impressive

> "…Again given that we are now using electricity, the use of oil-lamps has decreased tremendously in this village. So when I remember how the clothes in the shop were being affected by turning to black colour (getting the smoke colour), and even the roof of the house changing in black because the oil-lamp smoke, it makes me think that the oil-lamp smoke has effects on the environment in general. If this electricity would have enabled us to cook for example, we could have also served our trees to a large extent. Cashew nuts seems to continue to be used for charcoal production." (Response from a 44 years aged woman and a long-time resident of Kisiju-Pwani)

The similar argument was made by another young respondent in the village, who claimed solar energy could possibly save their cashew nuts trees, because they are now witnessing a continuation of charcoal production from the cashew nuts trees which is the back bone of the economy of people not only in Kisiju-Pwani, but also the Mkuranga District and the Coast region at large. The fact they failed to see was that despite also as villagers being in the same use of charcoal, the main market for charcoal lies somewhere else which is Dar es Salaam and other neighbouring areas. The point here is; even if they get electricity for cooking; charcoal remain one of the economic activities different people are relying on and so it wouldn't save the trees/ cashew nuts unless energy problem is addressed in the country at large

Although solar electricity project in Kisiju-Pwani has not been able to help in the forests conservation, its presence in the village seems to have made some people think of what modern energy can serve. It has given the people a new dimension

of thinking in relation to environmental conservation. Another aim of this study was understand if solar electricity project had created the sense of environmental conservation to the people in the rural areas. One respondent when responding on the question said;

> "I think we have seen in this village that since the start of the project, we have decreased the use of oil like diesel and kerosene. I don't think this kind of energy is good for the environment if it cannot be good for our health. So for that I think it can help keep the environment clean especially when more people start using this electricity" (Remarks from a 44 years old woman respondent)

It is well recognised by the solar electricity users that solar energy has helped in minimizing the use of oil lamps which uses kerosene and diesel. The problem with these kind of energy is that they are smoky and they cause indoor environmental pollution hence different health problems as will be explained on the health benefits. The idea of seeing solar energy serving the trees and more importantly Kisiju-Pwani cashew nuts could not be realized in the near future unless the issue of energy efficiency is addressed in the country.

4.4.7 Education Improvement

The potential of solar electricity in the development and improvement of education services in the village is obvious and evident. During this study; the respondent shown how hard it was during the time of what they called "*darkness time*", and the effect it had on the socio economic development of the village and education attainment in particular. The village chairman for example simply said;

> "Before electricity, this village was in a total darkness despite its potentials. And this darkness had effects. Students could not read at night as it was very hard for them." (Village Chairman remarks)

It was reported therefore that solar electricity had simplified the life in the village as now students can read at night something that was almost impossible in the previous days before electricity. During the FGD one participant acknowledged the contribution of PV solar electricity project in the village and that it would help in the development and improvement of education services in the village as he said;

> "Now that we have electricity all things which were not possible has been made possible. Children are playing and student reading at night. This will no doubt improve the understanding of students in this village…." (Comments from the project committee secretary)

In Kisiju-Pwani, this study found that there were improvement in education attainment basing on the information which were provided by the parents, the teachers, the village leaders and members at large. It is so unfortunate that up until the time of this study no school was connected to the solar electricity project due to the distance between the schools and the location of the solar electricity min grid itself. However, evidence from different households which had students, the village leaders but also the teachers proves the project to have had the positive impact on the improvement of students' understanding. According to the respondents during the FGD, the attraction to good teachers who will stay in the village has been added. According to the people's anticipation, the teachers located to Kisiju-Pwani will stay because the village has electricity. It is said it

was not easy to get teachers and make them stay in the village as there was no electricity. However, among the houses which were already connected to PV solar electricity, there was no even a single house in which teachers were living that could be pointed as an example. Even the teacher who participated in the FGD based much on students' current understanding compared to the time when all houses had no electricity, although it was still something to be proven as they admitted to be a short time to draw conclusions as one teacher said;

> "Looking at the student understanding sharpness it seems to be promising. But we should remember this project is new in the village. We all hope it will have the impact on the education development. For now it is still a short time to draw conclusion". (Remarks from a 34 years secondary school teacher)

The only example that was given was that they are getting some services they possibly could not get without electricity, but it was still anticipated that it could attract good teachers and make them stay when they are supplied with electricity.

> "We have just started using this electricity. We hope it will help us to get teachers who will not leave our village because of lack electricity. Now they can charge their phones which they couldn't do in the past." (VEO remarks)

According to the respondents in different households, solar electricity has made it possible for their children to set time tables for studying during the night, something they couldn't even think of during the time before PV solar electricity project was established and implemented in the village. For example in different households it was reported that children had no reading habit during the night, but they would do it occasionally. The introduction of PV solar electricity

changed the habits of their children. It was reported in some of the households that “the love of studying” was back to their children.

> “Children here are reading at night. I feel happy to see their *love of studying* because they had lost it I think. They had no night studying and reading habit, but now you don’t even remind them. They do it by themselves. As I look at their understanding and results, I think they have improved a lot” (Response from a 40 years old man, and a household head)

The secondary school located in the village was visited during this study, and the headmaster of that school together with some few teachers at that school had some things to tell about the PV solar electricity project. They all acknowledged the impact the PV solar electricity had made by pointing on how they see their students. Because they know almost all student due to the size of the school itself; the distinction could be made from the students who come from the electrified area and those who do not come from the electrified area; i.e. Pwani and Maputo respectively. It was said that the difference was from their understanding as those who come from Pwani mostly have the opportunity to study during the night, and those who come from Maputo have no enough time and opportunity do that. The headmaster said;

> “It is unfortunate that we don’t have electricity at this school possibly because of our location. Despite that it has started to be used in a very short time, but we are already seeing the difference it can make. When you look at the student you can easily see the impact. Also this electricity is only in Pwani, again from this you can see the difference of the students who come from these two areas” (Headmaster’s remarks)

However, some students had formed some studying group and they were meeting in Pwani sub village where there is electricity for night study. Those from

Maputo could meet in their friend's houses and get the opportunity to ready. This again was done by few students from Maputo while many of them could not have that opportunity.

However, despite all the praise most of the parents gave to the project, some pointed out that the project had created another problem especially to their children. It was reported that although it is development to have electricity, but it created the situation for their children to be lazy. The point was made on the fact that the village has a lot of video and gaming centres, which attract the attention of their children more especially those who come from the households which were not yet connected to the PV solar electricity. It was said that some of the children could not even think of studying other than watching movies and playing games which could have a negative impact on their education development.

Generally, PV solar electricity has helped and boosted the level of understanding to many children in different households. The evidence of the opportunity for students to have more studying time during the night was mention in all households when responding to the question. It was however suggested the electricity to be distributed to the areas where it did not reach especially to Maputo sub village to create the balance between the two sub villages. One respondent told me that all the benefits the people living in Pwani sub village are getting are also needed in Maputo.

4.4.8 Health and health services provision improvement

The application of the PV solar electricity in Kisiju-Pwani has helped the village and the health facilities in the improvement of health services. In Kisiju-Pwani the people are mainly depending on the Roman Catholic health centre and a small dispensary located in the main centre of the village in Pwani sub village. All these health facilities are privately owned. While the Health centre is owned by the Roman Catholic Church in the village, the small dispensary is owned by an individual who also happened to be the Kisiju Ward Councillor. The Roman Catholic health centre have been with electricity for a long time, while the other small dispensary have not had a stable electrification. It is however the findings of this study that most of the people of Kisiju-Pwani prefer using the small dispensary. The reason for this is believed to be faith and ideological differences. The findings under this section are mostly based on the dispensary other than the health centre, but also the in house environment.

During this study; respondents admitted the installation of PV solar electricity in the village had helped a lot in the improvement of health sector and the people at large. Among the people who were interviewed, all admitted by pointing that PV solar electricity had helped in the reduction of oil (kerosene and diesel) lamp use which were smoky and were causing respiratory health problems and other in-house environmental pollution. An interesting observation during this study, was people's ability in making the comparison of time (periods); that is the period

before the PV solar electricity in the village and the period after the project installation. During the interview one lady reported that it was hard especially during the night before the project in that she would mostly wake up in the morning feeling head-ache. When I asked as to why she thought that was the case the responses were as follows;

> "All the time from 07:00pm up to around 10:00pm we were using oil (kerosene) lamp commonly known as *kibatari* which is smoky. The smoke remained inside because we were using the lamp while the doors were closed. By the time we were going to bed, the whole house was full of smoke but we could not notice. When sleeping the air that we were breathing was the same smoke and I believe that is what was giving me the trouble because since the time I started using this electricity, I don't remember the time I have complained to have head ache." (Remarks from a 44 years old woman respondent)

A lot of cases which came out during this study were cases related to breathing problems; like developing flue. This was reported in all households every one reporting to have had developing flue and other breathing problems because of the kerosene lamp use. It was however reported that all these problems decreased if not totally disappeared after their houses were connected to the PV solar electricity. One respondent a father of 4 children had the following to say;

> "Flue was the illness of this family. Children were the mostly affected ones. Sometimes if not me then their mother. Now we haven't had such cases since we connected this electricity as I was among the first people to get connected. This electricity has helped us a lot in this village." (Response from a 40 years old man, and a household head)

During this study; Maputo; the sub village which has no PV solar electricity connection was visited and interviews with different people were conducted. In response to one of the questions concerning the diseases related to lack of clean

energy application, one respondent said the solar energy connection would have helped them with sufficient light, which would also contribute to the reduction of kerosene/diesel lamp use. He further provided that the application of kerosene lamp is dangerous for their health, eyes especially for children who are in school as they are forced to have night studies by using those lamps.

> "Like the others in Pwani we could have got enough light. This would have served us from things like eyes problems, breathing problems like flue which has been the common problem here. Children use sometimes kerosene lamps to study at night; but how are they leaving their eyes in the end?" (Remarks from a 42 years old Maputo residence)

It was moreover reported that the installation of PV solar electricity in Kisiju-Pwani has enabled the health facility in the village to work better in a good condition. Different respondents in their households recognised that the services have been improved at the small dispensary in the village. This was made on the ground that people can go at the facility and get the services at any time with sufficient light.

> "At the dispensary these days since it was connected to this electricity, the services are given at any time. We are now sure of the services because the light also helps a lot. It is not easy for a person to help a patient in darkness with the kerosene lamp" (Remarks from a 43 years old man, and a Kisiju-Pwani resident)

The owner of the dispensary mentioned was interviewed and asked how he analyse the life in business (health services provision) before the project and after the project. It was pointed in the earlier chapter that he had no electricity and he was working with kerosene lamp like most of the people, later he connected the facility to the generator which again did not work as expected and turned to be

very expensive, later he bought a solar set which again was small and could not manage to light the whole facility as it was weak. This is obviously a person who has a story to tell on how PV solar electricity project has impacted his business but also the whole process of health provision to the Kisiju-Pwani residents. This respondent provide how hard it was to work without sufficient light;

> "It was very hard to work in such condition especially when the patients were coming at night. It was a problem and sometimes when people were coming here with injuries, it was very hard to use the kerosene lamps for dressing of their wounds." (Response from a 51 years old man and the owner of the local dispensary in the village).

He also provided that he had to stop some of the services like maternity services because there was no way they could be provided without sufficient light. It was hard to go on with them but now with the installation of the PV solar electricity, the whole process of providing health services to the people and his working condition will basically be in a better condition. His plan is to get back the services he had to stop so that people can stop going out of the village unnecessarily for the services which could be provided in the village.

> "I had to stop maternity services because of insufficient light. Now we are working in a good condition and there is a possibility now to start helping in the maternity services. This project has helped us a lot in this village" (Response from a 51 years old man in the village. Have business in the village but doesn't stay (spend the night) in the village)

Basing on the data as they have been given, it is obvious that the solar electricity in the village has helped in different ways in ensuring a better condition for the provision of health services. The data have shown how the project has positively

impacted people's health by minimizing in-house air pollution which has been reported as one the major cause of respiratory and other health problems. It has been proven that it has and it will provide a good environment in the provision of health services in the village as some of the services which were not possible previously will now be provided in the village. However, it was reported that due to the inability of the project to generate enough electricity which can accommodate other health facilities, people will still be forced to go out of the village for other extra services.

4.4.9 Woment conditions improvement

During this study all gender participated and it was found that the PV solar project to had contributed in the gender relations improvement in the village. Not only women could recognise that contribution but also men. It is said to have been out of men's knowledge to realize what a woman could do for the household development. The most frequent response from men was their recognition that women in the families are more productive than ever before the PV solar electricity was introduced and implemented in the village. One respondent reported to have got a boost from his wife in the family income stability and here are is what he had to say;

> "Because of this electricity my wife also helps in strengthening the income of our family. She is also working in her own business; she wake up early prepare wheat for making pancakes which she sells in the morning. I couldn't realize it had a good profit because she was doing it in the morning. After this project I realized that there were more customers during the night than the morning and

> she was getting a good profit which in turn it has helped the family. Also there are many women who are now doing different business during the night and that helps their families too." (Comments from a 34 years old man)

It is reported that like how electricity has been beneficial to all age groups like children, youths, and older people it is the same way it has benefited women in the village. Like youth and all other people are working and have been encouraged to work or at least find something to do which can strengthen a person's economic muscles, women have also been able to utilize the opportunity for their families and individual economic benefit.

Most of women who participated in this study in one way or another, hailed the project in that it made them be productive and reduce dependency to their husbands. Those who had business got an advantage of more working time, and those who had no business decided to start because they had more customers during the night, and they could only do it because of the PV solar electricity. Women within their households and during the focus group discussion, reported to have more freedom on their lives as they could live and have the most important things or requirements without asking their husbands. In the focus group discussion; women when responding the question how PV solar electricity had helped them as women, they responded as follows;

> "First of all I must admit this project has directly impacted my life as a woman. Before this electricity I had this business but I was only selling in the morning. So the profit I was getting was almost nothing. But when this electricity started, I realized there were many people in the streets and I learnt they could be customers. Then I started working during the night. I get enough customers and a

> good profit which gives me the ability to help my family the same as my husband does. We are all contributing and not only my husband as it used to be in the past." (A 30 years old woman, a small trade vendor selling pancakes during the morning and pancakes and food (rice) during the night)

Plate 16: PV solar energy has provided more chances to do business during the night

Women also reported that there are other needs that they could not ask their husbands to buy for them, but after having their small business, the life freedom was strengthened and they could buy whatever they needed without asking their husbands. Men domination in the families for so long is said to have been caused by women economic dependency among others, which lead to women to be too submissive to the husbands

> "Not everything you have to ask from the husband. I used to do that but now I have stopped. We are all working and am getting my money from this small business am doing. This helps me to meet all my needs. We are also planning how to go about our lives because now he know I have something to contribute. It has been possible because this electricity which has extended my time of working"

It was reported moreover that women in Kisiju-Pwani now can have their own business in the village. One respondent during the household interview said to

have established the business which she termed to be stable business. She is actually the only woman doing such business as she owns a CD lending kiosk which she said to have established after the PV solar electricity was installed in the village. In it; she bought a computer which helps to simplify the business and make her survive in the competition with other people more especially men in the same business

> "I now see myself as strong like others. I have some of the business which I have established only because of this project. For example I have had this shop for a long time even before this electricity, but when we started using this electricity, I decided to open a CD lending kiosk. This is because I know now there are more people who would come to lend the CD because people with Video (TV) have now increased in the village. In that kiosk; I have a computer which is used to test the CDs and this gives me more customers as they can test the CDs right away before taking them. I am well surviving in this competition, and am running my family with this business" (Remarks from a 44 years old woman respondent)

The other contribution that was mentioned apart from the economic benefits was the ability for women to move or walk around during the night without fear. The night movement for women has now been secured in Kisiju-Pwani due to the lighting in the streets. It was reported that before the PV solar electricity was installed in the village, it was not easy to walk around, but also cooking time (dinner preparation) is reported to have been hard for women. Women were forced to cook as early as possible so that they could be done complete as soon as it gets dark. Now that situation has changed and they now cook at any time while doing some other activities. The presence of PV solar electricity in Kisiju-Pwani

has given more freedom and ability for women to pursue their activities without fear.

4.5 Project stability initiatives

The measures for ensuring the project stability were put in place but the most important one was the establishment of the PV solar electricity project management committee which could ensure the day to day management of the project like ensuring; the min grid security, monthly bills payments, and the timely check of the devices. It was reported that before the start of the project, some people who could take charge of the activities under the project were trained, and the committee's secretary is said to have benefited from that training. He is the immediate person taking care of the project in the village.

It was found out during this study that all the measure involved the people's participation and gave their opinions on how the project would easily be implemented. People gave their opinions and proposed that in order to ensure its stability the payment as a monthly bill was to be given so that in case of any repair, part of the money collected could help. The amount of money to be paid were suggested by the people themselves with mutual agreement

> "The donors of this project are already gone and if not yet we were told this project will be ours. We therefore see it as ours and so we had to think of how to maintain it. The monthly bill payment came as an immediate suggestion and we all agreed on the amounts that we are happy of. (Response from a 49 years old man and a village member)

The project security is taken care by the people in the village. From the money (monthly bill) paid by the beneficiaries, some amount covers the security expenses as the person who is guarding the project is paid. However, it was said to be every one's responsibility to ensure the safety of the project. Even those with no electricity, said to be very much concerned with the safety of the project and wanted to see it helping the coming generation.

The fact that this PV solar electricity was not related to any political affiliation, increased the peoples' trust that at last they had a project of the whole village and all people irrespective of their ideological differences. This observation was captured from many people who managed to either formally or informally participated in this study. Many of them said it was free from political affiliations and that could help in ensuring its stability. When people made the comparison with the wind electricity project which was given to them under the facilitation of their Member of Parliament which they said was too political, and said this was better and have a better chance of being stable for a long time. One of my respondents among other said;

> "We once got a project which was brought in the village by the MP. But it was directed to few people like 10 people in the village and almost all of them were CCM members. It failed because even when it stopped working no one in the village could ask as it had excluded us. This one is different and it seems to have touched the interests of all of us." (Remarks from a village member; a 40 years aged man whose house is not connected)

Moreover many people admitted that before the project started it was made clear that the project had no any political influence and it did not come from any politician and that no politician could use it for his or her political interests. One respondent told me;

> "The donor of this project made it clear to us that the project had no any political influence and no one was allowed to use it for his or her political agenda. This will help us and the stability of the project." (Remarks from a 44 years old woman respondent)

However, despite the commitment of keeping the project out of political influence, I found out that Kisiju-Pwani village is politically divided. As I pointed out in the introduction of this study, the village has two dominant political parties which are CCM and CUF. According to the local informants, the CCM members lives in the areas where PV solar electricity is believed to have passed and reached the people. The CUF members are said to be living a bit further from where the electricity connection boxes ends. It is believed however that they live within the radius of the electricity and so the connection should have reached them. Unfortunately it wasn't the case as electricity did not reach them. They complained the project to have had some kind of political influence. Different people gave this information as a complaint which turned to be an important finding under this study. One village resident said the following;

> "We were told that this project was not a political one. It is unfortunate that politics seems to have been applied in the distribution of electricity. Just go around and look where this electricity connection boxes are and those with electricity. Almost all are CCM members. And where others like us CUF are living, we are being told to bear the cost of getting the connection close to our

> homes. Is this fair?" (A 30 years aged village member who complained to me when I was going around in the direct observation)

Despite having a lot of people supporting the PV solar electricity and seeing themselves as part of the project, having such division feeling seems to be a bad sign for the wellbeing and stability of the project. It is up to the village authority to clear the doubts to avoid the possibility of sabotaging the project. Speaking to the village leaders and the project committee secretary of what they were planning in bridging that gap for the betterment of the project, they said they had a plan of taking the connection close to where the other people more especially those who complained are living, and leave them with their houses connection responsibility and expenses like all others.

4.6 Energy consumption behavious

The other aim of this study was to understand the solar electricity behaviour in the rural areas. It was the interest of this study to understand how people in the rural areas consume electricity but more importantly to find out if there is electricity consumption consciousness among the users in Kisiju-Pwani village.

It was found out that the village members were informed even before the project was completed that electricity that was to be produced under the project was to be enough for 68 households. So it was that number of people that was going to

benefit from the project direct to their households while the others would benefit from the street lights in their community as a whole.

According to the Kisiju-Pwani village members, basing on the number of expected households that was to benefit from the project, it was made clear to them that some devices wouldn't be allowed in any circumstance for the project to meet its expected goals. The list of the devices which were not allowed according to the Kisiju-Pwani village members included; Refrigerators, Deep Freezers, Radios over 100watts, TV over 100watts, ironing machines, and machines over 100watts, fen, and any other devices exceeding 100watts to mention but a few. A good number of respondents in Kisiju-Pwani informed me over the information they were given before the start of the project;

> "First of all we were told this electricity had to reach at least 68 houses, but also they said if there is a school close, hospital and worshiping places like Mosques and Churches they were to be given the priority. Then they told us we could use the lights with a limit of 2 bulbs in the house, one socket plug for radio or TV or charging, but those had limits of not exceeding 100watts. They said we should not use fridges, freezers, radio or TV over 100watts, hair dryer, sub woofers and fan so that it would be able to reach all those 68 houses." (Response from the 49 years old man)

This seemed to go contrary with most of people's expectations who bought different electricity devices after learning that their village was going to get electricity. It was interesting to find out that they admitted to have doubted the project and if it could sufficiently work, but that did not stop them from buying devices and get prepared to benefit from electricity. During the direct observation

in the village, one lady who had opened the hair dressing salon and was hoping to use electricity something that prompted her to buy the hair dryers, which in the end she learnt they were not allowed. To express her disappointments she had these explanations;

> "I have this salon for some years now. After learning we were going to get electricity, I bought these two dryers. It came as a surprise to me to be told that I could not use them. I was disappointed to be honest. I cannot use them and so I decided to not have electricity at all as it makes no difference" (A 37 years aged woman in the village, owning a hair dressing salon)

Despite the information and directives which were provided before the start of the project that the electricity was meant to reach to 68 houses, it found out that there were only 33 connections. Among the said 33 connections, 9 connection belonged to businessmen/women who had at least more than one connection. That is; the connection to their business and the other one to their homes or even two business having different connections. This is to say; they had a connection of their shops, and an extra connection to their homes. This means; only 24 households had benefited from the project but it remained to be seen if it can be possible to reach the expected number of people. However it doesn't seem to be a problem to the village leaders and the project committee as long as those people with more than one connection are paying the bills for each connection. The project seem to have been made more a business than a service. If this is not solved in time, then the original idea of meeting 68 households might end up to be a myth.

There seems to have been some kind of violations of the directives which were give before the start of the project by some of the electricity beneficiaries. According to the VEO and the project committee secretary; principally in the households, phone charging was principally opened for the father and mother (wife and husband) and possibly some household members. Individual households which were not registered under phone charging service agreement were not allowed to charge the phones for outsiders. This was an open service for those registered under such agreement. It was different in some of the households as some people from outside were witnessed charging their phones to their friends' homes whose houses were connected. The principle of charging the (father and or mother) phone without doing the same to the outsiders as it was stipulated under their agreement and as per information they were given was not respected. Such houses were registered as normal consumers, and they are paying 1000/- TSH (around $6 per month)

According to the PV solar electricity project committee secretary; the main criteria that was used was the peoples' ability to bear the costs; but also only people who applied were given the connection. Normal consumers with 2 bulbs, and one socket for charging are paying 1000TSH (around $6 per month), those with small business paying 15,000TSH (around $8.6) per month) while others with multiple business are paying 20000TSH (around $12 per month).

Among the businessmen, the consumption was high depending on the nature of the business. Those with phone charging business in their homes the consumption was a full time which is charging for 24 hours, while those whose charging centres are different from their homes charging was a business of the day and so the consumption start from morning to mid night which was their closing time.

In the households the consumption behaviour were impressive. Most of the people switch on the light for a reason. In most cases when charging their phones or when it was getting dark during the night. Some of the respondents said to have the consciousness in the consumption and so there could be no reason to switch on the lights unnecessarily. One respondent among others reported that the reason for that consciousness was his desire to see many people benefiting from the project and so unnecessary consumption would make it hard.

> "This project is for all of us. We were told that at least 68 houses have to benefit. So if we are not conscious in the way we consume, that may be hard to achieve. I want to see all of us benefiting" (Response from the 49 years old man)

The households with electricity have 2 bulbs, where as one is placed in the common area in the house and the other one is in one room, and mainly the household head room. In other households, the bulbs placed in the common areas, or placed in such a way that they can light the rooms of the house at the same time. In the households with shops inside, one bulb is placed in the shop while the remaining one is placed in the common areas.

The lights are mainly used in the evening and night when it gets dark, and early in the morning for the households where the mother has to wake up early for pan cake preparation so as to be able to sell in the morning. When asked as to what time the lights are switched on and off, most of the respondent said to normally switch the lights on at 06:30pm and switch them off as they go to bed in the midnight. They can switch on again during the night if it happens that they wake up for anything. This study found that people's consumption behaviour for most of the people was more based on the information they received before the project had started to operate.

4.7 Peoples confidents and trust to the village authority on the project management

Having learnt and understood the future of the PV solar project in Kisiju-Pwani, it was important to find out the confidence the people have over the project leaders on the future management and administration of the project. In all the interviews which were conducted especially the household interviews, and the other focus group interviews which did not involve the village leaders, it was obvious that people were sceptical of the village leadership on the management, and administration of the day to day activities of the project. These were kind of feelings learnt from the people across their gender and other differences.

It was found that people had no trust in their leaders especially given that by administering the project means they will be the ones collecting and keeping the money, it would in the end lead to a collapse of the project they love. For example; in one household the respondent said that the money collected now may not be seen if collected by the village leaders and said it may lead to the project failure;

> "So that means these leaders may start collecting the money? My friend you may not see the money and they may even not tell you anything. All the money collected will be in their pockets and that will lead to the failure of the project. For example if there is some batteries to be bought and there is no money for that, what will happen" (a 30 years aged man and a household head remarks)

Some factors concerning their fear were given and some were from the previous experience of the projects the village happen to have and were placed under the management of the village leadership. In the end all failed because of what was said to be improper administration and selfishness of the village leaders. One respondent went on to say that they were viewing the village projects as their personal and private properties and that as the village and community members, they were not ready to experience the same failure which may lead to their village being abandoned in the other development projects;

> "We are lucky in this village as this is not the first project. We have had different other projects which all failed. We had a boat project, it failed. We later got the wind electricity from our MP, it also failed. We don't want do the same mistake. Not these leaders we know. They will use this project as their private property like what they did in the previous project" " (Remarks from a 44 years old woman respondent)

I found that people had more trust in the project committee that was set to perform the day to day tasks of the project. Their feelings were the committee was more accountable and with good performance in their activities than the village leaders would be. Moreover, the committee members were named and proposed by the people specifically for that project and so they felt it would work better than the village leaders precisely for that reason. It was therefore proposed that there was no problem if that committee would continue even if the project is taken over by the village.

> "We have worked with the committee very well. We proposed their names and so far they have not yet let us down. They do their job like taking care of the project and bills collection. I would say that they should continue managing the project, not the village leaders." (Opinion from a 34 years aged man and a village resident)

It was clear that people had lost the trust to their leaders. Some village members went further to propose if there was a way in which the leaders could be *faked* (cheated for a good reason) for them to believe that that the project belonged to another institution and not the village so that they could not temper with the project devices and finances. This were the opinion of one village member aged 29, and owner of a small barber shop in the village who said;

> "We were told the project will be given to the village. That is fine, but I doubt its stability. It can only be stable if it keep working like now with the committee administering the day to day activities and not village leaders. If there is a way in which the leaders could keep on understanding the project doesn't belong to them; that may help."

During the focus group discussion with the village leaders, and even in our informal conversations, the questions that wanted to learn what the village leaders were thinking over the project administration after they take over were asked. The question were simple as; what do you think of the future of this project after it is entirely placed into your hands? And how do you plan to administer this project? The response which were given in all the focus group discussion and the informal and formal conversation when in the streets, were perhaps confirming the doubts people had developed over their leaders. One idea leaders had and which of cause seemed to be their plan was privatization. That is; giving the project to another person who could deal with it together with the collection of the bills and the village get some money from the collected payments as dividend as the VEO is quoted as saying;

> "Our plan is to find one person we can trust and give this project to him so that he can manage it, taking care of the project and collecting bills. From the money he gets, we as the village, we will be getting the dividend from what he will get."

This idea was supported by the village chairman. But one question that was developed was whether the village leaders understand the primary aim of the project. Instead of providing electricity services for their communities' social economic development, their future plans seems to turn it to be the village authority source of income. But why could they do that? However, the idea of privatising the project was challenged after some members refused to concur with the idea and said it would not work. Other members said there was no need for

that plan while they had a committee in place which could continue doing its great job as they said. One member of the focus group discussion said;

> "We have our committee which can do the same job as they are doing now when the project is not yet fully placed in the hands of the village" (opinion of the health officer in the village)

According to the village members, it was suggested that for the project to remain stable even after it is taken by the village, it is important that the village leaders should remain the overseers but not the administrators of day to day functioning of the project. The people's worry on this was that if that happens, there is a possibility for them to sabotage the project by misusing some project devices and there could be no one to question them. Like one village member who said;

> **"**If that happens that the project is put in their hands, it will give them the power to do anything they want without being questioned by anybody. What happened on the wind electricity project, will most likely happen on this project. That project had the batteries, but so far no one knows where those batteries are. They haven't been able to tell us."

The fear over the village leaders was obvious. It was therefore suggested that the project remain under the control of the project committee and the village leaders can only assist in overseeing the day to day activities of the project. This information and the fear of the people seems to be an important element that need to be addressed for the stability and betterment of the project.

4.8 People's challenges towards adaptability of the technology

In particular there was no challenge concerning the functioning of the project itself for the agreed ways of its utilization. As pointed out earlier, all people were happy with the way the PV solar electricity plant was working. The project was said to have had only one fault which is said to have been caused by the person in the village (the person who have the generator electricity distribution business) who connected the electricity from the solar plan for the aim distributing it to his customers. However it is said that it was immediately solved and this person was denied (by being disconnected) the service with immediate effect.

The main challenge that was mentioned by the people; both who are already connected to the project electricity and those who are not yet connected but with plans of future connection and those who had not yet decided, was the initial costs they have to incur in order to get their houses connected. It was said that the cost were high for them to afford and that is why the speed for many people to connect their houses was low. However it was interesting to learn that people despite the said challenges, believed it was not the responsibility of the donor to given that help like one respondent said;

> "….the responsibility of the donors is over, and now it is up to us to benefit from the project. I will find money and one day I will connect my house with electricity. We cannot ask for more than what they have done so far" (Remarks from a 43years aged woman, whose house has no electricity)

Another challenge that was mentioned was the distance between the connection boxes and the house for some houses in the village. Some people viewed this as unfair and that there were signs for double standard treatment for some house. Due to their political differences as mentioned earlier in this study, some people said it was made so on purpose. However the village leaders together with the PV solar electricity project committee were in the process of solving and bridging this gap.

The inability to use or apply some electricity devices like fridge, freezers, sab woofer, radio over 100watts and other devices of the kind to mention but a few was mentioned to be a challenge. For instance; some village members with business; and in this case shops with soft drinks and groceries (selling bear) were either using the kerosene fridges and or connected to generator electricity precisely for the purpose of cooling the drinks. In the households it was mentioned but also in the business light.

5. SUMMARY CONCLUSIONS AND RECOMMENDATION

5.1 Introduction

This chapter presents the conclusions drawn from the analysis of the findings of this study. My conclusions in this work are mainly centred on understanding the effectiveness of the rural PV solar electrification on the communities' livelihood transformation, understanding the readiness and acceptance of adopting the new energy generation technology, sense of ownership of the PV solar energy project and the reasons behind people's acceptance and sense ownership of the new energy technology provided under the PV solar electrification project. These conclusions are drawn from Amartya Sen's Capability Approach which has been applied by this study.

5.2 Summary of major findings

The data collected under this study aimed at understanding the effectiveness of PV solar electrification in the rural areas on the rural communities' livelihood transformation. From the data collected it was revealed that PV solar electricity is an effective way in the process of people's lives transformation in the rural areas. It was found that people's freedom, choices and capability in the rural areas have

been widen up. The study focused on the population with electricity connection and the population which is not connected. It also took the experience from the electrified sub village and the one which is not electrified. From all these areas; the households and the sub village, the data revealed the difference that exist between the electrified areas and the those which are not electrified

According to Amartya Sen in his *Capability approach*, development is a process of expanding freedoms that people enjoy (Ellis, 2000). Under this approach Sen sees human life as a set of "*doings* and *beings*" which we may call "*functionings*". Capability reflects a person's freedom to choose between different ways of living. The underlying motivation on freedom is well captured by Marx's claim that what we need is "replacing the domination of circumstances and chance over individuals by the domination of individuals over chances and circumstances" (Sen, 1990).

The effectiveness of the project and even its success is to be measured in the light of how it has impacted the rural population and how it has contributed in creating and opening more opportunities for the rural population. That is the way it has been able to replace the domination of circumstances and chances over individuals by the domination of the individuals over chances and circumstances.

From the data collected under this study, it has obviously been revealed that PV solar electricity project has been able to positively impact the rural population

through opening up more opportunities for the people to be able to control their lives, created more opportunities for socialization and increasing happiness to the people in Kisiju-Pwani. The creativity which came out of the PV solar electricity project in terms of what can be done in the village for survival is now evident.

In this study; the people's sense of project ownership, the attitude and perceptions, towards the effectiveness of the PV solar electricity project in the livelihood transformation were studied together with the reasons or the motives behind the positive attitude and perceptions. It is important to put in mind therefore that people's involvement is development and implementation of development projects; and in this case PV solar electricity project, keeping development projects away from the political interests, people's participation in decision making in the projects implementation process should never be ignored. According to the data collected under this study, these important elements are what strengthens the bond between the people and the project, for the projects stability. This study has therefore bridged the gap that existed on the understanding of people's perceptions, attitudes and commitments together with their reasons towards the PV solar electricity as a new technology for rural electrification in Tanzania and other parts of Africa.

5.3 Conclusion of the study

As given earlier, this study mainly aimed at understanding the effectiveness of rural PV solar electrification on the rural livelihood transformation and the rural community members' sense of ownership, attitude and perception of the PV solar electrification on their livelihood transformation. The findings of this study revealed that PV solar electricity is an effective alternative that can be used to light up the rural areas where the grid electricity is a challenge. Electricity is vital in bringing up development in the country especially the rural areas. In Tanzania grid electricity has not covered the large part of the rural areas where as only 2% of the rural population have the access to grid electricity. There are mainly two reason for this; first is the distance available from the grid to where the villages are located, and second is the fact that many people in the rural areas cannot afford to pay electricity bills, given the high cost incurred by TANESCO which is the main national electricity distributor, in the process of distributing electricity in the rural Tanzania. This study proves that PV solar electricity is the best alternative in the process of livelihood transformation.

Moreover, as given earlier, people's sense of ownership, attitude and perceptions on the effectiveness of solar electricity in livelihood transformation and the project were studied. The findings from this study shows that that people's attitude and perceptions are positive and that people can develop the sense of ownership and commitment over the projects basing on the benefits they get out

of projects, the level of their involvement and participation and the level and ways of how the project is benefiting and accommodating all people irrespective of their social and political differences. This goes hand in hand with keeping the project away from political manipulation or being used for political benefits or influence.

Having conducted this study in the village that had two sub villages where one village is electrified and the other one not electrified, the findings shows the difference electricity can make in impacting the people's lives. There were differences in the social and economic realities of the two areas. Light (in the houses and in the streets), more shops opening hours and women actively engaging in economic activities during the night hours, more socialization time for all people; from children to old people; men to women, electricity device ownership were obvious in the electrified sub village. The sub village without electricity was characterized by total darkness during the night, minimal time for business like shopping, limited socialization time and lack of children (student) study time, and with very few people who owned electric devices.

Moreover, in pursuit of understanding the people's trust over the village authority; that is leaders in the project leadership or administration after it is taken over by the village; this study came up with the view that people had not trust to their leaders. In the process of getting more data for this study and particularly this area, there was no any respondent apart from the leaders who

were interviewed, who was positive about the village authority in the administration of the project. The issues which were raised to support their fear was that they would use the project for personal benefits, they would end up sabotaging the project by misusing the project devices and the project could fail in the end, and that their (people's) wish could not be realized. All people who were interviewed at the household level suggested the project committee (which is the result of their participation) to continue even after the project is taken over by the village. When the leaders were asked about their plans on how they would manage the project; it was found they had no plan of administering the project by themselves and that they would privatize it instead. The project could turn into business other than service. These ideas and plans of the village proves people's fear over the village leaders.

It is important therefore, that the village should be supported in capacity building and possibly be given more training on the importance of controlling the project by themselves without privatising it, and be made clear to the leaders that the project is mainly meant to be a service to the people and not just as a source of income.

5.4 Recommendations and suggestions

Due to the proven effectiveness of PV solar electricity, with the aim of lighting up the rural areas, the investment in solar energy cannot continue to be ignored.

More investment should be made in the renewable energy, solar energy in particular. The investment in the renewable energy will help to light up the rural areas, provide equal opportunity for development for the entire population in the country.

With the increasing demand of modern and clean energy, it is important to encourage the different people in the societies to invest in solar energy and see it as an important area for their development. Having people from the societies investing in solar energy will strengthen the bond between the people and the projects.

Capacity building on solar energy development is important in the rural areas if revolution in the energy sector is to succeed. From different literatures visited in this study, it is clear that solar energy development in Tanzania is still in infant stage. There is a need therefore for investing in this area as much as possible. In different parts in the rural areas, some entrepreneurs have invested in solar energy, but only for selling solar panels and other solar energy devices. If these people can be trained and supported to the extent of getting them to stand alone and go beyond selling devices but also dealing with distribution, then the revolution in the renewable energy sector especially in the rural areas can have more momentum.

In regard to the above recommendation, unity among the local entrepreneurs is important for making the development of renewable energy and in this case solar energy development a reality. Despite having the sun a free source of energy like how it has been given in a number of literature, its conversion is not free. Moreover, producing under one plant cost more money which could not be simple for people to do. Their unity is important as together they can be stronger and possibly get support in their unity. Can be easy to even get help as a group other than individual level

From the data of this study, it has been proved beyond reasonable doubt that people's involvement in the implementation of solar energy projects and possibly other projects is important for the project survival and stability. The data revealed how people's involvement can strengthen the bond and create the sense of ownership to the people over the projects.

Keeping the projects away from political interference is another lesson that can be taken from this study. Avoiding project political interference is important as it leaves the people united under one common goal of ensuring the survival and stability of the project. In the village with the population divided across their political parties political interference may be dangerous as it may put the project in jeopardy. One group feeling not favoured in any case by the may decide sabotage the project. Therefore, removing the project from the politicians hooks

and manipulation and inform people to know that leaves all people across their political differences united by the same project.

Solar energy research and innovation is still needed for the aim providing more energy not only for lighting, charge phone and watching video and TV/ listening to radio but also for cooking but also being reliable during the rainy seasons. The study from Kisiju-Pwani has shown the way the PV solar electricity have had good impact to the people, but leaving them with no clean energy for cooking. People have got light but they still depend on charcoal and firewood as their main of energy for cooking. More research and innovation on the effectiveness of solar electricity could serve the community with energy for cooking.

Plate 17: Children learning how to make charcoal.

People in Kisiju-Pwani shown to have no trust to their leaders on taking care and managing the project when it is taken over by the village. This fear should not be ignored and it should be taken seriously and be given the attention it deserves. Having people with no trust to their leaders is a challenge of its own kind. Many suggested the project committee to not be dissolved even when the project is

taken over by the village. This should be studied and find the advantages and disadvantages if we are to help on the stability of the project.

The village management plan of the project after it is taken over does not sound to be a good way of administering the project. When asked of their plan; they claimed to have a plan of looking for a private investor or person who could run it. I have two kind worries on this; one is that it will open the chance for more people to have access to the devices house something that may attract unfaithful people who may temper with devices; and two the project could turn to be a business other than a service which could discourage the people hence their commitment and sense of ownership of the project could disappear. It is important to keep the service aspect of the project to the people and the village at large.

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APPENDIXES

APPENDIX 1: INFORMED CONCENT

My name is Bernard Matungwa, a student from The University of Oslo, pursuing Masters of Philosophy in Culture, Environment and Sustainability. The major aim of my presence in this village is to undertake the study on the An Analysis of the Effectiveness of Rural PV Solar Electrification on The Community Livelihood Transformation, In Kisiju Pwani, Mkuranga District.

I would like to have your full cooperation and participation in this study by freely responding to the questions I will ask. This study is meant for academic purpose and not otherwise. I therefore ensure the anonymity and confidentiality of the higher standard. The responses given under this study will remain a secret between you and me as a researcher.

Thank you for your cooperation.

Signature.....

Date.....

Thank you for your cooperation

Appendix 2: Key Questions in the Interview guide during the Household Interviews

These were the questions which were asked to the beneficiary of the project. The main job of the project was done by these questions. Moreover, some of the questions were asked to the non-beneficiary sub village households. The people's attitude over the project were captured under these questions, together with people's feelings of the future of the project.

1. Respondent's name, Respondent's age, Marital status, Family size Education level, Place of Birth, Duration in the village, Income generating activity, Assets ownership (TV, Radio, Celphone, fridge, deepfreezer)
2. What was the condition of this village in terms of energy/ electricity? Has there been electricity in this village at least in the past 10 years?
3. What is your main energy for lighting, cooking, charging and listening to radio or watching a TV or video?
4. What are the corrent sources energy for lighting in the village?
5. What is the suource of energy for lighting, phone charging and listening to radio?
6. How did you know the establishment of this PV solar electricity project in this village?
7. What was the level of people's participation in the whole process of the solar electricity project implementation?

8. Is electricity in the whole village? If not how was the decision of subvillage to be electrified reached?
9. How do you differentiate your life before solar electricity and the time after solar electricity in the village?
10. How do you measure the effectiveness of the PV solar energy in this village
11. How do you think of the effectiveness of the PV solar electricity in this village in the whole process of transforming your livelihood in this village
12. How has this PV solar electricity been able to change your life to a better condition
13. What are the opportunities which have been created out of this PV solare electricity project in this village?
14. How do you differentiate the effectiveness of this solar electricity from the other sources this village have had?
15. To what extent has this PV solar electricity project been able to help the youth and the entire population of this village?
16. How has this village helped in the improvement of the quality of education in this village?
17. How has this PV solar electricity helped your children in their education improvement?
18. Before this solar electricity, were your children in your household with the night study habit?

19. What do you see as the contribution of this PV solar electricity in the improvement of health services
20. In your own understanding, do you think this project has helped your in in the improvement of environment of this village?
21. How has this project helped in the improvement of security in the village if any?
22. How has this project helped you in the improvement of your business?
23. How do you consume electricity in your household?
24. How has this roject helped you as a woman?
25. What is your feelings on the project? / Do you see yourself as a part of the project?
26. What are the reasons behind the such attitude over the project?
27. How do you think over the performance of the Project committee in the administration of the project?
28. What challenges are you facing in this project?
29. What would be your views on the administration of the day to day activities of this project was to be performed by village authority other than the Project Committee

Appendix 3: Interview guide to the non-electrified sub village

The main reason for these questions was to capture the feelings of the people on the project after their sub village was not connected to the electricity project. It was also aiming at capturing if the people were involved in the decisions which ended up affecting them.

1. Name, Age, Gender, Family Size, Income generating activity, Duration in the village, Material ownership: TV, Radio, Fridge, Deep freezer?
2. How did you know of the solar electricity project in this village?
3. How were you involved in the process of this project implementation?
4. How do you feel for this village to have solar electricity?
5. This sub village is not connected to solar electricity, how was this decision reached?
6. How is your household benefiting from solar electricity in this village?
7. Do you think the electricity in this village has been able to improve security in the whole village?
8. Does your children study during the night in this household?
9. Having no electricity in your house, how does your children study during the night?
10. How has the project been able to improve the health services in the village?

11. Having no electricity in this sub village, do you see yourself as part of the project? What is your attitude on the project?
12. How would you like to see the project administered?
13. What are the suggestions you would like to give in the improvement of this project?

Appendix 4: Interview guide for one FGD

This included the village leaders, education officer, health officer, village assembly members, and committee members. The main reason for these questions were to get a good understanding of how the project was started, the level of people's involvement, the perceived impact of the project on community's livelihood transformation and future plan of the project administration

1. The role of each participant in the village
2. What has been the sources of energy in this village?
3. How did you learn of the establishment of PV solar electricity implementation in this village?
4. What did you do for this project to be implemented in this village?
5. What are the steps you had to go through before the establishment of the project?
6. Having got the project, how did you get to the decision on the location of the project?
7. To what extent were the people in the village involved?
8. I have learnt electrified houses are only from one sub village (kitongoji), how did you get to that decision and what was the reaction of the people from the non beneficiary sub village?
9. What are the criteria used to identify the people who were to be connected?
10. Are there rules guiding the consumption of this electricity, and how are the people (consumers) observing them?

11. Are there mechanisms in place to monitor the consumption behaviour if it accoring the agreed pronciple?
12. Is there any school or health facility connected under on this project?
13. To what extent have this project been able to transform this community?
14. What are the immediate impact of this project on education improvement in this village?
15. What are the immediate contribution of this project on health services provision?
16. To what extent has this project helped in the security improvement of this village?
17. How has this solar electricity impacted the functioning of the port?
18. To what extent has this project helped in the improvement of your environment in your perspective
19. What are the challenges you are facing with this project?
20. How do you plan to manage this project in the future? What are the strategies in place?

Thank you for your cooperation

Appendix 5: Interview guide with fishermen

The intention of these questions were to get a good understanding of how the project has impacted fishing activities as one of the main economic activity for the people in Kisiju-Pwani and to get a good understanding of history of the fishing activities for the past years in Kisiju-Pwani.

1. For how long have you lived in this village and working on this port?
2. Is there any other ports around and close to Kisiju Pwani?
3. For how long have you been doing this job?
4. How do you remember the effectiveness of this port in the past?
5. What do you remember about this port and fishing activities in Kisiju Pwani?
6. Did you happen to have electricity at this port?
7. When for the first time did you get electricity at this port?
8. How do you think of the effectiveness of this PV solar electricity project development in this village
9. To what extent has this solar electricity project helped in the improvement of fishing activities at this port
10. In terms of sailing (water transportation) do you think there has been a contribution in it? If so how?
11. How has this project helped in the security of this port?
12. What are the other possible contribution this project have given to this port and the whole village at large

13. How would you like to see this project managed in the future?

Appendix 6: Interview Guide for small trade vender: women

A good number of women in Kisiju-Pwani have business and done mostly during the night hours. These questions were meant to capture how the PV solar project has impacted their business. Also they meant to capture how the project has helped in the improvement of women conditions in Kisiju-Pwani

1. For how long have you lived in this village?
2. For how long have you been doing this business?
3. How do you think of the solar electricity in the develpment process of your village?
4. How has this project helped you in your business?
5. At what time were you doing this business before the start of this project?
6. Why do you prefer to do this business during the night?
7. How long do you sell during the night compared to the time before the start of the project?
8. To what extent have this project helped you as women?
9. What are the other contribution from this project in your families and the village in general?
10. How has this project helped you and your village in the improvement of education, and health services provision in the village?
11. In your own perspectives, how has this solar electricity project village helped in the improvement of environmental conservation in your village?
12. How would you like this this project to be administered in the future?

13. What could be your opinion if this project has to be managed by the village leaders?