LUND UNIVERSITY

FACULTY OF SOCIAL SCIENCES

TURN THE LIGHTS ON

A MULTILEVEL ANALYSIS OF SUSTAINABLE ENERGY IMPLEMENTATION IN THE GLOBAL SOUTH: THE CASE OF MONKEY BAY, MALAWI.

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Abstract

Nation-wide access to sustainable energy is central to socio-economic development in Malawi. It is particularly challenging in rural areas where a significant amount of the population does not have access to energy, let alone sustainable energy. Nonetheless, renewable electricity deployment is slowly increasing in rural Malawi and manifests itself on the local, national as well as the international level. To analyse this manifestation at the respective levels as well as their interaction, Actor-Network theory has been applied taking sustainable energy technology as the focal point of inquiry. By allowing for agency of technology, this paper contributes to the current developments in Techno-Anthropology while opening up the field of sustainable energy implementation in the Global South, a new field of research within the discipline. Furthermore, illuminating networks of sustainable energy in the Global South, can contribute to achieving Sustainable Development Goal 7 – ensuring access to affordable, reliable, sustainable and modern energy for all.

Keywords: Sustainable energy, sustainable development, Techno-Anthropology, Actor-Network theory, SDG7, Malawi, case study, ethnography, multilevel analysis.

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List of abbreviations

ADC: Area Development Community

ANT: Actor Network Theory

CDM: Clean Development Mechanisms

ESCOM: Electricity Supply Corporation of Malawi Ltd.

EGENCO: Electricity Generation Company Malawi Limited

GHG: Greenhouse gas

ICT: Information and communication technologies

IPP: Independent Power Producer

LDC: Least Developed Country

MK: Malawi Kwacha

SDG: Sustainable Development Goal

SE: Sustainable Energy

STS: Science and Technology Studies

TANT: Techno-anthropology

UN: United Nations

1. INTRODUCTION

In the Anthropocene, people are increasingly faced with the consequences of severe environmental damage. Low-income countries of the Global South are not only affected the most immediate, but they are also poorly equipped to deal with associated extreme environmental conditions and natural disasters (Steffen et al., 2007). Development efforts can increase the greenhouse gases (GHG) these countries release in the atmosphere, by putting pressure on the environment in an effort to develop. For instance, this refers to land-use changes, related to deforestation to increase economically productive farming, or the increasing use of unclean energy source (Favretto et al., 2018). The energy sector is key for socio-economic development but simultaneously often accounts for a disproportionate contribution to GHG emissions (Rockström et al., 2009). Therefore, balancing socio-economic wellbeing with the planetary boundaries is central for energy implementation. Rural electrification is a fundamental problem in Sub-Saharan Africa. Sustainable energy is presented as a solution as it allows countries to develop without deteriorating the environment. With the UN defining SDG 7 as "ensuring access to affordable, reliable sustainable and modern energy for all" (UN, 2011) this issue has been put on the international agenda. Several efforts towards meeting SDG 7 have been made on a global scale, with multilateral organizations or in bilateral agreements between countries, on a national and local level. However, there is still a significant amount of areas that lack sufficient access to clean energy. Programs aimed at the implementation of sustainable energy often lack sensitivity for potential side effects and thus run the danger of creating dependency structures, while neglecting the agency of the local population.

One area lacking access to sustainable energy is Malawi, where only 12% of the population has access to electricity, most of the people without access are living in the rural areas (GoM, 2017). Electrification happens on multiple interlinked levels, from international projects over national agendas to the local context, together building a network. Sustainable energy can be analysed as a part of this network. There is a lack of in-depth analysis of the currently used sustainable energy networks. This thesis addresses this gap thereby contributing to working towards SDG 7, by analysing sustainable energy use in the rural areas in Monkey Bay, Malawi through Actor-Network theory.

1.1. AIM AND OBJECTIVE

The purpose of this paper is to understand sustainable energy networks as well as structural synergies and contradictions between global, national, and local sustainable energy implementation. It aims to investigate energy technology and its role as an integral part of a network while considering the interconnectivity between the global, national, and local level. Taking the example of rural Malawi village Madzedze it explores the complexity and interconnectivity of sustainable energy implementation, while simultaneously considering the role SE might play in the field. Furthermore, this paper contributes to Techno-Anthropology by putting technology on sustainable energy at the centre of analysis and using Actor-Network theory to uncover the complex, interdependent networks on the multiple levels. Its objectives are analysing the local sustainable energy deployment, applying Actor-Network theory to analyse SE role and offer in-depth understanding and explanations for the shaping and reshaping of the actants in the network.

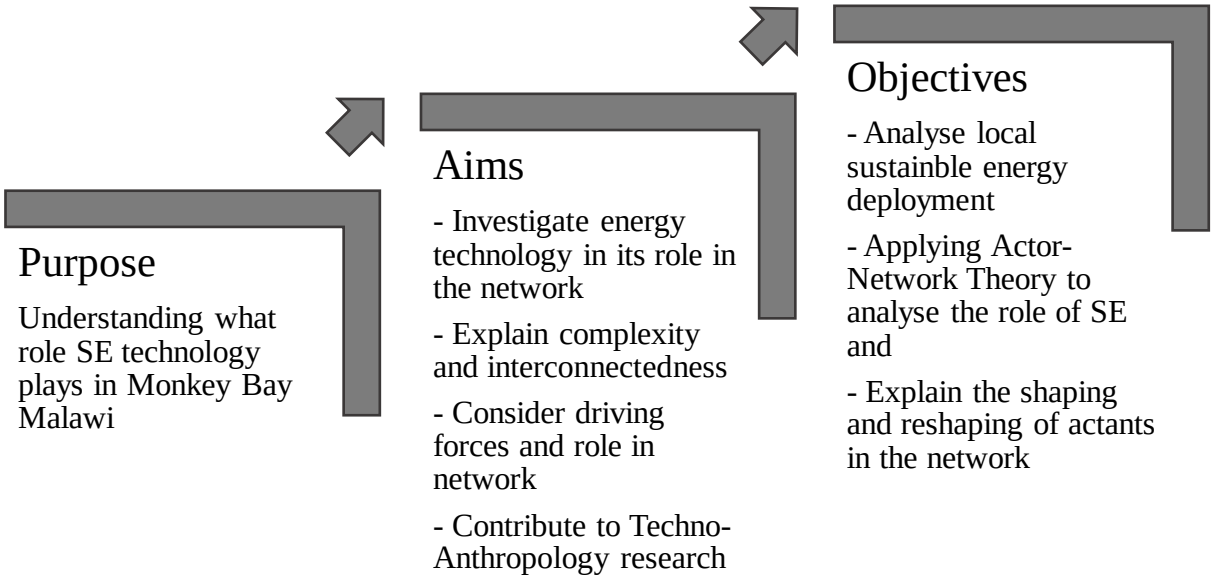

Figure 1. Overview of Purpose, Aims and Objectives

1.2. RESEARCH QUESTION

In line with the aim and objective discussed above the paper is guided by the following research question:

RQ: How does sustainable energy technology manifest itself in networks in Monkey Bay Malawi?

This research question will be answered through the following sub-questions:

- What is its role of the local, national and international level and how do they interlink in terms of SE technology?
- How is sustainable energy technology shaped and reshaped?
- How does energy technology shape and reshape actors in the network?
- What networks are formed around sustainable energy technology?

1.3. STRUCTURE

To answer these questions the paper will in a first step give an overview of prominent discourses in relevant fields. This is primarily separated into literature on energy, which includes energy in the Global South, sustainable energy and anthropology of energy and techno-anthropology. The latter addresses the roots of anthropological interest in technology, dives into the beginnings of the discipline and finally discusses the current field of Techno-anthropology. Orienting itself in the field of Techno-Anthropology this paper uses a prominent theory from the field that is Actor-Network Theory (ANT). ANT will be discussed in its specific definitions and core concepts, address some of the criticism around it and show fields of applications including its benefits for this field of this paper. After the theory, this paper will outline the methodology and point out methods and data collection. That includes the sampling strategy, participant observation and interviews. Furthermore, this section includes ethical considerations and limitations of this research. After that, the results are introduced, giving an introduction to the field and showing the findings of this research. Subsequently, this paper presents its analysis divided into three levels, individual, national and international level. Lastly, the conclusion is presented followed by the references and the appendix.

2. LITERATURE REVIEW

In order to gain a better understanding of the problem area, it is necessary to give an overview of how sustainable energy is discussed within the existing literature. Thus, in a first step, the discourses of sustainable energy in the Global South will be laid out. Particular focus will thereby be put on anthropological contributions and calls for an anthropology of energy. Behind this backdrop, this paper will, in a second step, locate itself within the field of Techno-

Anthropology, as it contributes to exploring the interface between humans and technology. It will thereby draw on the most prominent theory in the field: actor-network theory. Due to the vast amounts of research in other fields and the benefits of interdisciplinarity research, there will be made occasional references to research outside the discipline of anthropology.

2.1. ENERGY IN THE GLOBAL SOUTH

Energy is often discussed in three entangled pillars, namely energy equity, climate justice and energy security, with an increasing global consensus about the importance of tackling energy poverty in general (Brown et al., 2018, 3). This is also manifested in SDG7, which states that affordable, reliable, sustainable and modern energy access needs to be ensured by 2030 (UN, 2011).

Worldwide 68% of anthropogenic greenhouse gases (GHG) are emitted through the energy sector (Chirambo, 2016). Despite the urgency of universal access to energy, it would have detrimental impacts on the environment if the whole world would become reliant on the same energy sources currently dominating energy provision in the Global North. While the Global North is working on a transition to more sustainable energy sources, the Global South is presented with the challenge of implementing these from the beginning (Chirambo, 2016, 749). Renewable energy alternatives are solar power, biomass power, wind power, hydropower and geothermal energy. Their implementation in the Global South is supposed to lead to a sustainable social and economic development as well as to secure energy supply in the respective countries (ibid.).

The world's commitment to stabilize global temperature increases below 2° Celsius, makes the implementation of low carbon technology necessary. This is particularly true in the energy sector. However, high investment costs of low carbon energy such as solar and wind energy present initial barriers to their uptaking. One prevalent argument is to use technological learning to help overcome this barrier. Technology learning is a multiscale process as it is often driven by the global trade of equipment as well as the local accumulation of knowledge. Learning by doing, learning by searching, regional spillover and cluster learning (learning spillovers across technologies that rely on certain components) are among the most mentioned channels of technological learning to reduce costs. The driving forces are thus knowledge accumulation and experience (Zhang et al., 2020). Likewise, these factors were relevant in Monkey Bay Malawi, in terms of network changes related to energy implementation. High technological heterogeneity affects both renewable and conventional energy. Costs depend on

both global and local factors and their interrelation. In the case of Sub-Saharan Africa relatively high initial costs, related to renewable energy sources do not necessarily stem from their import but are also due to the lack of infrastructure such as local specialized construction firms and skilled staff. The associated problem is thus interlinked between the local, national and global level and involves multi-scale learning processes (Zhang et al., 2020).

2.1.1. SUSTAINABLE ENERGY

Sustainable energy can be defined as a form of energy provision that meets the needs of this generation without compromising the needs of the next (Kutscher et al., 2018). It can take different forms such as hydroelectricity, biomass, geothermal, wind, wave, tidal and solar energies (Hollaway, 2013). Electricity in contrast to petroleum, coal or wood, is an artificial form of energy as it has no existence in neutral, and is an immaterial object, that can come from varying sources for instance hydropower, wind power or solar power. Electricity is invisible, however, we can see the objects that produce, transport and store it. That it is presented as superior to other forms of energy, roots in its use for lighting. It provides steady luminescence without producing negative side-effects, such as creating fumes or fire hazards (Gupta, 2015). Supporting electricity implementation in the development context often follows the underlying, unquestioned assumption that being connected to the electrical grid is the most desirable option. As Latour points out, so much is taken for granted among "us moderns" (Latour, 1993). Likewise, the quality of electricity is often underestimated, with measures usually simple focussed on simple access (Gupta, 2015). This is problematic as for instance businesses need reliable energy solutions. That is the case for many businesses and government facilities that fall back on diesel generators when the governments' hydropower supply shows inconsistencies. There is generally several options for electricity: on-grid networks, mainly focussing on the extension of the government grid and the increase of its capacity, mini-grids or microgrids, referring to isolated small scale energy networks often powered from sustainable energy sources such as solar energy, and other individual off-grid solutions such as generators (Bhattacharyya & Palit, 2016). All of these are relevant to this paper. Local definitions and differentiations related to energy will be discussed later on.

2.1.2. ANTHROPOLOGY OF ENERGY

The anthropological interest in energy goes back to two generations of thought that accompanied transitional moments in energy. The first-generation stems from the context of the nuclear energy revolution, where it constituted the new source of creative and destructive

power. Central is White (1943), who against this background positions energy as the focal point of understanding human culture. The second wave refers to the 1970s "energy decade" (Nader, 2004), where for a short time political willingness to investigate alternative energy sources was high and sparked anthropological attention to the accompanying energy-related conflicts between defendants of old and new energy sources. These two waves of anthropological engagement where followed by a low-interest period from the 1980s to the mid-2000. However, the last decade can be said to show signs of a renaissance, with increasing case studies leading to increasing theoretical challenges (Boyer, 2014, 315).

A number of ethnographic studies have emerged, treating energy from an anthropological perspective, in particular through drawing attention to related power structures, difference in patterns of energy extraction, distribution and consumption. Anthropologists with a background in Science and Technology Studies (STS) tend to address energy infrastructure as a mediator for questions of justice, the components of a good life and sustainable development. Countries in the Global North rely heavily on energy, whereas in the Global South energy is often important for subsistence and a growing middle class is starting to use energy services such as household electrical appliances or cars. The importance of electricity for daily life and its significance all around the world is increasing. Anthropologists who historically have researched energy to understand human culture and the role of sustainable energy thus can play a central role in engaging with this increasing importance particularly in the Global South where the importance of energy access is increasing drastically.

Furthermore, anthropologists can contribute more to central debates on sustainable energy. Energy is passed through socio-technological systems to reach its place of use, where it is converted into another technology such as tv, radio or lighting. The production, delivery and consumption of energy make it a social good. Resources needed for energy and debates around it such as privatization efforts, production or delivery system emphasize social capacity, central in anthropology. Despite this, these debates have not been central anthropological debates thus far. This holds true for both debates on the role of energy in regard to pollution and to the environment, thought of as a global or local issue. Thus, energy debates can benefit from anthropological input, in relation to for instance political economy and power, globalization of social and material flows, or with emphasis on the role of energy in everyday life (Wilhite, 2005). This thesis contributes to anthropological inquiry in energy, as it discusses energy in the global south at the example of Monkey Bay, Malawi. It shows how energy as a socio-technological system takes its place in a network, both with human actors, for instance, people

involved in sharing information, delivering, or consumption and non-human actors such as the technology it is bound to, the gadgets needed for implementation and the technology it powers. Another central debate to which anthropology should contribute is that of energy as central for economic growth. The concept of growth is increasingly questioned in the Global North where contributions against business as usual approaches related to energy supply for consumption are becoming more common. In the Global South renewable energy will be essential for development. Sustainable energy has the ability to provide less centralized solutions and local control (Wilhite, 2005). Socio-cultural systems surround energy infrastructure, and all are cultural artefacts placed in particular local contexts. Anthropologists can bring critical and often creative perspectives on energy to the table helping to rethink and rebuild the worlds energy systems (Powell, 2013). Taking these local contexts into consideration in line with long-standing anthropological traditions of using methods such as field-work and participant observation can help understand the phenomena that is energy transitions and implementations both in the Global North and the Global South. This thesis, against an anthropological background, offers such an approach focused on the Global South.

Consumption, and with it demand, are often pointed out as areas of uptake where anthropology could contribute the most. The lack of uptake can be explained by the misconception of energy as a technical issue. However, anthropologists can investigate demand by looking at the social construction and discursive influence of actors in the production of meaning of energy. Thus, they are not required to use the pre-established economic or technological language and discourses, but instead situate energy consumption debates in established debates on social relations or culturally grounded practices (Wilhite, 2005). The paper does so by conducting a multilevel analysis of sustainable energy technology in Monkey Bay, where consumption does play a role in the network of agents. While it is not the main focus, situating the consumed technology, or the technology needed for consumption in a network of human and non-human actors makes social relations and culturally grounded practices visible. Powell (2013) shows the potential for anthropologists to attend to energy developments, bringing up its ability to show stakeholders at multiple levels and address the complex networks of human and non-human activities.

> *"Indeed, ethnographic attention to energy development, from coal to solar, has the power to illuminate the diverse stakes behind the stakes: that is, the ethical commitments, political visions, desires, and identities that are invested in, and*

worked out through, material transformations of landscapes and their constitutive, human -to- nonhuman engagements" (Powell, 2013).

This paper applies these insights and engages with human to non-human relations from an anthropological perspective. It does so in the context of sustainable energy technology networks in Malawi.

2.2. TECHNO-ANTHROPOLOGY

This paper positions itself in Techno-Anthropology, by analysing human to non-human interaction in terms of sustainable energy technology in the global south. Techno-Anthropology is a relatively new field that focusses on human-technology interaction. It is complex and often interdisciplinary; therefore, the following section will give a short introduction into the discipline's origins, its current researches and fields of application, while positioning this research within recent developments and theoretical breakthroughs.

2.2.1. ANTHROPOLOGICAL INTEREST IN TECHNOLOGY

The origins of anthropological interest in technology can be traced back to the beginning of anthropological inquiry on artefacts and material objects. Pfaffenberger sees roots in the 20th century when, as he points out, oftentimes amateurs were collecting artefacts and armchair anthropologists assigned simplistic interpretations (Pfaffenberger, 1992, 491). Material culture, and with it the study of technology, came to be representative of these problematic aspects of the discipline, particularly in English- speaking anthropology. Malinowski (1935), condemned technological enthusiasm and rendered the study of technology alone as scientifically sterile. Thus, material culture, and with it, technology was left to museums and experienced limited academic uptake thereafter (Pfaffenberger, 1992, 192). Anthropologists of the time have suggested a clear distinction between what is technical and what is magic or religious. This distinction often consists of a clear hierarchy, associating what "works" with technical and what doesn't work with magico-religious and can still be found in arguments made today (Interview 6). Problematizing this, Pfaffenberger later (1992, 501) calls for absolute impartiality in order not to miss the crucial role ritual components play for technology, especially in the context of labour coordination related to technology. In accordance with prevailing modernism, artefacts were perceived to be developed primarily out of a specific necessity. Accordingly, inventions always develop in order to fulfil specific needs (Pfaffenberger, 1992, 496). As people need energy, they too find ways to create it.

Correspondingly, Binford (1965) defined culture as a means of adaptation. He suggests technology arises form primary means of viability, limited by the given environmental constraints and social integration (Binford, 1965). This entails that artefacts, and with that technology, have two dimensions. The primary, related to the function and the secondary referring to its social meaning and symbolism (Pfaffenberger, 1992).

Anthropologists have since come to criticise the predominant "standard view" of technology in anthropology, which likewise emphasizes this role of necessity for technological innovation and presents the history of technology as a unilinear process from less complex to more complex (Pfaffenberger, 1992, 514). In the same vein, Binford is criticised for assuming the existence of "real" needs, which are addressed rationally by selected artefacts, when actually there is an extensive variety of technologies that can be chosen for any utilitarian objective. There is a latitude for choice, with their inherent trade-offs, in solving arising technical problems. Therefore, Pfaffenberger rightfully points out: "Culture, not nature, defines necessity" (Pfaffenberger 1992, 496).

It is fair to say that there has not been extensive interest in technology in the American School of anthropology as it does not perceive technology as a central part of culture (Bray, 2007, 43). British social anthropology likewise has largely remained silent in relation to technology as a theorizeable category within the field (ibid.). These first thoughts on technology in English speaking anthropology, therefore, do not render an independent discipline useful, but instead point out early fields of tensions.

In contrast to first explorations in English speaking anthropology, French anthropology has had some more fruitful contributions to early explorations. Claude Lévis-Strauss researched cooking techniques that lead to the birth of structuralism and André Leroi-Gourham combined pre-history, anthropology and technology (Wellner et al., 2015). The French School of anthropology of techniques has developed an interdisciplinary comparative study of technologies (Bray, 2007, 44). Two concepts in this anthropology of techniques are the "technique du corps", defined as distinctively cultural by Marcel Mauss (1967) and the, by the French approach emphasized, "chaînes opératoires", operation sequences. It describes a chain of operations in the process of transformation of matter, that includes the human body itself, by human beings (Lemonnier, 1992, 25). Lemonnier, a central figure and one of the first authors in the field, whose work was translated into English, furthermore, identifies the "social representation of technology" as focal, which refers to the kinds of meanings and the ideas involved in the production and use of technology (ibid). Thus, the French school of

anthropology, early on, developed conceptual frameworks and methods that address both old and new technologies (Bray, 2007, 44).

2.2.2. THE BEGINNINGS OF A DISCIPLINE

As shown above, classic anthropologists have been more or less ambitiously describing technical activities and their meaning, including necessary work, production and skills, related rituals, the role of kinship, dynamics and social differentiations since the beginning of the discipline (Bray, 2007, 45). However, technology as a field in itself within social anthropology has only been slowly emerging and is still in its forming phase (Sokolovskiy, 2019). Hess (2007) points out that only in the late 1980s a small group of anthropologists have taken on the task of forming an anthropology of science and technology as its own subdiscipline, facing difficulties of recognition within the major departments (Hess, 2007, 463). He argues that with growing recognition the focus grew narrower, limiting itself to cultural analysis of changing nature-culture relations that were associated with the developing bioscience and biotechnologies (Hess, 2007). In the 1990s French research started to be translated into English and efforts to form a discipline increased (Wellner et al., 2015). Technology was then defined by the French anthropologist Pierre Lemonnier as an intrinsic part of culture and society that should be considered a system. He pointed out that through the social representation of technology, social phenomena influence technological systems. In his view, technological operations are systems of technological know-how and cultural practice, that reproduces through our daily contribution with or without our will (Lemmonier, 1992). However, the majority of research of the times still focused on artefacts as static parts of social life (Hess, 2007).

A social anthropology of technology, as Pfaffenberger imagines it, includes firstly techniques, secondly, sociotechnical systems and lastly material culture. Techniques can be defined as a system, that includes among others material resources, skills, work coordination, that are used in the fabrication of artefacts (Pfaffenberger, 1992, 497). The French School of anthropology of techniques includes the mentioned “techniques du corps”, bodily practices, and the use of tools (Bray, 2007,44). While, as mentioned above, Marcel Mauss (1967) originally described “techniques du corps” as distinctively cultural practices that exist in objective isolation, Ingold (1997) now describes them as properties of the whole systems, made present by the agent. This trend towards systems influenced current theories addressing energy technology, relevant for this thesis. Sociotechnical systems, as introduced to social anthropology by Pfaffenberger (1992), are technological activities that come from the connection between techniques and

material culture to the social coordination of labour (ibid). The term stems from technological studies and lays the basis for researching meaning in the places of technologies (Bray, 2007, 43). They are adaptations in line with cultural ecology. However, the existing system, is not the only one possible. Under different circumstances, with different needs and aspirations a different system could have emerged. A sociotechnical system therefore is always connected to the context of its origins, since the system must draw on existing social and cultural resources. System builders use existing resources and modify them to the context and system in place. Therefore, society in turn is a result of sociotechnical system-building. The concept of sociotechnical systems thus states clearly that technological innovation is not created out of mere necessity (Pfaffenberger, 1992, 502). That entails acknowledging the importance of the social, legal, economic, political and scientific contexts of technology (ibid., 498). A sociotechnical system is a central way, in which humans produce their social world and has a distinctive form of social solidarity that is neither economic nor political (Pfaffenberger, 1992, 500). Pfaffenberger (1992) redefines technology itself as a completely social phenomenon while referring to Marcel Mauss' (1967) definition of technology as simultaneously being material, social and symbolic. In the Standard View, it is suggested to look at technological evolution as the advancement from simple tools to complex machines. Meanwhile, the sociotechnical system concept as described above presents a universal concept of human activity with technology both as adaptive and expressive (Pfaffenberger, 1992, 513). The concept entails complex social structures, nonverbal activity systems, advanced linguistic communication, the ritual coordination of labour, advanced artefact manufacture, the linkage of phenomenally diverse social and non-social actors and the social use of diverse artefacts (ibid). In the same vein, this research does not ascribe to the standard view and welcomes complexity of social structures as central to human-technology interactions.

Other scholars have attempted to identify key areas for an anthropology of technology such as Ingold (1997), Escobar (1999) or Suchman (2001). Ingold names eight themes for anthropological contribution to technology. For instance, tool making and tool using or technological change, which are relevant in the context of this paper as they were central themes encountered in the field in relation to energy technology in Monkey Bay. Escobar et al. (1994) identify four guiding sets of questions for anthropological research on technology. These engage with emerging discourses of the discipline such as the background from which technologies emerge or the role of ethnographic research for exploring technologies. Central for this research is furthermore Escobar's emphasis on technological design and its

appropriation to the context, due to its prevalent role in the field (Escobar et al., 1994). Suchman (2001) identifies three fields of anthropological research on technology: ethnographic studies on site of production, technology in use and design interventions. These different fields illustrate how scholars in anthropology have included the concept of technology in their work.

Sergei Sokolovskiy explores this, in his 2019 article "Bodies and Technologies through the Prism of Techno-Anthropology the Origins of Techno-Anthropology in Philosophy". He identifies four waves in the development of research into technology and philosophy of technology, with the fourth and thus far final wave resulting in Techno-Anthropology. This period, which in contrast to before, where "traditional" technologies remained the focus, addresses "modern" mass technology and products of global technoculture (Sokolovskiy, 2019, 103). It often concentrates on attitudes towards new technologies in subgroups and social, cultural and ecological consequences of technical innovations (ibid). In this new discipline, technological phenomena emerge from specific cultural contexts and contribute to new cultural worlds such as "cyberculture" (Escobar, et al. 1994) or "techno-nature" (Escobar, 1999). American anthropologists Suchman (2001) and Downey (1992) advocate for a "cyborg anthropology" that would go beyond describing the consumption of technology. It would advance in addressing culture of technology producing communities, and the material effects of technology on perception, communication and identity. Their aim is an action-oriented agenda uncovering cultural dimensions of domination by race, class and gender. Their empirical research focused on the design and production of technologies, the business context and related values and worldviews inscribed in the technologies (Bray, 2007, 43). While this thesis does not engage with the cites of construction, it is important to reflect on them, as the inscribed meaning, based on its design and production, determine how end-users will engage with the technology. In line with this, Schiffer (2001) introduces 'technology transfer' as a behavioural framework. While it stems from behavioural archaeology, Schiffer argues for its relevance for anthropology in terms of the interest in technology and its transfers. He suggests that the framework can help understand technological change in any kind of society. Technological variations between communities' stem from its redesign to a more appropriate form to the given context. That includes its utilitarian function, its symbolic function and related activities (Schiffer, 2001, 1148). Thus, while it transports meaning from its context of origin, it is also appropriated in its context of usage. Furthermore, Lemonnier addresses the notion of technological choice. He argues to take it further than necessity, and beyond the

internal logic of specific material culture. He shows how technologies can be voluntarily ignored in any context and suggests that in light of the complexity of material cultures involvement in systems of meaning calls for new approaches (Lemonnier, 1992).

Lastly, above all scientists within the field of social anthropology (Pfaffenberger, 1992; Bray, 2007) and beyond (Schiffer, 2001) call for an interdisciplinary discourse on technology, which manifests itself in the emerging disciplines of the 21st century. Technologies throughout history seemingly come with both benefits and bring about new problems. The most prominent example is the global ecological crisis, largely linked to technological interventions. For instance, the invention of the car brought about unprecedented levels of CO2 emissions, pollution and congestion (Jensen, 2013, 2). Science and Technology Studies looks at the relationship between science, technology and society, considering both its problematic and the productive side. STS uses social studies to look at scientific and technological practices. The empirical focus of social sciences enables looking closely at the practical, local circumstances of science and technology at work. This is central due to the idea that every form of knowledge is entangled in material circumstance, which questions the notion of higher rationality (Jensen, 2013, 4). Three types of efforts are to be made by the discipline according to Jensen (2013), reclaiming the field, reflection on our own practices and engaging in experimentation. Jensen further claims that Techno-Anthropology is a part of these efforts and constitutes a new move within STS (Jensen, 2013). While these roots are a crucial part of techno- Anthropology, it has since emerged as its own discipline.

2.2.3. TECHNO-ANTHROPOLOGY

Techno-Anthropology (TANT) as a discipline draws on resources from both the humanities and engineering. It is an interdisciplinary research and study area, which was taken up by the Aalborg University in Denmark. The institute plays a central role in facilitating related debates and are prominent in recent publications in the field (Børsen, 2015, 234). Their program addresses the interface between humans, techno-science and technology, with techno- referring to both techno-science and technology (ibid). They define techno-science and technology as products but also as processes and practices. Therefore, their program also aims to answer questions on ways of engagement with technology or techno-science of scientists, experts, or simply their users (Børsen, 2015, 234). The new discipline discusses and creates solutions to societal problems that are technically and socially robust, putting interdisciplinarity at the forefront.

The emerged Techno-Anthropology in essence attends to human- technology interaction. Techno-Anthropology has found increasing uptake in the last decade, with enthusiastic claims made towards what it might become. Birkbak (2013) for instance declares that all anthropologists should be called Techno-Anthropologist, arguing that the fundamental entanglement between humans and technology calls for such ambitions. Being human means being techno-human. Latour (1992) a central figure in debates on technology emphasizes this point by suggesting that what separates humans from animals is not, as often argued, the level of complexity in social interactions but instead our use of things. Objects and technologies frame our interactions and enable us to not have to deal with the full complexity of the social world all the time (Birkbak, 2013). Traffic lights, for instance, make it possible for humans in cars to coexist without having to watch all cars at every moment. "In Latour's language, technologies like traffic lights shifts human life from requiring constant attention in complex settings to require complicated infrastructure" (Birkbak, 2013,4).

This complicated technological infrastructure Latour refers to, mediates human interaction: "Human interaction is always mediated by something " (Birkbak, 2013,4). That something is not without meaning but instead conveys messages integral to its design. Technology can transport morality as in the case of a seatbelt, and the related mechanisms to remind oneself of its usage, which communicates the moral dictum of not killing oneself, delegated to the technology (Birkbak, 2013). Therefore, Latour (1992) renders the dichotomy between social and non-social entities, humans and technology as unproductive, supporting Birkbaks claim of viewing all humans as techno-human. In line with this argument, this paper addresses technology, more specifically sustainable energy technology, not in dichotomy to humans.

Current research in techno- anthropology often addresses the role of technology in networks, often related to social media (Turkle, 2011). However, as Birkbak (2013) argues technology always plays a central role in collectivity, not the least in its ability to coordinate actions across space and time. Thus, research inquiring about sustainable energy technology is well situated in the discourse of Techno-Anthropology.

The interdisciplinarity of the roots of Techno-Anthropology has the advantage of offering a variety of different methodological approaches. These can be exclusively informed by social anthropology or draw on the interdisciplinary field of STS (Birkbak et al., 2015, 3), including anthropological studies of techno-science and technology, analysis through Actor-Network analysis, post-phenomenological thoughts or post-normal science. Børsen (2015) explores one of these research strategies that is the post-normal Techno-Anthropology. This has three elements it tries to explore by asking questions of: Where are we going? Is it desirable? and

What should be done? (Børsen, 2015, 237). The first element addresses epistemological thoughts related to the assessment of uncertainty in foresight scenarios, the second concerns the ethics, and the third aspect involves action and suggests interventions in techno-scientific and technological developments (ibid.).

Even though this thesis will not draw on post-normal anthropology it offers a useful perception on anthropological, methodological insight into the field of Techno-Anthropology. While all of the approaches offer their share of insight, this paper will employ Actor-Network Theory (ANT). ANT offers a unique perspective on how technology and artefacts participate in our daily life by acting with us and not just sitting there benignly (Oppenheim, 2007). Thus, ANT enables a focus on connections between human and non-human entities, that are made and remade in relation to the issue at stake (Bencherki, 2017).

Lastly, this research is situated in Techno-Anthropology and draws on many of the established thoughts on the interface between humans and technology. Much more, however, does looking at the previous thoughts on human-technology interaction in anthropology, show what is still to be discovered in the new discipline. Such is the field of application on energy technology in the Global South, that this thesis contributes to, by applying Actor-Network theory.

3. THEORETICAL FRAMEWORK

3.1. ACTOR NETWORK THEORY

Actor-Network Theory (ANT) is a theoretical and methodological approach that is most usually deployed in the aforementioned technology and society studies (STS) and Techno-Anthropology. It originated in the 1970s as an approach to study scientific activity and science in itself (Bencherki, 2017, 2). Influential actors in the creation of ANT are Bruno Latour (1996; 1999; 2005) John Law (1999) and Michel Callon (1986). ANT has received little attention from development scholars but Donovan et al. (2015) suggest, its relevance for the meeting of anthropology and development, especially focussing on Latours contributions (Donovan et al., 2015, 2). Drawing on his line of argument, this paper uses ANT from both an anthropological and development perspective.

ANT sparked a discussion on non-human agency and material ability, which distinguishes it further from other network theories (Latour, 1996a, 369; Oppenheim, 2007, 472). It looks at how things that assemble and reassemble produce the reality as we see it. Latour gives the following examples of an agenda of ANT: "The attribution of human, unhuman, nonhuman, inhuman characteristics; the distribution of properties among these entities; the connections

established between them; the circulation entailed by these attributions, distributions and connections; the transformation of those attributes, distributions and connections of the many elements that circulate, and of the few ways through which they are sent" (Latour, 1996a). ANT has thus found many fields of application and is considered powerful beyond analysis of the construction of scientific facts or technologies, far into the fields of collectives, organizations and social groupings, seen in its contribution to this research (Bencherki, 2017, 5).

Instead of analytically using sociological groupings such as class or ethnicity as in depended variables, ANT suggests looking at "how actors are made to fit in groups that are never without spokespeople and that are defined against other groupings" (Oppenheim, 2007,474). Groups then are connected and maintained through intermediaries and mediators. Intermediaries transmit cohesive action, that entails merely acting as a placeholder doing what any other actor would do in its place and mediators, who "adds something to a chain of interactions of associations" (Sayes, 2014, 138), who transforms, translates, distorts and modifies the meaning and elements they carry. Furthermore, action, that is accumulative, and actors, made up from connections of mediators that bring about capacities, ANT suggests, are made to act by others. In this system, the mediating element can take the form of objects, such as a solar panel or battery. That means they entail the capacity to make others act a certain way. For instance, this can be shown in the case of the instalment process of a solar panel. The Panel is already inscribed with a specific set of actions necessary to make it work. In order for any actor to make it function the person setting it up needs to act a certain way conveyed by the technology. Therefore, the solar panel can be considered, too, as a performative agent (Oppenheim, 2007,475). A performative agent in what form ever, "comes to bear as associations are made and remade" (Latour, 2005). Furthermore, facts, as objects, cannot be seen as static or natural order but pull actors into complicities with the world (Oppenheim, 2007, 475). When one acts, it always is in interaction with others and interaction in ANT is all there is (Law, 1999).

ANT is in its broader sense a constructivist approach, seeing the researched reality as constructed. Analysing this construction through interactions and practices enables an understanding of networks made of humans and nonhumans. (Sayes, 2014; Garcia et al., 2018) Latour (2005) suggests observing how actors multiply or reduce entities. The context of sustainable energy in Monkey Bay presents a case of a network of humans and technology that is made and remade with non-humans and humans reducing and multiplying, with intermediaries and mediators acting.

3.1.1. DEFINITIONS AND CONCEPTS

ANT engages with a number of concepts that are central to analysing networks made from humans and non-humans. This includes a specific terminology henceforth used to analyse the empirically rooted findings. The following pages give an introduction to some of these core concepts and terminologies in ANT, enabling the reader to engage with the analysis.

Agency and 'Agencement'

The use of the term 'agencement' was introduced by Callon (2008) and describes actor-networks that are made from physical forms (objects, virtual systems, humans) with capabilities of action related to their combined capacities. Even though it shares roots with the term 'agency' or 'agencemente' emphasizes the capacity to act, stronger (Caliskan and Callon, 2010). Levels of agency depend on the different configuration of the physical forms. An example given by Molony (2009) shows how access to information and communication technologies (ICT) can influence abilities and actions in market participation at the case of blackwood carving traders in Tanzania. The same can be said about energy access in Monkey Bay, where energy deployment leads to increased possibilities, such as in personal development, information access or economic development or market access. Thus, the 'agencement' made up of for instance a solar panel, shavers and humans that have these technologies have the capacity to act by creating a shaving business (Interview 1).

Applying ANT entails following actor's reality that where hybridizations of social, technical, natural and other elements continuously occur (Bencherki, 2017). As ANT warns researchers about heterogeneity, that is not to hold assumptions about people and things, nature and identity or about their "intentionality". This holds true when referring back to the theories most prominent notion of the inclusion of non-human actors. Any being that has an effect on a researched situation holds credit, that also includes non-humans that have the ability to make a difference. In other words, all actants in a network, human or non-human are afforded the same amount of agency (Bencherki, 2017). Therefore, as Bray (2007,40) suggests: "we may delegate to nonhuman actor's moral as well as material roles, inscribed into their design". This point relates to current themes in Techno-Anthropology previously discussed, that dedicate the design of objects the role of mediating human interaction by conveying messages (Birkbak, 2013). Sustainable energy technology in Monkey Bay mediates human relations through its message in several forms directly and indirectly, through itself or the use of extended gadgets.

Actor

ANT breaks with the common philosophical dichotomy between object and subject (Sayes, 2014,136). An actor in ANT is thus seen as its semiotic definition "actant", that means someone or something that acts or who is perceived as acting by others (Latour, 1996a,373). An actant takes the role of a node within a network. This stands in contrast to the dominant notion of an actor as a human, intentional, individual (Bencherki, 2017). Applying this definition to network most often leads to misunderstandings, as research then as Latour points out, usually focusses on man attempting to take power by networking and making allies. Latour renders this inaccurate by comparing such definitions with for instance a declaration of the night sky as black because there are black holes found in it. This comparison shows that the causal relation between them is false, and to points out that there is no special motivation of human individual actors necessary in ANT. The single definition for an actant is that it is the source of action (Latour, 1996a). A material artefact, for instance a piece of technology such as a solar panel, is loaded with a 'script', referring to the intentions set by its engineers or designers (Bencherki, 2017). Furthermore, ANT does not acknowledge the existence of a group but only that of a group formation (Latour, 2005). All assemblages are made up from actants and all actants are in themselves assemblages. That means, for instance, that the assemblage of a specific singular solar panel is made up from actors that contribute to the solar panel, including the engineers, the materials, the materials to make the materials needed, the means of transportation, the people who set it up and so forth. These actants then in themselves are again made up from assemblages of actants for instance a material such as the frame, is made up from wood, the saw for cutting down the tree, the material needed to make the tree into a frame, ect. Therefore, the solar panel is itself an actant within a different assemblage such as the assemblage of sustainable energy implementation.

Non-human actors can take varying forms that central ANT authors such as Latour or Law give varying examples of. Sayes (2014) gives a more systematic summary of what can be meant as non-human in ANT. That includes animals, natural phenomena (reefs), tools and technical artefacts', material structures, transportation devices, texts and economic goods (commodities). Not included in the term non-human besides humans are entities that are as a whole symbolic, supernatural entities and entities that are at a scale that composes humans and non-humans (Sayes, 2014,136). Therefore, non-humans can be durable materials that outlast the interactions that created them. Thus, the capacity of non-humans is the condition for human society, which ascribes them the role of stabilizers in human collectives (Sayes, 2014, 137). Human society

then works only if "certain ties can be sufficiently stabilized or placed in a black box" (Sayes, 2014, 137).

This relates to the "black box", which, following the theory's jargon, describes an actor-network that seems simple and unitary. The expression captures the thought of experiencing objects and people one interacts with, "only to the extent that they provide us with some expected output" (Bencherki, 2017,4). Solar panels charging a battery or a cashier scanning your items can be seen as examples of this, in that they show an expected output.

Translation

Latour (2005) and Callon (1986) identify the notion of translation. ANT is often called 'sociology of translation', as this constitutes a central theme. Translation consists of an actor or "black boxed actor-network" that is able to take the role of a spokesperson for others which are enrolled in a specific program of action (Bencherki, 2017,5). The spokesperson acts as the face or voice of the actor-network, by carrying out or expressing the action of others. Translation can make action of actor networks equivalent in other places or times or different in orders and magnitude. A successful translation constitutes of the spokesperson speaking for others while using his own language (Shiga, 2007). Therefore, for instance, an ethnographer writing about geographically or culturally distant places in comparison to their own, is using translation. It goes without saying that translation is flawed (Bencherki, 2017, 5). The act of translating becomes the performance of relationships. ANT is concerned with constituting that process and the study of the relationships (Kien, 2009; Garcia et al., 2018, 55).

Power

The notion of power is argued to be underrepresented in ANT, because it is not perceived as "a priories [sic] inherent in some 'ether'" (Oppenheim, 2007, 478). It does not allow for previously defined assumptions on the phenomenon (Garcia et al., 2018, 54). However, ANT clearly acknowledges the existence of power differentials, which are held together logically with greater reason of things in distribution in fields of mediating entities (Oppenheim, 2007, 478). The result of translation, where the social and natural worlds progressively take form, is a situation where certain entities control others. Therefore, the concept of power acknowledges that certain entities control others, that is the effect of a performance (Oppenheim, 2007,472). The effect of power is produced by associating entities together. Therefore, in contrast to other theories on power, here having power means having the potential to associate entities together (Kien, 2009). Latour defines power as the movement of tokens through the network. Using

power is having others perform for your benefit, not excerpting yourself. The tokens travel freely through mediums, consistent of a network of actors, who change the token in the process. This process is slow and rare considering the durability of the objects in question. Thus, concluding that power is not, as stated in the beginning of this paragraph, pre-set given but instead, the illusion people get when they feel obeyed. It is thus a consequence, not an origin (Oppenheim, 2007,478).

Ritual

Using and interacting with objects in the broader sense entails a certain way of doing things in order to use the object. These can become routinized and the routine itself can turn into cultural practice. This relationship between cultural practice and objects enables consistency across time. Therefore, the interaction with technologies can take the form of rituals. These can be passed along through history and more concretely in family relations. A common example is the use of utensils for food intake. The active role of objects conveying meaning further enables a feeling of togetherness, belonging and sameness, which stabilizes everyday life, by routinized ritualistic performances. In this act, the object further reveals the conceptual, symbolic categories used to organize the world. ANT, therefore, ensures going beyond interacting with objects as purely aesthetic phenomena and enables the perception of recognizable symbolic practices. In terms of the utensils- food example, this consists of specific foods abiding to specific utensils, or even specific ritualistic dates such as Christmas where symbolic practice is deeply intertwined with material objects. In this case, then ANT presents an adequate method of mapping the participation of material objects or technologies in everyday life (Kien, 2009).

3.1.2. CRITICS

Critics of ANT have revolved around central aspects such as usefulness, agency and power. Often criticised is the theories' refusal to acknowledge an actants inherent a priori power. That, as argued by its critics, doesn't adequately take into account categories such as gender, race or religion. However, ANT does acknowledge the existence of differentials in power. The theory suggests that these are held together logically in the bigger picture by mediating entities, as discussed above (Oppenheim, 2007, 478).

Acceptance of non-human actor's agency has sparked criticism in the reigns of social scientists as well. Amsterdamska (1990) accuses Latour of abolishing any distinction between human and non-human actors (Sayes, 2014). This criticism is in line with the general belief in social sciences that agency is an exclusively human attribute and can't be transferred to things. ANT,

while not arguing that humans and non-humans are identical, challenges this view of humans simply imposing their will on passive artefacts (Shiga, 2007). Thus, it tries to capture how any given collective extends 'social fabric' to other entities (Latour, 1996b). Criticism emerged also about ANTs methodological framework of 'follow the actant'. The problematization doesn't address the concept itself but suggests that studies in ANT often don't follow the methodology as research tends to focus on the sites of construction and does not indulge with the use of artefacts enough (Shiga, 2007). This paper addresses this point by focusing on the site of use instead of the site of production.

Another point of critique addresses that analysing networks can theoretically lead to overanalyses of assemblages and networks to an atomic level, as one could always go deeper in the inclusion of actants and assemblages. However, this point of criticism is easily addressed by the researcher identifying the necessary scope clearly. Further critics go into its ontological perspectives as a discipline in itself, however considering that this paper does not aim to contribute to solving theoretical debates in ANT but merely discuss its applicability in the context these points of critique bear limited weight for this purpose (Shiga, 2007).

3.1.3. FIELDS OF APPLICATION

There is a number of relevant fields taking up ANT, with their own interpretations of it, such as organizational analysis, informatics, health studies, geography, sociology, anthropology, gender studies and economics. A relevant area of application, in the context of sustainable energy in the Global South, is found in environmental theory, predominantly in environmental justice (Holifield, 2009). An unexpected role of ANT is pointed out by Rosa (2016) who suggests that some aspects of ANT can be used to reinforce 'theories of the South' in challenging global sociology. Namely that "the social is not a stable force, that sociology should be active in the production of ontologies and that it is necessary to include new 'ontological politics' within the scope of sociology" (Rosa, 2016). Furthermore, the contributions of gender studies cannot be dismissed in both ANT and anthropology of technology (Bray, 2007). However, this thesis considers ANT primarily in the context of techno anthropology, rooted in STS research.

Anthropology has appropriated ANT predominantly in the context of larger and historical non-human agency, hybrids, sociotechnical borderlands and amodernity (Oppenheim, 2017, 485). The benefit of ANT in the context of sustainable energy is its ability to describe networks, how they come into or omit of existence. It can thereby help understand and identify their components and the contingency between actants. Therefore, ANT can show how sustainable

energy technologies are constructed and operate in the network, how they are manifested and how people vis-versa change through the new technology.

Furthermore, by highlighting the network, with components on different scales this paper argues that ANT is qualified to take into account the multiple scales of energy implementation. Thus, making it applicable to the multilevel analysis presented in this paper. Applying ANT to the context of sustainable energy in rural Malawi can both contribute to the field of Techno-Anthropology by opening up the fairly new discipline to new areas of operationality, while at the same time contributing to research on sustainable energy implementation and rural electrification. ANT as a part of Techno-Anthropology is not a novelty and has been applied in several contexts as shown above, however, to my knowledge it is yet to be applied to energy implementation in the global south as this thesis attempts to do. ANT should not be seen as a 'ready-made' theory or method but instead as a repertoire that increases sensibility shaped by the collection of case studies (Blok et al, 2019).

In the frame of this paper ANT will be applied to the context of sustainable energy implementation in Monkey Bay, Malawi through a multilevel analysis, taking into account, the local, national and international level. ANT is primarily used within these levels of analysis to show a human-technology network around sustainable energy. It makes visible the transformation of actants, 'agencements' and black boxes in the network, routinized ritualistic practices related to the new technology, aspects of power, processes of translation and analyse the role of the network and its nods in general.

4. METHODOLOGY

Before elaborating on the methods this paper builds on, some words about the underlying ontology and epistemology are necessary. This paper builds on a constructivist approach. Ontologically this implies that the world is socially constructed and no reality independent from our knowledge about it exists. Social phenomena can thus, from an epistemological point of view, only be studied through investigating how they are constructed and what underlying meaning is attributed to them by social actors. ANT can be considered a well fit theoretical framework for these considerations. Methodologically, this implies a qualitative approach. This paper thus applies interpretive research in its aim of understanding beings attribute to their behaviour and the external world, by discovering meaning (Della Porta et al. 2008). Inductive research is typical for ethnographic work and concerns itself with open-ended matters rather than the modelling of expected change (O'Reilly, 2005; Mosse, 2001). Therefore, this paper

does not start from a strict hypothesis to be tested, it does, however, follow guiding questions and draws on existing literature and theory. Leaning on ANT as a theory that is rooted in constructivism, this paper also is based in social constructivism. Methodologically ANT, that rejects a priori assumptions of the field, constitutes radical empiricism, based on the 'follow the actor' dictum (Blok et al., 2019). 'Follow the actor' has become a central part of STS in the use of ethnographic methods that insists on researchers attending to practice. "Fieldwork requires attending to experience and participation, as well as to apparatuses for categorising, formalising and knowing the work, informants' as well as the ethnographer's own." (Blok et al., 2019). Anthropological ethnography and what is to be considered as ANT ethnography in the sense of the 'follow the actor' principle share history in the story of ethnography.

This paper conducts a case study based in Malawi, a “Least Developed Country” (LDC) in Sub-Saharan Africa (Blok et al., 2019). The aim of this case study is not to generalize and instead keep the unique context in mind. Especially on the broader geographical area of Sub-Saharan Africa, where, as Keller (1991) points out "nowhere does the temptation to succumb to such continent-wide generalisations appear to be as strong as it is for Africa." (ibid.,50). Instead, this case study can provide perspective on the challenges in electrification, renewable energy and climate change management. Madzedze was chosen as the unit of analysis because of the simultaneous lack of energy in the region and the multiple different scale attempts to establish sustainable energy in the village. However, I also chose it due to already established access to the field, which enhances the feasibility considering the limited timespan.

4.1. METHOD AND DATA COLLECTION

This paper is based on classic anthropological qualitative methods of ethnographic fieldwork, including participant observation, informal and semi-structured interviews. A qualitative approach was chosen based on its ability to better explore and understand complex phenomena. It also enables in-depth analysis, leading to deep knowledge. This “Knowledge is considered ‘deep’ when a subject is examined in the context of its complex connections” (Della Porta et al., 2008, 298). Furthermore, in comparison to quantitative research, which is based on numbers, this qualitative research is based on words (Bryman, 2012). Fieldwork was conducted in a primarily rural area, namely the village Madzedze in Monkey Bay Malawi. However, throughout the fieldwork movement within the Monkey Bay area was a given, leading to numerous observations and interviews from neighbouring villages, with their own specific local contexts. In line with STS’ call for experimentation in ways to engage with the field of

society, science and technology the paper doesn't limit itself to looking at a specific technology, but instead inquiries about public knowledge, sustainable transitions and so forth. Jensen (2013) believes that ethnographic case studies, as is done here, continue to be useful in the field of Techno-Anthropology to take up questions of how new techno-science relations are constructed or multiple or to conduct comparisons (Jensen, 2013, 8). This agenda is, furthermore, in line with ANT, which enables inquires of networks, specifically including technologies (Garcia et al, 2018). Therefore, qualitative research fits the context and aim of this thesis. The empirical data used in this paper is derived from fieldwork conducted in the Monkey Bay area in Malawi for the duration of one month.

4.1.1. SAMPLING

The purposive sampling strategy taken aims to purposively select a sample of participants that can enhance understanding of the explored phenomena (Cresswell, 2015,76). Therefore, sampling was done in accordance with qualitative purposive sampling. Accordingly, units of analysis were selected through the criteria of whether or not they contribute to answering the research question (Bryman, 2012, 410). That includes the locality determined in the research focus as Monkey bay. Participants thus were subjected to exclusion if they had no connection to the region of interest. The snowballing principle was furthermore applied, following local information and guidance in the inclusion of additional people or relevant places. A focal gatekeeper was the Area Development Community (ADC) chairman who was well connected in the area and opened access to the field.

The sampling size was determined in accordance with necessity. Necessity sampling size suggests that research will be conducted until new participants do not add substantially to the research (Cresswell, 2015, 77).

4.1.2. PARTICIPANT OBSERVATION

One of the main methods used in this paper is participant observation. It constitutes one of the main methods in ethnographic research. It entails taking part as a member of a community while documenting, theoretically informed observations through mental and written notes (O'Reilly, 2009:69). It requires the involvement of the researcher with people in their natural environment, over an extended period of time. Observable details, hidden details and unravelling complexity, come to the forefront through time (Della Porta et al., 2008, 306).

The primary observations were made in the village of Madzedze, due to my staying there with a local family. There I was able to observe and participate in the activities of individuals and

communities in their daily lives, with a theoretically informed focus in relation to human-technology and energy. However, the scope of observations was not limited to this village. More extensive explorations in the Monkey Bay area in varying places where interaction with Sustainable energy was present, were conducted. This includes varying sectors ranging from the individual level, over private businesses to government facilities. However, the most central participant observation was made in the daily life and interactions in the village I stayed in and more concretely the family I lived with and their extended family. Another key participant observation was made in relation to a solar panel deployment in the house that I stayed in. I also participated in an ADC meeting, that entails representatives from all the areas in Monkey bay, who meet once a month to discuss issues and accommodate representatives of organisations thinking of implementing community benefit projects in the area. The participant observation made throughout the month in the field was amplified by interviews.

4.1.3. INTERVIEWS

Informal conversation throughout my participant observation presented a large part of my fieldwork, however, they were complimented by unstructured and semi-structured interviews. The inherently qualitative focus of this thesis with an explorative research question lead to interview questions being open-ended with no answers suggested or options given (Della Porta et al., 2008, 310; Becker, 1998, 85). In accordance with the multilevel analysis scope of the thesis, they included individuals, local authorities, different scale businesses (both from local and international owners), and government facilities i.e. a local hospital and the government electricity company ESCOM. I used different but related sets questions to the different scales of analysis in accordance with the groups**.** Questions, especially for individuals, were formulated with taking into consideration that they should be non-intimidating or indiscreet. Due to the role of energy in the private sphere of people's homes questions enquiring about this aspect can be seen as sensitive or private. this presented a challenge. The questions were modified throughout the research to incorporate findings and take into consideration priorities set by the interviewees.

In total there were 19 relevant Interviews conducted, seven of which were with more than one person at a time making the total number of interviewees 26. In four of the interviews, the multiple people were connected to limited English skills, leading to Fosco translating when needed. These interviews spread out over the area of Monkey Bay covering 8 villages/towns. Four of the interviews were conducted in Madzedze, two in the neighbouring village Balamanja. Four were conducted in Mvuguti, a remote village with no alternative energy

options. Mvuguti is a village that can only be reached by boat, approximately one hour away from the central town of Monkey Bay. Two were conducted in Nanquari, a remote village with two schools. One interview each in Nkudzi Bay and Nagoma and three in Monkey Bay town. One interviewee originated in the area but had since moved to Zomba, however, the interview was conducted in Monkey Bay. Lastly, one interview was conducted in Zomba, a city outside the Monkey Bay region connected to the national level of analysis. Finally, two interviews were conducted with representatives of the government-owned electricity company ESCOM. One was a regional manager of the monkey bay area, the other a security guard with over 30 years of experience at the company. The interviewees were business owners such as a property developer, a lodge owner and a farmer, government facility representatives such as two headmasters, a public hospital authority and two government electricity representatives, local authorities such as a chief and her relative and the ADC chair and his secretary, and they were private citizens engaging with various energy sources.

4.2. ETHICAL CONSIDERATIONS AND LIMITATIONS

This paper does not aim to generalize its findings, but instead wants to provide insights into the wider field. Time constraints also need to be reflected on. Classic ethnographic fieldwork is conducted on a small scale and over a large period of time of approximately one year (Clifford, 1998). O'Reilly (2009) points out the essentiality of enough time in the field to build trust. By having pre-established trust from previous stays in the village and crucial connections to gatekeepers, this aspect could be approached in terms of time constraints posed by only one month in the field. Furthermore, recent anthropological fieldwork is increasingly done in shorter periods of time.

Subjectivity and my role in the field is a central limitation of qualitative research. Even though English is one of Malawi's official languages, in rural areas many people did not speak it fluently. Therefore, in cases where interviews could not be conducted in English, there were translated people accompanying me. Furthermore, a critical reader must consider that some of my interviews were conducted in social settings and not one on one, therefore the surrounding may have influenced individuals and their answers. However, considering the focus on the network and not the individuum, potential biases from and individual to a community perspective, pose only a limited problematic.

Furthermore, even in interviews that were held in English Bourdieu (1990) suggests considering probable biases arising from the researcher's academic background and the

inherent language. Indeed, during the first informal conversations and interviews conducted, certain barriers related to the chosen words used were found. Particularly related to what energy and sustainable energy is. In order to combat potential confusions, inquiries of local definitions and differentiations were conducted. These presented itself fruitful not just for future interviews and conversations but also presented themselves useful for the findings.

Another limitation during the fieldwork relates to gender relations (Warren, 1988). The research agenda of this paper is directed at all actors related to sustainable energy, that includes all genders. However, my role as a female researcher and the prominent dominance of males in relation to technology had undoubtedly effects on the results. Firstly, my role as a female researcher could be the reason for a-priori assumptions about my knowledge or the assumed lack thereof on technology and energy (Interview 2). Secondly, the asserted dominance of men towards energy and technology also lead to skew towards interviews with men, with 20 out of the 26 interviews conducted with men. This skew can further be accredited to the lack of representativity of women in higher positions. All of the interviews conducted with official business owners and government facilities were with men.

How much to reveal about interviews in relation to protecting their privacy presents an ethical consideration challenging to fieldwork-based research. Furthermore, power relations need to be reflected on, such as what is recorded already assumes a certain power of frame (O'Reilly, 2009; Burawoy, 1998). A fundamental principle to combat this is transparency towards informants and research (Della Porta et al., 2008). This was considered in the research in terms of answering posed questions honestly. Privacy was established by using first names only in the paper and excluding even the first names of people who asked for complete anonymity. Power relations were harder to address as they are not as easily visible, however, consistently reflecting on the way people are represented in this paper presents a starting point.

Compensation for their collaboration and information about research results and avoiding manipulation are further considerations (Della Porta et al., 2008,15). Interviews conducted with local authorities, such as the chiefs, were compensated with a small financial donation, mandatory from foreign visitors. Furthermore, my host-family got financial support and a solar panel. Other facilities asked to keep them in mind for future donations or potential fundraisings.

5.RESULTS

5.1. INTRODUCTION TO THE FIELD

Malawi has a population of 19 million as of 2020 (Worldometer, 2020) with 83% of the total population living in rural areas (World Bank, 2020). The current president (2020) is Peter Mutharika from the Democratic Progressive Party. However, due to widespread irregularities in his re-election in 2019 the constitutional court of Malawi annulled the election results and ordered new votes that are scheduled to take place on July 2nd leaving Malawi in tumultuous political times (Faiti, 2020). In light of the COVID-19 Pandemic, the president tried to enforce a stay at home order, leading to multiple protests and ultimately the postponing of the order. SEforAll argues that the current political unrest shows the importance of energy during the pandemic, as staying connected, from home, requires affordable energy access (Ogunbiyi, 2020). The electrification rate in Malawi as of 2017 is 12.7%, with only 3.7% of the population having access to electricity in rural areas and 57,5% of the urban population (World Bank, 2020). However, the vast majority of Malawi's population live in rural areas where between 2016 and 2017 access to electricity has been decreasing from 4.9% to the now 3.7% (World Bank, 2020). In Malawi, the increasing population and GDP growth of 4% in the same year, suggests that the demand for electricity connection will increase. Currently, 81% of Sub-Saharan Africa's populations still relies on biomass fuels at least for cooking and heating. With the current growth trend in energy demand, this energy source is projected to increase by 10% by 2030 in comparison with 2009 (Chirambo, 2016, 749).

In 2000 Malawi started the "Vision 2020" as a long-term national development policy in line with regional and international sustainable development strategies. Its aim was to further the direction of becoming a middle-income country. Vision 2020 is built on three pillars: developing the agricultural sector for domestic and export demand, sustainable water resource use and management and transitioning from biomass energy to modern energy (Nyasulu, 2018, 5).

Biomass dominates Malawi's energy sector and is expected to keep doing so even within the available energy diversification scenarios. To support the sustainability of this energy source reforestation measures can be taken into consideration (Nyasulu, 2018, 7). Land-Use change and forestry have the most significant GHG emission levels accounting for 56% of the Countries emissions, which can amongst others be linked to agriculture and the energy sector (Nyasulu, 2018, 8). Thus, while energy derived from wood is a renewable energy source in that

trees re-grow and a balance between re- and deforestation could be held in theory, it is in reality not a sustainable energy source as this balance is far from being reached (Nyasulu, 2018).
Communities who have not had access to fossil fuel for development should be able to use low carbon solutions for problems of their home contexts (Brown et al., 2018). These can be off-grid as with individual solar panels, or on-grid with thus far primarily the government's hydropower supply. Sometimes, mini grids occur which can be connected to the grid but are predominantly off-grid. Problems for the home context can vary and are thus far addressed with different energy sources. Phones are increasingly prominent in the rural context and need electricity to be charged. For this purpose, the energy source, whether acquired privately or from small businesses, is usually government electricity or solar energy accessed primarily through the use of batteries.

The concept of energy within the field

In order to correctly interpret the following findings, a few clarifications are necessary in regard to what is meant by sustainable energy. Energy, as discussed in the literature review, can take forms such as hydroelectricity, biomass, geothermal, wind, wave, tidal and solar energies (Hollaway, 2013). Electricity, as an immaterial object, manifests itself in objects. In Monkey Bay distinctions between electricity and other forms of energy were often made visible. Fosco (Interview 7) defines energy as "something that makes something out of something". However, during my inquiries about energy use, most people immediately referred to electricity either in the form of hydroelectric power from the government or solar power. The third mentioned source of energy was diesel generators. Other sources of energy such as firewood or charcoal were exclusively mentioned after specifically asking about them. These sources, furthermore, are predominantly not sustainable, even though efforts to increase their sustainability were found such as a project maximizing the efficiency in firewood use for cooking stoves (Fosco, Interview 6; 9). These sources are furthermore often separated into modern versus non-modern energy sources both by international actors that want to guarantee access to "modern" energy sources (UN) and by locals (Interview 11).
Energy is used in different areas with different sources: for cooking and heating water the primary source is charcoal for wealthier families and firewood the cheaper option. Charcoal is transported partly by bike from long distances "They have started their journey at 4 in the morning" (Interview 8). Firewood is collected closer to home. Both can be purchased both on markets and on the streets. There is an intersectionality between unofficial markets of the informal economy and energy. Energy needed for cooking presents a challenge as the "non-

modern" but cheapest option is firewood. For Madzedze the chief suggested an estimated 95% using firewood and 5% using charcoal or other energy sources (Interview 11). This presents a local challenge as it leads to deforestation that can have tremendous impacts on food security due to higher chances of flooding (Interview 11). Initiatives that incorporate this reality promote efficient cooking stoves that need less firewood or charcoal which leads to less individual energy costs and decreased deforestation. Other initiatives use recycled paper blocks for more sustainable energy usage (Interview 9). However, ultimately none of these options are sustainable over the long run and "modern energy" usage for cooking is still far from common in the local, rural context in Malawi. Under the Rio Earth Summit (UN, 2011) that promotes sustainable natural resource management systems for development, self-organised local systems for natural resource surveillance and cautious harvesting was promoted which can be equally applied to low carbon energy. In line with these arguments these sources of energy are henceforth excluded from the sustainable energy narrative of this thesis, unless otherwise specified. However, even though interviewees referred predominantly to electricity, when asked about energy or sustainable energy, this paper will continue to use the term sustainable energy.

5.2. FINDINGS

As previously mentioned, the regional focus was set on Monkey Bay. In Malawi and therefore also in Monkey Bay, there are two electricity companies: ESCOM and Egenco. Originally it was just ESCOM however now Egenco produces the energy and ESCOM is responsible for its distribution. The village of Madzedze represented the basis for this research. Madzedze's chief estimated the distribution of different energy sources at 95% having no electricity and using firewood or charcoal for cooking and heating. The rest of the 5% use either government electricity or solar energy. Her aim would be for firewood and charcoal to be replaced with electricity, especially due to the interconnection between environment and well-being. "Help protect the environment for children to find it the same way" (Interview 11). Her son further addresses the region's transition away from paraffin and the new phenomenon of torches imported from China. In Madzedze most of the families that have access to electricity use the government on-grid solution. The polls and wires present high initial costs limiting many people from access, as is the case for the chief's house that in rates started establishing the wiring but is yet to wait for enough money to pay for the necessary polls and cable connection (Interview 11). Other houses that managed to fund the initial costs of connecting to the grid

use it according to their income in that month as it is a flexible get what you pay system. Therefore, television, lighting, refrigeration, radio and other applications are used according to income of the month (Interview 10). The initial costs can be subcommand by somewhat illegally laying cables between an already connected house and one that lacks access. This was observed between a household without electricity and their neighbours, who simultaneously were family members. More specifically the mother-brother (uncle) of the household without electricity shared his electricity with his sister-daughter (niece). Mother-brother/ sister-daughters share a special relationship in the Chewa culture, dominant in this part of Malawi. This obliges the uncle on the mother's side to give special attention and support to the sister daughter as was the case here when a foreign visitor, i.e. me, was received. The government electricity is either connected directly to wiring or used to charge batteries that function as intermediaries to power specific appliances. People without direct access to electricity sometimes acquire a battery that they charge at the houses of people with a direct connection. One house in Madzedze charged multiple batteries at a time to generate the costs for the electricity used and as an additional source of income.

Picture 1. Neighbours sharing electricity through a fence. Madzedze. Zoe Elsner.

One house established solar energy technology during the time spent in the field. The process was initiated by acquiring information from other solar users. The network of the household was activated with emphasis on the search of a sizeable solar panel and related information, until a suitable connection was established with a fisherman from Mvuguti importing solar panels from Zambia. Their relationship was based on previous business, where the father of

the household without electricity access, Joseph, repaired batteries for the other. Before its instalment, the solar panel rested in the house for several days, as they were given the instruction to make sure the panel is not placed directly on then iron-roof but instead with some distance to it to ensure air circulation. Therefore, additional money had to be gained to afford the wooden construction (Interview 10), the construction was crafted in Monkey Bay, the nearest town. The instalment on the roof was done by Joseph with the help of his close friend. The two man used a self-made ladder to climb on the roof, fixated the construction and solar panel and put the connected cable through an already existing hole in the roof leading to the kitchen. The wires were then connected to an inverter and further to a battery inside the house and the battery to a screen and two small lamps.

Picture 2,3,4 & 5: Michael holding solar panel on the roof; Joseph moving the cables from the solar panel to the kitchen; Michael and Joseph on the roof with the solar panel; Michael and Joseph fixing cables from the solar panel on the roof. Madzedze. Zoe Elsner.

The man that sold the solar panels was from Mvuguti, a village entirely disconnected from the government grid, only accessible via boat. The village thus has the reputation of a solar village, as it is the only source of electricity found there. The house of the family that sold the solar

panel was situated in a hilly part of the village and had three solar panels displayed on the roof. The house was fully wired powering a variety of applications, such as a television running in the background during conversations. From the hill of their house, other houses with solar panels on the roof were visible. One of them had an array of cables hanging from the solar panel on the roof and pointed out problems with the inverter, limiting the electricity use. Another displayed two solar panels in front of the house and charged four batteries with them, stating that only some of them were their own and others were of customers and their daughter. Solar power arrived in the village an estimated three years ago in connection with the booming fishing industry, where the desire to fish during the night lead to increased deployment to power lights.

While large scale solar panels are not available in Monkey Bay town, small panels are sold at the market. These can power a small light or some radios. Monkey Bay town is also home of the Monkey Bay community hospital, where a solar mini-grid has been deployed by a multitude of international organisations including ICEIDA, US-Aid and UK-Aid. There are two mini-grids, one powers a water pump, to address the otherwise extensive disruptions in water supply, while the other powers the lighting in the maternity wing and a hospital data collection system. The clinic is constantly facing power shortages by the government supplied hydroelectric power and counteracts these with a diesel generator. However, this puts financial strain on the hospital, which is thus planning to expand its solar power for lighting other parts of the hospital (Interview 12). In Monkey Bay there is also a sub-regional office from ESCOM. The office manager pointed out severe infrastructural challenges and discrepancies of supply and demand of the hydroelectrical power. This was furthermore elaborated on by his superior the regional manager of the whole Mangochi area, including Monkey Bay. A short walk from the Monkey Bay town centre there is a beach lodge., which has a complex looking solar construction on the roof. The construction had been imported from Canada to cope with the constant energy shortages and to financially relief the business from the expensive diesel purchases for the generator. Furthermore, the lodge displayed several environmentally conscious projects such as the disinfecting and recycling of plastic bottles for customers. However, the solar panel on the roof was not functioning due to instalment issues (Interview 18).

Picture 6: Solar energy at the roof of Monkey Bay beach lodge.Monkey Bay. Zoe Elsner.

Another internationally sponsored mini-grid can be found in Nanquari, where a primary and a secondary school are situated. The secondary school faced high drop-out rates and high numbers of students failing exams and repeating classes. However, the headmaster managed to acquire first funding assistance for solar panels in 2004 from an American woman. In 2005 China-Aid sponsored two batteries and connected solar panels to power the office building. In 2009, the American woman sponsored a library including the lighting through solar. In 2019 UNICEF built a solar pump, including courses on how to repair and maintain it for the staff of the school. The originally too salty water forced students to bring water from home or stay without it throughout the school day, decreasing their capabilities. Another organisation assisting the school in the construction of buildings was ICEIDA and the Solomon Foundation, a Canadian NGO that invested in a "Girls hostel" housing female students, also equipped with electricity from the mini-grid. The school thus has two mini-grids for the different buildings and a solar-powered water pump each constituting of between eight and twelve large solar panels. According to the headmaster, there is a direct correlation between the dorm and the decrease in pregnancy-related dropouts which have dropped drastically since its deployment, thus he would like to eventually build a second dorm for the other two years of young women to further eradicate pregnancy-related dropouts. The solar energy and library deployment he strongly links to performance. The lectures take place in the mornings leaving the hot afternoons free and, in the evening, teachers continue to assist students studying in the lighted library. He pointed out that the nice setting of the library, also equipped with a beamer that is

sometimes used to show educational movies, encourages students to study during the evenings and spend time on site. This increases performance clearly visible by an increasing number of students now being awarded grade related scholarships for universities after their final examinations and a declining number of students repeating classes or failing exams. However, the school's batteries have stopped working recently and it is now looking for funding to replace them.

The primary school is located about fifteen minutes by foot from the secondary school, more central in the village. It has access to the solar pump installed by UNICEF through pipes, another pipe connection reaches the general village. UNICEF has also donated a battery and a projector to the primary school. In 2019 China-Aid has further sponsored solar equipment. The World Food Program (WFP) has furthermore sponsored nutritious food supplies for the school's food programme aimed at increasing participation (Interview 16).

In the village of Nagoma a large-scale farmer switched from a pump powered by a diesel generator to a solar pump with the assistance of ICEIDA. During the process, a second pipeline was constructed to power a village community garden, chiefly used for growing potatoes. Accordingly, the farmer's popularity in the village is high. He had previous experience with solar energy through his participation in a related seminar and was aiming to transition eventually. According to the farmer he has increased his revenue drastically since the implementation due to increased productivity, extended size of the field and the lack of additional energy-related costs as previously paid for diesel.

Balamanja, a neighbouring village of Madzedze, further has individual households using small scale solar panels. One house with a small and a medium-sized solar panel uses them for minimal applications such as lights and a radio (Interview 7). The other household only has a small solar panel to charge the phone, while another house has a big one in the inner yard additionally uses it for powering a screen. The devices were all acquired within the last five years and are still fully functioning.

The tourist centre of the region, Cape McClear, also has several solar projects one observed in the context of this thesis was a private clinic established in memory of a deceased Australian man, by his mother. The clinic and its education facility are powered by mini-grid systems displaying each between eight and fourteen large solar panels held up by a metal construction. A second metal construction seems to be designed to keep birds from sitting on top of them.


Picture 7 & 8: Solar micro-grid at clinic in Cape McClear from the side; Solar micro-grid at clinic in Cape McClear from the front. Cape McClear. Zoe Elsner.

6. ANALYSIS

At the time of this study, solar energy deployment had increased significantly in Monkey Bay (Interview 1). Several individual households and businesses had deployed it and even the local markets now displayed smaller version of solar panels. Nevertheless, many people desiring electrification were still primarily inquiring about the government's hydropower grid. While both options are sustainable in essence, households, businesses and government facilities connected to the grid often have to counter the regular power shortages by using diesel generators. This is not only environmentally degrading but also financially straining, making solar energy a tempting alternative. These technologies are part of a complex network shaping and reshaping itself and its participants. ANT in energy research can help to untangle this web of agents that all possess agency in the sense that they can make or stimulate change in other entities of the network (van der Waal et al., 2018).

6.1. MULTILEVEL ANALYSIS

Energy access and low carbon transition are key in any efforts towards sustainable development. Research at different scales can address the discrepancy between increasing energy access and climate change mitigation efforts. This can help to reach the goal of inclusive development in communities in Africa while using low carbon transition. Climate change drives the popularity of low carbon energy transitions as an integral part of sustainable development. The "Energy Trilemma" (Brown et al. 2018) introduced by the world energy council describes three dimensions: energy security, energy equity and reducing energy's GHG emissions. In order to address these through policy, one needs to recognize the

interconnectedness between public and private, government and regulators, economic and social factors, natural resources as well as the urgency of climate change (ibid.).

Furthermore, over-simplistically promoting North-South technology transfer can present itself problematic when local knowledge practices are not equally valued. Taking into consideration local capacities of learning and adapting to different techno-economic transformations promotes symmetry of knowledge from northern countries experts and local empirical knowledge (Brown et al., 2018, 5; Interview 8). By not dichotomizing structures and agents, humans and non-humans ANT allows the inclusion of people, institutions and non-human realm as a scope of analysis. Power and influence as not a priori given can be analysed within the ANT framework on the micro-level. ANT permits to address the socio-technical nature of energy projects as it focusses not only on human interaction but also the technical and material aspects.

Therefore, knowledge can be selectively recombined from different components in terms of interdisciplinarity in energy research or in the North-South dynamics. Renewable energy projects beneficiaries are "reflective observers of a complex, and challenging world, who prioritise time and resources in constrained circumstances" (Brown et al., 2018, 6). Projects aimed at off-grid energy solution contribution are well-advised to take organic kinds of technology governance practices into consideration and understand the relationships that affect their deployment, capacity and in impact (Byrne et al., 2012). Therefore, this multi-level analysis, building on ANT, puts a strong emphasis on the individual level, while drawing connections to the national and international level as relevant to the network. This way the interconnectedness of the topic can be shown and a broad network, centred around sustainable energy in Monkey Bay, uncovered.

6.1.1. INDIVIDUAL LEVEL

The technology, that is the equipment and installation of infrastructure, interacts with its users in a multitude of ways. They can be seen as "assemblages with possibilities for application not foreseen by their designers." (de Laet & Mol, 2000, 10; Brown et al., 2018, 6). There are several forms of sustainable energy technology found in Monkey Bay as discussed above, with emphasis on on-grid hydroelectric power and off-grid solar system both in micro and mini-grid form. On the individual level, the primary uptake was between government electricity and microgrids. The uptake, installation and maintenance of off-grid low carbon energy takes different forms, is context-specific, related to social drivers and incorporated skills. That is the knowledge about the possibility of these technologies coming from varying sources (Brown et

al., 2018). Knowledge from international sources in terms of individuals or organisations has effects on the deployment (Interview 6). However, primarily local knowledge and trial hubs in the form of individual families, businesses or public institutions that interact with off-grid energy sources were named as prominent sources of technology learning. “I see other houses, with solar on the roof or in front of the house” (Interview 3) says a villager about initial contact with solar. He continues by explaining conversations with the solar users about benefits, costs and origin as helpful in assessing the technology as a potential source of energy. The technology has the capacity for modification in line with domestic, productive, and aesthetic purposes (Brown et al., 2018). The success thereof influences the value people see in the technology to enhance their livelihood. *“People are linked to each other, the nature of those linkages, local norms, and power relations” (Brown et al., 2018).*

In ANT, people, in this statement, would be replaced by human or non-human actors, however, the essence remains applicable. Actants are linked to each other, to the nature of the relations, to the cultural norms and the changing power relations. This, however, does not mean that any human actor in the network views the value added by the non-human actant in the same way. Two opposing cases from Mvuguti, the remote village with no access to the grid, highlight this in terms of assigned value in relation to successful modification to the intended purpose of solar energy. One family with a solar panel displayed in front of their house charges batteries from other villagers.

Picture 9. Solar Panel displayed on construction. Mvuguti. Zoe Elsner.

That is an often-found source of income connected to electricity. A second solar panel pointed out as the family's daughter's, is charging too. They lay on a construct made of dry weed and wood, often also used for displaying fish. Their lives have been renegotiated after the new actor, in the form of the solar panel was introduced to their network. It led to additional income enabling the usage of additional technologies such as radios and lighting systems (Interview 4). Lighting also enables life after dark, where new activities can now take place. Within the household these can be related to useful activities, such as reading or learning (Interview 2), watching television or simply extended time spent time with others. The technology here takes the role of an active agent in terms of its ability to change other people. This is equally true for increased information access acquired by the actants using the technology access to applicants such as lighting, radio or television (Gupta, 2015). In turn, this can affect the technology as for instance information about climate change related to the use of solar technology can lead to the expansion of this energy source. "The television is showing climate change, how using biogas is bad, cutting trees is bad, so we want to use solar" (Interview 2). Furthermore, the increased information is spread across their network voluntarily and involuntarily influencing people's decision making in regard to energy choices. The network also plays a crucial role for business purposes related to the technology as they sell the electricity too, pointing family and acquaintances out as primary customers. Thus, the family points out the successful implementation of solar technology in applying it to their context. That includes the family relations, the construction usually used for displaying fish, powering screens, radios and lighting that enable a change in behaviour and information access and so forth.

However, this positive association with solar energy is contested by another village inhabitant. A few houses away lives a man with a set of cables hanging from the roof, connected to a solar panel. In contrast to other households, he experienced significant issues related to solar electricity. The issues were primarily with the battery, which needs costly repairs every year and the inverter breaking down unexpectedly. He states that he would prefer the village to be connected to the government electricity grid, as the solar energy is too unreliable: "You can't plan when it will break, and we are poor we don't have the money to fix it. With the government, you pay how much you have and get the energy you pay for" (interview 5).

Picture 10: Joseph and solar energy owner in front of his house. Mvuguti. Zoe Elsner.

The government electricity company ESCOM has no access to the village, which is only reachable by boat. Thus, the initial costs of connecting the village to the nearest grid would entail extensive instalment costs. The situation in the village where the grid is no option as of now is different to villages where there are houses connected to the grid, due to the lack of choice in Mvuguti. The man points down the road in the direction of the house discussed before stating that he now has to go there to charge his battery and his phone, while he waits until he has enough money to replace the inverter.

Mvuguti started using solar energy for commercial purposes in terms of lighting for fishing at night. Before solar reached the village, its inhabitants made the boat ride to charge their devices in Monkey Bay town. Considering that Mvuguti is not reachable for government electricity it is no surprise that other energy sources became apparent. The village is known for fishing as it is used to be a primary fishing location with an abundance of fish. However, this has changed in recent years and particularly during the rainy season fish is scarce. This has led the fishermen to become creative. Firstly, by travelling to locations with more fish during this season and secondly by increasingly fishing at night. The fishing at night requires light, and the lights

require energy in some form. This need for energy for fishing has been pointed out as the beginning of solar energy in the village. Only after the use of solar by fishermen where they implemented in houses. The transition from paraffin to solar was also pointed out in relation to the fishermen. These now can go fishing for 24 hours: "Solar either way, makes people here to be rich because they are using solar panels for business" (Interview 2).

Energy access has the potential for livelihood improvement, even though overly simplistic parallels should be avoided, several factors can be identified in what way the two can be connected (Brown et al. 2018, 2). On the local scale, low carbon energy innovation can play a significant role in livelihood options. Thus, on an individual level, small scale businesses can be created enabled through energy access. Whether government or solar electricity in the Monkey Bay area many individuals capitalize on energy access through small scale businesses. In its most basic form that can translate into transferring energy access from one's own house to other households by charging batteries as shown in these pictures.

Picture 11, 12 & 13: Michael connecting a battery to construction connected to governement electricity; Michael moving batteries; the construction connected to the government electricity. Madzedze. Zoe Elsner.

Here the government electricity network access is used to charge batteries from individuals in the village. Furthermore, local shops and individual people use government electricity as much as solar to charge phones for on average 100 MK (12 cents) per phone. However, there is higher potential in this field for solar energy, as the government electricity is subjected to long intervals of breaks. Thus, in this time supply and demand shifts to the benefit of people offering services through solar energy. Furthermore, there are more creative businesses created out of

energy access. These demand initiative and creativity in human technology interaction in the local context.

On the village level, shaving people's hair too can be used to create additional income. Joseph, who got sent two shavers from his sister in South-Africa started to shave family and acquaintances in exchange for a small amount of money, the moment electricity access was established. Another business was selling frozen juices. This includes an initial investment in a refrigerator or freezer where juices can be frozen and sold either at a nearby market or in a more informal context within the village. These aspects together can be considered as an actor-network or 'agencements'. The specific configuration of the physical forms involved, such as the solar panel, the battery, the wires, the refrigerator, the person that makes the juice, the person selling it and so forth, have a combined capacity. This capacity enables access to the market by selling the refrigerated juices. There are countless similar examples connected to the individual's ability to think creatively about the prevailing demands and create business opportunities from them.

In one case the electricity was preliminarily generated by illegally moving a cable from the neighbouring house that had government electricity access. This can be seen in the context of the high installation prices for government electricity. Electricity access can be applied for online or in their regional offices, with a calculation of expected instalment costs. These include the necessary connection polls, wires and work needed (Interview 4). Thus, the further away from the next house with electricity the higher the prices. These initial costs, and therefore difficulties, in accessing the on-grid power supply option have often been named as primary reasons for individual-level solar deployment (Interview 3; 15). However, it requires other factors than mere necessity, as was suggested in early thoughts of an anthropology of technology (Paffenberg, 1992). One factor is knowledge.

Knowledge both on what to make of electricity access but also on the technology itself also plays a fundamental role in the sustainable energy network in Monkey Bay. People without electricity access lack access to information. "*Maybe those people who have no money they just stay without knowing anything. The world can look that side, they can help us to preserve from climate change."* (Interview 2). Applications such as devices with access to the internet, lights for reading, radios and TVs give access to information also on climate change or preserving the environment. Thoughts and meaning are integrated into the design of solar energy such as its role as a low carbon alternative. Sustainable energy contributes to environmental protection with more than just its limited carbon footprint.

"On the TV there is a program that says we should not cut trees, because trees protect us and whatsoever. It protects from wind, protects from floods, shades, people can live because of shades, good life and whatsoever. So people say 'oh yes that is good'. So those messages are provided through solar energy" (Interview 2).

Thus, sharing of knowledge on climate change and sustainable energy presents itself among one's social network, enabled through access to energy. This example also draws a connection to how the assemblage of climate change or environmental protection discussion entails sustainable energy as an actant in Monkey Bay. Solar panels, the meaning and purpose inscribed in them, the technology that is powered by them, the information conveyed through them, assemble and reassemble to produce the reality that is perceived in the network. It is not just the panels themselves that circulate, but the attributes assigned to them and in this case also the assemblage of which it is a part of. Electricity is important to development, and its sustainability is important to preserve the environment (Interview 11). Madzedze's chief and her grandson explain that some years ago everything was full of trees while now there is rarely any. Growing a tree takes a long time and without them, there won't be any environment left for the next generation: "We are cutting trees without replacing, a few of us know things are going bad" (Interview 11). They further connect the crucial role trees play for managing water, particularly influencing the outcome of the fields, with energy used for cooking. With many people without electricity, using firewood or charcoal for cooking is by far the most common and the chief partially blames this phenomenon for the decrease of trees and suggest intensified solar use as a solution to make cooking more sustainable. Therefore, "electricity is important to preserve our nature, trees can remain, and rain comes in good amounts" (Interview 11).


Picture 14 & 15: Men selling firewood; Charcoal stove. Madzedze. Zoe Elsner

Another way in which energy influences knowledge is in regard to the weather. With solar energy knowledge on simple weather changes forecasted and broadcasted through connected devices, can be accessed. These now foreseeable changes in weather conditions are critical for instance for farming, and in the case of fisherman can prevent the loss of lives through storm warnings.

The other part on knowledge related to electricity is knowledge on the technology itself. People who learned how electricity works, transfer their knowledge, redesign technologies and interact with the actants in a transformative way. This is the case for Joseph. He was taught by an acquaintance who had himself been trained in a city, for a small amount of money, how to repair batteries (Interview 10). The network of energy in the village thus spans through knowledge transfers from the countryside to larger cities in the country through this learning process and within the actants in Monkey Bay. Batteries play a key role in rural electrification considering that many houses use them as primary storage for electricity or used during the times that the government electricity is turned off (Interview 8). Thus, the charging of batteries by solar panels can somewhat be seen as a black box (Bencherki, 2017). The actor-network seems simple and unitary in the sense of an expected outcome of the connection establishing a battery that now stores power created by the solar panel. Historically this relates to the transition away from paraffin, which used to be available at all the gas stations, and towards batteries. Whatever energy system people are using they usually use it to charge a battery and that battery then powers the applications (Interview 6). Thus, Joseph is part of the network of sustainable energy in Monkey Bay, transmitting knowledge and skill and the actual physical objects between nodes.

Furthermore, knowledge on solar energy supply and fixing problems connected to them on the small-scale can be transferred intergenerational and between genders. This is the case for a family in Mvuguti. The family regularly goes to Tanzania to buy solar panels that they then sell in the Monkey Bay area. Similarly, to Josephs first introduction to knowledge on the technology, the father of this family first learned about solar from a friend that had studied engineering and found it an area of business with high demand, particularly for areas without the option for government electricity, as is the case of his village Mvuguti. He learned from the engineer and then taught his daughter. Nowadays, he is focussed more on fishing and the import of solar panels while his daughter is responsible for repairing their own technology in case of problems with the solar energy. These reoccurring problems as she points out are primarily linked to the wiring or the inverter. Non-human actors such as the solar energy can outlast the humans that created it, both in the bigger sense of the inventor of the technology

passing, but also in the intergenerational sense of its deployment and use in one household. The application is handed from one generation to the next with the inscribed and incorporated knowledge, stabilizing a certain way of living within the household (Sayes, 2014). For batteries, however, the family does not have the necessary skills themselves but instead access their social network and employ Joseph to do repairs where problems occur. Joseph appropriates the knowledge he has on repairing batteries to his context. The necessary resources are often unavailable, so he finds alternative approaches. For instance, for making the negative poles he uses a bag whose previous purpose was to transport charcoal. He rips the bag apart and uses the plastic strips to bind the negatively poled mass around its metalcore. The positively poled plates lay out to dry, get inspected and if necessary fixed and are placed back in the battery box.

Picture 16, 17, 18 & 19: Joseph making positive poles for battery; untangling a ripped plastic bag; closing up the battery by melting the plastic; tools heating up in cooking stove. Madzedze. Zoe Elsner.

Tools are heated up in the cooking stove powered by charcoal and are used to melt metal parts and ultimately the plastic to close the battery up again. Furthermore, Joseph taught himself to fix specific solar batteries as they increased in uptake. The process of repairs described above can take several days and often he has company of friends or acquaintances while he does the work. However, the process often entails risks for him, as he is working without safety equipment, getting in contact with acid and toxic fumes. His hand is often showing open wounds which he got from working with acid.

Picture 20, 21 & 22: Joseph fixing batteries in company of people. Madzedze. Zoe Elsner.

Incorporated knowledge both in humans and non-humans is a central theme in ANT-theory and techno anthropology. Non-human actants are inscribed with the with meaning that unfolds and changes in interaction with its network (Gupta, 2015). Sustainable energy, predominantly solar energy as found on the individual level in rural Monkey Bay, entails agency incorporated through its designed purpose. This early incorporation predominantly happens in the Global North. However, it is appropriated to the context in several ways, for instance its placement varies greatly. Solar panels are predominantly displayed at the roofs of houses. However, this is limited to houses where the roofs are stable. Houses with straw roofs rarely display solar panels and if they do so, the solar panels are of a significantly smaller size than what can be found on other houses. A simplistic connection to stability cannot be drawn as other factors such as the relation between type of roof and income must be accounted for. Since access to larger solar panels and stable roofs usually corelate this is not surprising, but smaller panels can be found even in less advanced houses. Houses are often used by locals to determine its inhabitant's income level. With unburned bricks and straw roofs being the poorest and indicators such as the walls, material and type of the roof, access to the grid-electricity or satellite television, have all been mentioned indicators of assessing income of other villagers. Solar panels can be considered part of this assessment. The categories assigned by locals towards other people who own solar panels are, in line with ANT, not to be seen as 'a priori' given but instead results of associations, negotiated between heterogenous actors (Donovan et al., 2015).

The strategic positioning on the roof is suggested to be explained by its increased exposure to the sun, such as its display in in front of people's houses. The solar panels are appropriated to the purpose. In some cases, they are displayed in front of the house on specifically build tables made from straw for this purpose or with the tables being re-appropriated from other purposes such as displaying fish (Interview 4). The displaying in sight for outsiders is a way of voluntary or involuntary communication and identification within a network of actors. Through their display a central network of actors in direct interaction with solar energy can be identified, it can influence people's perception on the technology and affect people's decision making. This can lead to increased solar panel deployment and for the families themselves to increasing businesses through people bringing phones or batteries to be charged (Interview 3; 4; 7). Decisions on new technology adoption is influenced among others by observation of how other people they know use the technology (Brown et al., 2018, 6). The generation, transmission, distribution and consumption of energy is linked to social arrangements and influences political and social structures (Gupta, 2015). Thus, transformation procedurally occurs in non-human

and human actors and with that the network they are a part of (Latour, 2005). Humans incorporating knowledges on technology and apply it to their context.

The general interaction with other actors, whether human or nonhuman can take ritualistic forms as habits are established. As the intergenerational stabilization of a certain way of living in relations to the technology is established, with it there is the habits and rituals it connects too. That is for instance the display of solar on a table appropriated from the display of fish to the display of solar on a regular basis to reach the assumed outcome of a battery being charged by the solar panel, i.e. a black box. The ritualistic aspect of routinized action conveys meaning in the sense of revealing categories that organize the world. That includes the role of the individual participators in the interactions. These practices can enable a feeling of togetherness, belonging or sameness. Both within the family, that displays the solar panels in a particular way and in conversations with other solar users. This is conveyed amongst other through the knowledge of other actors with the same energy sources and practices or in othering people with different technologies or ways of usage (Interview 2).

The interaction between the actors in this network does not have to be based on physical interaction but can also be based on the way roles are defined and distributed and how others are mobilized or invented to play roles within the socio-technical network. As shown in the findings section the network of sustainable energy, more specifically solar energy shows a network of actants spread across the monkey bay regions. While some of them know each other physically, what connects them as a network is the system and their meanings (van der Waal et al., 2018). Emerging actor networks create roles for actants to engage with the new technology, such as the site, the roof that becomes solar carrying, generators, a young woman repairing upcoming issues with the technology with know-how gathered from her father, her father becoming a provider of resources by importing the technology from Zambia, the man at the market becoming a solar panel frame builder, the headmaster of the secondary school becoming an advocate, and so forth. Accordingly, actants change throughout the network in relation to the technology.

Social coordination of labour as addressed as part of socio-technological systems by Pfaffenberger (1992), greatly relates to social and cultural contexts. In this view the agents that build the system use existing resources to modify them to the context and system in place, as discussed above. While ANT neglects gender as a priory determinant, the roles of gender in relation to technology is negotiated in the network, with occurring changes. These relate to heterogenous factors in the network. In the case of solar energy implementation in Madzedze, the panel was primarily found and installed by the family father, who asked a male friend to

assist in installing it, bought it from a man and had a man craft the necessary wooden construction to fixate it on the roof. However, the money for the panel came from a friend of the family's mother. Furthermore, the village is primarily matrilineally organized meaning that the husband moves to the family of the wife. Thus, in this case they live in close proximity to the mother's family on the mother's family grounds. Therefore, she explains: "This house, is on my land, if we break up, he has to leave, it is my house. The solar is from my friends it is mine. Maybe if it was his friend, he can say I take it with me, but this one is mine" (Interview 10). The same relationship also includes violence in relation to technology. Communication technology, powered by heterogenous energy sources, enables contact with a social network outside the region. That is the case for Chims, who speaks English very well and is also part of a network to outside of Africa, which she occasionally can access for financial influxes. During a fight in regard to this network her husband destroyed the phone of the mother by throwing it on the ground. He thus assigned the technology the role of representation of the imbalance in social network between them which he was angry about. The implemented energy technology, furthermore, changes their roles as a financial contributor to the family, as she now contributed more than him. He, however, immediately became a small-scale barber as he uses the shavers sent by his sister from South Africa in connection to the energy for a more powerful assemblage translating to increased income. Thus, their roles both as individuals and in relation to their role in the family change due to the new technology.

Picture 23: Solar water pump house for farming. Nagoma. Zoe Elsner.

Businesses such as large-scale farmers and lodges in the Monkey bay still largely rely on diesel-fuelled generators or accept the sporicidal power outages of the government electricity supply (Interview 18; 13;). However, some business aim to change to solar energy. Technological choice as presented in Techno-Anthropology is not simply motivated by necessity as there is a multitude of available options, but more complex interactions between factors determine their uptake. Such as in the case of Makande, a local farmer, transitioning from a water pump powered by diesel towards a solar water pump.

Makande went to agriculture school where he first got in contact at a one-week solar workshop in 2004. The workshop revolved around a small solar pump used to water one hectare of farmland while the farmers' pump now waters ten hectares. *"Back then they were just developing [...] that is where we got interested, no diesel, how does it work, just from the sun! But it works, it's very good"* (Interview 13). This information stuck with the farmer, even though he did at first investment in a diesel generator. *"Even though I bought a diesel one, I was still thinking of the solar pump, so when the opportunity came with this man saying I can help you with the pump, I said oh my God that's what I was looking for."* (Interview 13). The man that assisted in acquiring the solar pump that now holds fourteen solar panels was a friend from Iceland. They came and asked how they could help and Makande asked for a solar pump. The machine pump is German-made and a company from Blantyre called 'blue zone' taught the farmer how to maintain the technology. However, as he points out there is not much maintenance needed. The solar panel was installed in 2015 and no major problems had appeared subsequently. Much less problems than previously experiences with the diesel generator. The main motivations actively pointed out for making the transition to solar energy were financial and easy maintenance. *"I was spending a lot of money on diesel. [...] I tell you to maintain that engine it is not easy you know, blockages and so on, but since we put the solar pump its only maintaining the pipes that we use anyway."* (Interview 13). The instalment thus amongst others relates to impressions made early on, with the showing of a small solar pump in agriculture school, an international actor offering assistance on finance and information on the technology, problems experiences with the previous technology such as maintenance troubles and finances and benefits in the same areas expected from the new technology. Makande states: *"There is no magic, you need just the sun." (Interview 13).*




Picture 24, 25, 26 & 27: Makande shows water pipe; Makande shows eggplant produced at his farm; no longer used diesel generator; Solar water pump. Nagoma. Zoe Elsner.

Community benefits also play a role in this as he built pipes from his pump to the village were a community garden was established, that provides fruits and vegetables for the people living around it. Thus, according to the village chief the popularity of the farmer in the community is high, as he shares some of his privileges with the community. In the ANT, this shows a complex network of actants, that are the source of action in others. In the instalment phase several actants provoked action in the farmer to install a solar pump that is the diesel generator, the Icelandic friends and so forth. The installed solar pump provokes further action by the farmer and the community for instance by growing crops in new areas or new connections between humans. There is now a network of connections established throughout the transition, that goes beyond the community level to the national and international level, both of which I will discuss in turn to complement the analysis of the individual level.

6.1.2. NATIONAL LEVEL

The national level connects to the local level in multiple ways. Policies and regulations decided on a national level influence the local context as for instance regulations for Independent Power Producers (IPPs). Regulations regarding them concern energy projects outsources to international companies that then build their energy technology on a local level and sell the energy to the national energy company ESCOM. Their purpose is to complement energy produced by the Malawian company Egenco, so that the rising energy demand can be met. However, as far as local managers are concerned this is still in the planning phase (Interview 14). Two such projects were encountered in conversations however neither of them was already established. One was an online promoted floating solar island in Monkey Bay and the other a solar farm established by a Chinese businessman (Interview 18). The delay in application of these problems was linked to inefficient institutions. Weak institutions and unrestricted trade openness can furthermore increase environmental degradation, for instance with environmental dumping. Institutional quality can help with the adoption of clean technologies alongside the rise in incomes. This is especially important as there is a link between income and pollution that can be answered with policy responses. Increasing income also leads to a rise popular demand in energy (Oluwabunmi, 2018). This is central for ESCOM the state own energy company in Malawi, they increase their electricity supply network in line with individual demand as people can apply for the inclusion of their houses individually, holding the construction costs themselves (Interview 1). The Malawi government's agenda is clearly set in the expansion of the grid, however the high discrepancy between supply and demand, i.e. the lack of sufficient electricity produced in Malawi makes quality of electricity an even more important problem. Quality of electricity here mainly refers to its reliability but also to its ability to maintain a strict current as too high amounts of fluctuations can ruin appliances and negatively affect the use of electrical utilities (Gupta, 2015). Malawians identify this as a central hinderance for development. "The economy runs on energy, I have seen fuel running out for a day or two and the whole country was standing still, 2012, people were sleeping at the fuelling stations, it is the same way with electricity. We don't have enough electricity. It means the industry can't run. The successful countries all have robust energy systems." (Interview 14). Concretely, he compares the 220 Megawatts Malawi officially produces – which he points out does not mirror the much lesser amount they actually put out – to the Giga watts other countries produce. Thus, he emphasises that energy access is central for development as it can lead to powerful 'agencements' leading to development of the nation as a whole. Energy technology can take the role of a mediating entity as it makes other people

act. In this case it could enable an increase in industry and development of the country (Interview 14; 17; 19).

The service sector often entails increased CO2 emissions in developing countries due to the use of self-power generators run with fossil fuels used to cope with the otherwise erratic power supply (Oluwabunmi, 2018, 322). The unreliability of government electricity is a problem for this sector in Malawi, load-shedding, unplanned power outs or a general lack of access to government electricity supply make alternatives desirable. Hospitals, for instance, highly depend on stable electricity availability for numerous purposes such as cooling medication. One clinic in Monkey Bay has deployed multiple energy sources in an attempt to compensate for limited government supply. The public hospital relies primarily on government electricity for powering the main parts of the hospital and a diesel generator for covering essential needs during the common power outages. In 2015 they have additionally installed a mini grid of 10 solar panels that now powers lighting in the administrative building and the maternity ward (Interview 12).

Picture 28: Maternity wing, Monkey Bay Hospital. Monkey Bay. Zoe Elsner.

The hospital, furthermore, faced water shortages, particularly during the dry seasons. To address this issue, they installed a water pump powered with solar energy. This enables adequate treatment of the patients in terms of water availability. The varying energy technologies are not merely intermediaries, acting as placeholders for other energy technologies but mediators who add to the chain of interactions for instance in the sense that

they have different environmental impacts, spark different associations such as the provoke varying actions through their maintenance, modify the electricity usage of the hospital and so forth. The varying technologies applied in this clinic present a network of actants that make each other act, if the government electricity fails to work the diesel generator is turned on. If the diesel prices increase solar energy is redirected to other areas. Human actors participate in this network, their actions and perceptions change in line with the changes in energy source used. This example shows very well how objects cannot be seen as a natural order but instead make its actors complicit with the world. One actant acts it is in interaction with others, such as the change in energy used (Oppenheim, 2007). This is also the case when international organisations deploy sustainable energy sources in the local context. This example also shows the interconnectedness of the different levels, as the individual, national and international level cannot be analysed isolated from each other.

Intra-national networks span from the rural areas in Monkey Bay to nearby towns to the big cities of Malawi. These can take the form of exchange of goods or people, such as the acquiring of materials for energy implementation or businesses moving their locality to areas with more energy availability or better infrastructures. The networks can also take the form of an official and organized system such as the ADC, which is a traditional African authority with members from every village in the Mangochi area. They work autonomously, however, convening with the village headmen (chiefs). That includes group village headmen, holding the position for more than one village, while the villages still hold individual chiefs whom the group village headmen are the superiors to. The area of Mangochi has 31 village headmen, which despite the name, can be both male and female. They convene once a month with occasional additional meetings and function as spokespeople for their community in the meetings and for the ADC in their villages. Information on what other villages are doing can thus be translated in this way from one village to another creating equivalent actor networks. Networks including sustainable energy in one area can thus be translated to make the actor-network equivalent in other areas. Whenever problems occur or projects want to be established that relate to the community's development, they are discussed in these meetings led by Fosco the ADC chairperson. Organizations realize specific projects or hold seminars. One such seminar was held in 2015 on the subject of climate change, which Fosco describes as follows:

> *They taught us what the world is doing to avoid climate change. They told us that in other countries, developed countries, they have got big factories. Big factories*

produce more smoke, that smoke makes a certain layer there, so that layer broke the light, the sun, so those things make here some problems in terms of our health or even how rain comes. So, we learn those things so what we are doing, those organizations from outside, those developed countries have brought funding, money here in Africa, Malawi, to us to plant more trees. So that those trees can absorb, those things in atmosphere instead of their countries, because in their countries there is not enough place to plant trees, because many areas they have got factories. (Interview 6).

These financial transfers aimed at reforestations are increasingly common between developed countries and developing countries, with Clean Development Mechanisms (CDMs) and carbon trading systems on the forefront. These often relate to forest management which in turn is linked to the role of wood and charcoal as energy sources.

When we were trying to make Monkey Bay as a town we applied for many things there, a new market, a depot maizemeal whatsoever on top of that there is a component of planting trees, so, when people planted trees they were receiving some money from the government, that gov was funded by other countries. (Interview 6).

While he could not specify who and under what framework these exchanges happened, the mentioning of such transfers shows how far and on how many levels networks on climate change can span. While it would exceed the scope of this thesis to go into depth on these mechanisms and the networks around them, it could be a fruitful area for further research.

6.1.3. INTERNATIONAL LEVEL

Within the framework of climate equity and justice, dominant in the literature, the focus often lies on North-South relations. However, multilevel governance structures are now increasingly used to involve developing countries and the local communities in more integrated multilevel relation (Mathur et al., 2014, 42). These relations make the complexity of relations between the different actors in the network, apparent. Research on electricity, by international agencies, often aims at introducing technologies that can increase electrification at a large-scale and low cost, while lowering carbon emissions. Thus, electricity access as a measurable goal remains central for multinational organisations. The quantity of delivered equipment and the number of

new connections made to the electricity-network present the focus of interest. However, other areas such as quality of energy, community involvement, off-grid solutions remain underrepresented. Furthermore, the implications of electricity access upon matters of livelihood opportunities, quality of life or social divisions lack sufficient research (Brown et al., 2018, 4). Looking at networks with sustainable energy as the focal point can help address these aspects and their relationship by taking a more holistic approach. ANT then allows questioning without previously determined categories or judgements. Thus, it endorses questions on the impact of interventions on the different levels of the network and for the different actors involved. This questioning is central as Rist (2008) points out: *"How dare one think, at the same time, that the cure might worsen the ill which one wishes to combat?" (Rist, 2008, 1).* In this statement, he critically addresses the arrogance of not reflecting on potential negative effects of interventions by international actors. Technology and development research show a multitude of errors in deployment such as inappropriate equipment, inputs and infrastructures. Interventions, on different levels such as the government, energy companies, NGOs or in international policies often lack understanding of the context and extended network of which the technology becomes a part of. That includes its end-users which results in top-down engineered solutions that lose connection to the actual local needs, preferences and aspirations. "An ANT approach to development would be concerned with tracing the activity by which locals become included in an intervention, trusting in their agency and right to be convinced that becoming enrolled in 'development' is in their interest." (Donovan et al., 2015). In the case of the farmer in Nagoma, discussed above a central aspect influencing the success of the project was his own initiative to ask for assistance with establishing a solar pump. Similarly, the success of solar energy in the schools in Nanquari relates to the ability to appropriate the technology successfully to the purpose. For instance, the pump put in place for drinking water supply in the primary school by international actors in collaboration with the headmasters, is now used for personal hygiene of the students, or for cooling in the heat. Furthermore, a Chinese-installed beamer with educational purposes in the same primary school, is used for both education and leisure. Thus, it is used to show documentaries and English videos, but it also shows entertainment movies for the staff (Interview 12). The nearby secondary school with the headmaster actively engaging international actor in assisting the schools needs similarly appropriated the technology to fit the context. Furthermore, the 'agencement' or actor-network of actors such as the solar technology, the headmaster, the library books and so forth, establish a combined capacity to act. This shows itself in increasing numbers of students from this school that attend university after their final exams. The

headmaster can give a detailed account on how technology introduced influenced specific benefits experienced by the students. Such as the introduction of a dorm for girls, sponsored by an American private person, decreasing yearly dropouts of girls due to pregnancy, or the instalment of solar panels and lighting in the library, increasing time spent in the library and the passing grade of students. Thus, he points out the specific capacity of the 'agencement' to act as catalysers for development.

Sometimes the effects of an actant or 'agencement' on its network cannot be determined right away. A British owned private clinic in the Cape McClear, for instance, is almost exclusively powered by solar energy. Through its establishment of electricity, it can provide better health services, for instance by cooling equipment for medications or lighting. However, there are indirect effects that are easily overlooked. For instance, getting fast and easy access to medicine that can now be stored in the clinic due to its reliable energy access. This affects faster treatments after a snakebite or getting fast assistance when going into labour (Winther, 2015, 162). These effects influence people's actions, for instance turning to this clinic instead of the farther away hospitals, making them active agents in the network. Furthermore, the internationally founded clinic, deploying imported solar panels in a local village shows how far these networks span. The network reaches from the design from the solar panels over its materials and import to the local effects. It stretches from its international origins over national contexts to the local level, with each level being a network of humans and technology that is made and remade with reducing and multiplying actors and intermediaries and mediators.
Furthermore, the international level is often linked to translation as the views of locals are translated by spokespeople from the Global North, who are becoming the face of the network. Much like translation in general, this is often problematic as an actant or black-boxed actor-network that is, for instance, an institution acts as the face or voice for a whole actor-network. This act of translating thus becomes a performance of established relationships. This entails certain power relations as certain entities control others and the narrative about them as a result of this performance.
Thus, projects manifest themselves on the local level and an analysis based on the local networks must acknowledge the relation to national and international actants to the local context. That entails an understanding of the multiple levels on which these systems manifest themselves. In the same vein the international level is discussed here in its relationality to the local level through its visible impact in the field. Interventions, from any international actor, are visibly appropriated to the local context or fail to stand the test of time. International

organisations implementing sustainable energy systems in Monkey Bay should be aware that they and the technology they deploy, directly participate in a network. Even if the organisation leaves nothing but technology and knowledge behind, as for instance in the villages Nanquari or Nagoma, the energy remains as an active participant in the network

7. CONCLUSION

This paper has analyzed the deployment of sustainable energy in Monkey Bay, Malawi, by drawing on Actor Network Theory. It has made apparent the shaping and reshaping of actants in the network. Through investigating energy technology and its role in this network it has shown complex cases of interconnectedness, considered driving forces of energy transitions and contributed to research in the field of Techno-Anthropology by working towards understanding sustainable energy technology better. This paper revolved around the question of how sustainable energy technology manifests itself in networks in Monkey Bay, Malawi. The collected materials through fieldwork, participant observation and interviews show a number of ways in which sustainable energy presents an active agent in networks, in that it has the ability to make other actants act in a certain way. That is shown in several examples on the different levels, from the private solar panel owner over the national public hospitals mini-grid to international projects. Sustainable energy technology changes other actants in the network's behaviours and with it the network itself. 'Agencements' form and create new, more powerful actor-networks influencing abilities and actions of its members. The analyzed material shows how energy technologies and the appliances they power, assemble and reassemble and are more or less successfully appropriated to the context, changing the actants involved. They shape the perceived reality and are themselves actors of other overarching assemblages. Their role in these assemblages of the wider context or for instance in climate change is not without translation or spokespeople who act as voices or faces of the network. In part this thesis can be considered such a form of translation. While the focus remains the local perspective, the national and international level show how far the networks of sustainable energy span and how they interlink. While this thesis took an overarching perspective, further research could go into specific aspects of sustainable energy networks, such as its role for carbon trading schemes as suggested above or with an in-depth focus on micro- mini- grid systems. Building on empirical data, it has shown sustainable energy as an active agent in the formation of actor-networks, which displays the many possibilities of sustainable energy.

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9. APPENDIX - LIST OF INTERVIEWS

Interview 1 I-1-J Jay Monkey Bay resident Monkey Bay 5.2.2020 §00:19:57	**Interview 2** I-2-F-L Fosco, Loraine and daughter Private solar owner Mvuguti 7.2.2020 §00:35:47	**Interview 3** I-3-F-D Fosco M. and D.M. Private solar owner Mvuguti 7.2.2020 §00:10:33
Interview 4 I-4-F-D Fosco M. and D.M. Private solar owner Mvuguti 7.2.2020 §00:18:32	**Interview 5** I-5-F-M-W Fosco M. and M and W Private solar owner Mvuguti 7.2.2020 §00:18:32	**Interview 6** I-6-F Fosco M. ADC chairman Balamanja 8.2.2020 §00:46:20
Interview 7 I-7-F-B Fosco M. and Ben, M. Private solar owner Balamanja 8.2.2020 §00:26:12	**Interview 8** I-8-F Fosco M. ADC Chairman Madzedze 12.2.2020 §00:12:03	**Interview 9** I-9-ADC Secretary to ADC chairman Monkey Bay 13.2.2020 §00:11:22
Interview 10 I-10-C-J-S Chims, Joseph and Stephano Private electricity owners Madzedze 14.2.2020 §00:30:13	**Interview 11** I-11-C Chief Madzedze, and Son Village chief of Madzedze Madzedze 16.2.2020 §00:41:06	**Interview 12** I-12-H Head of administration Monkey Bay Hospital Monkey Bay 17.2.2020 §00:23:17
Interview 13 I-M Makande Farmer Nagoma 17.2.2020 §00:34:33	**Interview 14** I-14-L Lucian Escom Mangochi Nkudzi Bay 18.2.2020 §00:35:49	**Interview 15** I-15-S Secondary school headmaster Nanquari 20.2.2020 §00:49:29
Interview 16 I-16-P Primary school headmaster Nanquari 20.2.2020 §00:14:11	**Interview 17** I-17-C C-Jay Businessman Madzedze 23.2.2020 §00:37:02	**Interview 18** I-18-H Howard Lodge owner Monkey Bay 24.2.2020 §00:18:48
Interview 19 I-19-S Escom security guard Zomba 2.3.2020 §00:08:15		