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Smart Grids? Intersectional Discursive Analyses on Gender and Sustainable Renewable Energy Development in East Africa

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by

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Table of Contents

List of tables	iv
List of acronyms.....	v
Abstract	1
1 Introduction	2
1.1 Statement of the Research Problem.....	5
1.2 Research Objectives and Questions.....	6
1.3 Justification of the Study	6
1.4 Conceptual Framework	8
1.4.1 Sustainability/ Sustainable Development	9
1.4.2 Gender and Masculinity/Femininity	10
1.4.3 Intersectionality	14
1.5 The Outline of the Thesis	15
2 Review of Literature on Discourses of Sustainable Renewable Energy, Gender Sensitivity and Sustainability	18
2.1 Sustainable Renewable Energy for Sustainable Development.....	19
2.2 Smart Mini-Grids: Meaning and Contribution to the Advancement of Sustainable Renewable Energy Solutions	26
2.2.1 Optimising Mini-grids Capacity through Hybrid Technologies	28
2.2.2 Using Smart Grid Communication Technology to Enhance the Sustainability of Renewable Energy Mini-grids.....	31
2.2.3 Role of (Smart) Mini-Grids in Facilitating Sustainable Energy Access	33
2.2.4 Constraints to the Deployment of Renewable Energy Systems.....	35
2.3 The Case for Integrating Gender and Other Social Perspectives in Renewable Energy	40
2.4 Applying Gender Analysis in Renewable Energy Planning.....	46
2.5 Dynamics of Women's Participation in Sustainable Renewable Energy: Constraints and Opportunities	51
2.6 Discourses on Energy Access, Labourforce participation and Women's Empowerment.....	56
2.7 Identifying Gender-Based Conflicts in Renewable Energy	60
2.8 Gendered Education as a Constraint to Women's Participation in Renewable Energy and Other Technology-based Fields.....	64
2.9 The Influence of Gender Discourses in Educational and Occupational Pathways in the Technology-related Fields	69
2.10 Conclusion and Gaps.....	71
3 Research Methodology and Methods	75
3.1 Discourse Analysis: Meaning and Application	75
3.1.1 The Foucaultian Discourse Analysis	78
3.1.2 Foucaultian Discourse and Gender Research	81

3.1.3	Application of Discourse Analysis in this Study	84
3.2	Data Collection and Research Participants.....	85
3.3	Research Questions and Information Sources	91
3.4	Data Processing and Analysis	96
3.5	Limitations and Challenges Encountered.....	100
3.6	Ethical Issues, Situated Knowledge and Reflexivity.....	101
4	Women's Participation in Renewable Energy Project Processes: Discourses on Opportunities and Impediments	104
4.1	Level and Scope of Women's Participation in the Mini-Grid Processes	104
4.2	Discourses that Women are More Dynamic, Authentic and Committed at Work.	109
4.3	Negotiating Benefits from Mini-Grid Electrification by Women: Labour Force Participation	112
4.4	Discursive Impediments to Women's Participation in Mini-grid Value Chains.....	116
4.4.1	Discourses on Inimical Stereotypes and Perceptions.....	116
4.4.2	Discourse, Socialisation and Gender Division of Labour and Roles	121
4.4.3	Discourses on Sextyping and Body Politics	123
4.4.4	Power Relations, Intrahousehold Negotiations and Religious Discourses	125
4.5	Discourses on Gender-Based Conflicts in the Mini-Grid Processes	128
4.5.1	Discourses on Gender Conflicts Emanating from Energy Deficiencies	129
4.5.2	Gendered Conflicts Linked to a Clash between Energy /Electricity Access and Local Gender Roles/Discourses	131
4.5.3	Gendered Conflicts Lessened by Electrification of Communities.....	136
4.6	Breaking the Glass ceiling? Discourses on Solar Mamas and the Barefoot College	137
4.7	Chapter Summary	140
5	Discursive Analyses on Gender and Education for Sustainable Renewable Energy Development	142
5.1	The Structure of Uganda's Education Sector	142
5.2	Discourses and Stereotypes in Education and their Implications for Energy-Related Career Choices	147
5.2.1	Discourses on Allure, Decency, Marriage and Subject/Course Choice	151
5.2.2	The Politics and Discourses of Beauty and Options for and Against STEM	154
5.2.3	STEM Subjects (discursively) Deemed to be Complex, Abstract and Boring for Females ...	157
5.2.4	Teachers' Character and Teaching Methods that Reinforce the Gendered Discourses ..	160
5.2.5	Teachers' Prejudice, Biased Guidance and Biased Examples in Teaching	163
5.3	Discourse-engendered Experiences and Challenges for Females in STEM.....	164
5.3.1	Disruptive Effect of Marginal Numbers of Females Amidst 'Crowds' of Males.....	164
5.3.2	Friction with Parents as Girls are Branded Defiant Rebels	165
5.3.3	Access Restrictions During Internship.....	166
5.3.4	Discourses that Technical/Vocational Courses are for Academic Failures	167

5.3.5	Even Males in ‘Feminine’ Courses Suffer Backlash	168
5.4	Not all is Gloom for Female Participants in Technical Courses.	169
5.4.1	An Increasing Number and Excellence of Females in STEM Courses and Careers.....	169
5.4.2	Special Consideration for Internship and Job Opportunities	171
5.5	Gendered Discourses in Textbooks and Curriculum and (probable) Implications.....	173
5.5.1	Mapping Discourses: Textbook Analysis Matrix	175
5.5.2	The Feminisation of Characters, Roles, Trades and Professions	182
5.5.3	Gendering Roles- Masculinisation of Tasks and Professions	184
5.5.4	Characterisation of Men and Women with Traits that Imitate Popular Discourse	188
5.6	Interventions to Mitigate Gender Differences in the Education Sector.....	191
5.6.1	Continuous Professional Development for Teachers and Mobilisation of Parents for Mindset Change.....	191
5.6.2	Gender-sensitive Language Use in Teaching.....	193
5.6.3	Special Incentives and Affirmative Action.....	194
5.7	Chapter Summary	197
6	Discussion, Conclusions and Recommendations	198
6.1	Recapping the Study Aims and Conclusions.....	198
6.2	An Intersectional Reflection.....	205
6.3	Walking Backwards into the Future? Enhancing Gender Justice in Renewable Energy	207
6.3.1	Gender Analysis and a Gender Mainstreamed/sensitive Approach to Renewable Energy Planning and Delivery	208
6.3.2	Participatory and Conflict-sensitive Approach to Mini-grid Project Implementation....	213
6.3.3	Promote Gender Justice in Education Delivery and Training.....	214
6.3.4	Address Gender Discourses and Biased Content in the Textbooks	216
6.3.5	Promote an Interdisciplinary and Context-responsive Mini-Grid Project Planning and Implementation.....	217
6.4	Contribution to the Academic Fields of Gender, Renewable Energy and Sustainable Development	218
6.5	Directions for Future Research.....	220
6.6	Final Remarks.....	222
	References	224
	Appendix: Participants Consent Statement	296

Table of Figures

Figure 1: Factors driving the adoption of renewable energy sources.....	20
Figure 2: Major renewable energy sources and corresponding functions	22
Figure 3: Multidimensional and intersectional features of sustainable development.....	23
Figure 4: Illustration of a hybrid mini-grid combining solar, wind, hydro & diesel sources	30
Figure 5: Smart grid interactive infrastructure	32
Figure 7: Conceptual framework for the impact of productive use of energy on gender relations	59
Figure 8: Distribution of female students' enrollment in higher education by study field- world average	67
Figure 9: Illustration of the interactive desktop platform for f4analyse software	97
Figure 10: Analytical framework for Barefoot College training approach and outcomes for women	139

List of tables

Table 1: Research Participants and Corresponding Methods.....	91
Table 2: Research Questions, Data Sources and Methods.....	94

List of acronyms

ADB:	Asian Development Bank
AMI:	Advanced Metering Infrastructure
ARE:	Alliance for Rural Electrification
BESS:	Battery Energy Storage Systems
CE:	Consumer Efficiency
DESD:	(UN) Decade for Education for Sustainable Development
DR:	Demand Response
ENERGIA:	International Network on Gender and Sustainable Energy
ESMAP:	Energy Sector Management Assistance Programme
FGD:	Focus Group Discussion
GW:	Gigawatts
HESA:	Higher Education Statistics Agency
IEA:	International Energy Agency
ILO:	International Labour Organisation
IPCC:	Intergovernmental Panel on Climate Change
IRENA:	International Renewable Energy Agency
IT:	Information Technology
NDP:	National Development Plan
NETL:	National Energy Technology Laboratory
NIST:	National Institute of Standards and Technology
ODA:	Official Development Assistance
OECD:	Organisation for Economic Cooperation and Development

PUE:	Productive Use of Energy
SAFE:	Safe Access to Fuel and Energy
SDGs:	Sustainable Development Goals
SMSS:	Super Conducting Magnetic Systems
STEM:	Science, Technology, Engineering, and Mathematics
UBTEB:	Uganda Business and Technical Examinations Board
UIS:	UNESCO Institute of Statistics
UNDP:	United Nations Development Programme
UNEB:	Uganda National Examinations Board
UNEP:	United Nations Environment Programme
UNICEF:	United Nations Children's Emergency Fund
UNIDO:	United Nations Industrial Development Organisation
WCED:	World Commission on Environmen

Abstract

Popular discourse touts gender equity as critical for the sustainability of renewable energies and sustainable development in general. Indeed, access to renewable, clean energy, gender justice, and quality education are interlinked necessities for the attainment of the sustainable development agenda and transformation of society as envisioned by the Sustainable Development Agenda 2030 under goals seven, five and four, respectively. This study therefore analyses the discourses that underscore the interplay between gender equity and the sustainability of renewable energy minigrids, examining their role in addressing energy gaps in energy deficient rural communities of East Africa.

It critiques conventional approach to renewable energy project implementation for focusing narrowly on technical and economic metrics while neglecting social and gender contexts. This oversight exacerbates gender disparities in energy access particularly in Africa, where societal discourse and practice depict energy careers as an exclusive field for males. Entrenched gender biases in education further restrict women's participation in energy-related professions, as STEM subjects are discursively deemed unsuitable for females. Despite these biases, however, there is evidence that the number of females participating in renewable energy projects and STEM careers is on the increase.

Situated on the epistemological assumption that 'reality' is socially constructed based on society's experiences and reflected within the individual or group's discourses this study deployed discourse analysis together with the conceptions of gender, masculinity, femininity, intersectionality and sustainability to examine the influence of gendered discourses and discursive practices on the sustainability of renewable energy projects in East Africa with the principal goal of identifying the gender gaps in the energy and training sector whose fixing would enhance gender justice and contribute to the sustainability of the renewable energy mini-grids.

Data from interviews, focus groups, and observations reveal that while women are increasingly involved in technical roles and energy enterprises, they face backlash and conflicts when their economic activities interfere with traditional domestic responsibilities. Persistent societal beliefs label energy work as masculine and discourage women from STEM careers. The study recommends a gender sensitive, participatory, context specific, multi-stakeholder approach to renewable energy programming that integrates technical, economic, and social dimensions. It emphasizes addressing gendered discourses and power dynamics to foster gender justice, enhance the sustainability of renewable energy projects, and contribute to broader sustainable development goals.

Keywords: Sustainable renewable energy, Gender, Discourses, Gendered education, Sustainable Development

1 Introduction

The current discourses on sustainable development tout renewable, clean energy and gender equality as essential requirements for sustainable development¹ and poverty reduction, as envisioned by the Sustainable Development Agenda 2030 (Korkovelos et al., 2020. 1-29; UNIDO & UN Women, 2015: 1). The same discourse adds that gender equity, women's engagement and collective action (Sustainable Development Goal 5) contribute a critical role to finding and nurturing more robust and sustainable pathways to manage natural resources more equitably and sustainably (sustainable development goal 15), tackle world challenges like climate change (Sustainable development goal 13) and promotion of clean, healthy and secure energy services (Sustainable Development Goal 7) (UN Women & UNDP-UNEP, 2015: 1). Accordingly, acquiring a deeper and more scientific understanding of the energy-gender linkage is essential to achieving these interrelated objectives (World Bank, 2018. 1-3).

Dominant discourses tend to create power relations (Rozzaq & Ratnadewi, 2016: 9), and since powerful bodies from the West dominate development discourse and its associated prescriptions, then donor-recipient economies, especially in the South are compelled to adopt the said prescriptions as they strive to move to middle or 'developed' economies. According to this discourse, developing countries need an increased energy supply to power their development initiatives. Renewable energy, particularly micro and mini-grids, will play a more significant role since a larger percentage of the population stays in remote rural areas that are not easy to connect to the main national power grids. Failure to access national grid power is partly associated with the sparse distribution of the households, making it costly to connect to the main grids (ARE, 2014a: 4). Consequently, renewable energy solutions, particularly in the form of mini-grids have been applauded by several sources (e.g. ARE, 2011:1ff; ARE, 2014:1; Baruah, 2017: 18-29; Dutta et al., 2017:1; Khamati-njenga & Clancy, 2022: 11) as being handy in providing sustainable solutions to energy supply gaps in the hard-to-reach remote communities, especially when these mini-grids are made "smart". By smart, we mean when these grids are fitted with modern communication technology software and apparatus that

¹ In this context, I refer to sustainable development as the transformational development that caters for the long-term human, social, environmental and economic stability of individuals and communities without compromising the development of future generations. This kind of approach ensures greater social equality and justice of current (intragenerational) and future (intergenerational) generations (Brundtland , 1987. 41; Mininni, 2020: 9).

makes it easier for communication between the energy supply side and consumer sides of the system, which reportedly makes them more convenient to use (Details on the meaning of mini-grids and their associated smart technologies are explained further in chapter 2.3). The claimed advantages of these smart mini-grids would, in addition to other benefits, help to promote gender justice, primarily through easing women's productive and reproductive work and increasing labour force participation.

However, as results and discussions in chapters four and five reveal, despite the several benefits, how these grids are implemented, their reported performance, the costs, the levels of participation by all genders, and other factors reveal some contentious questions as to whether these grids provide an ideal sustainable solution to energy gaps and related gender justice issues.

Indeed, discourse has it that for these grids to provide adequate and sustainable development solutions to communities where they are installed, gender (and other social-cultural issues) is a necessary issue to be integrated and given due attention in much the same way as the technical and economic factors (Aguele & Agwagah, 2017: 121). The implications of the broader use of renewable energy sources for gender have not been adequately examined, although some minimal attempts have been made to document women's roles and interests in energy use. In addition, experience in other sectors and anecdotal evidence from the energy sector suggest that women and men have an essential role in sustainable energy development, which needs further examination and harnessing (Cecelski, 2000: 16).

In the case of women's participation, common discourses claim that women are not inherently technologists and that even with appropriate support regimes, they are incapable and not worthy of getting involved in building, operating or maintaining sophisticated technologies like renewable energy grids. Such beliefs have permeated many societies, leading to less participation of women in technological areas like enrolment in electrical engineering courses at University (Aguele & Agwagah, 2017: 121-126). Yet, enrolment in such courses would increase opportunities for females to enter the energy industry.

While many discursive roadblocks to women's involvement in technology do exist, women's enormous potential in technology and related fields has been overly disregarded by scholars and practitioners. But scholars like Cecelski (2004) contend that women have for long been innovative and sophisticated, and a study to generate empirical evidence supporting women's innovations and abilities is an essential source of knowledge for improving and sustaining

renewable energy projects in addition to mainstreaming gender in the field, which is vital for sustainability (Cecelski, 2000: 4).

Evidence from this study's field results concurs with findings from other anecdotal studies, primarily by NGOs like IRENA (2019: 29), that mainstreaming gender in energy projects can generate significant improvements in women's (and men's) lives in terms of their health, income, education, time use and productivity; aspects presented as an essential requirement for sustainable development (UNIDO and UN Women, 2013: 1ff). Secondly, unlike the traditional discourses that glorify the participation of men alone in the energy sector, it is evident that when accorded appropriate opportunity and support, females can be influential producers, suppliers and operators of energy products in addition to being credible energy service providers (Cecelski & Soma, 2011: 1).

On the other hand, in agreement with existing literature (e.g. IRENA 2011), this study observed that lack of access to clean energy has far-reaching consequences on women's livelihoods. It also breeds gender-based conflicts/violence. For instance, illness from indoor pollution results in more deaths of women and children annually than HIV/AIDS, malaria, tuberculosis and malnutrition combined (IRENA, 2019; UN Women & UNDP-UNEP, 2015). Other costs of 'dirty' energy use include chronic diseases like asthma, burns, and injuries to women and girls as they carry firewood and charcoal. There have also been rampant cases of gender-based violence, particularly in rural areas, due to energy poverty.

Furthermore, due to their suppressed bargaining positions at the household level, women (in developing countries) sometimes get battered by male spouses while attempting to request money to buy woodfuel or kerosene and other fuels. In contrast, others get punished for allegedly "misusing daily or weekly fuel budgets/ funds" allocated to them by their husbands.

Aside from the household-level competition for the available energy, the study reveals that mini-grids installed in the community can also generate frequent conflicts in the village if not well managed with adequate community engagement that addresses contextual, educational, and didactic issues using an interdisciplinary approach. Therefore, a study investigating how gender and other contextual issues can be mainstreamed in renewable energy supply was conducted. It also unpacks the gender discourses' discursive bottlenecks in the broader social structure and proposes mechanisms to make renewable energy investments more participatory, gender inclusive, and sustainable in the long run.

1.1 Statement of the Research Problem

There is considerable literature examining the role of energy as a catalyst for economic development. However, there is also evidence that most of the renewable energy projects implemented in Africa do not succeed or fail the sustainability test in the long run (Antwi & Ley, 2021: 1), though the reasons for this failure have not been adequately addressed in the available academic literature. Likewise, there are glaring knowledge gaps regarding how energy projects in developing countries are or can indeed be designed and operated in a gender-sensitive and gender-mainstreamed way that promotes equal participation and opportunity between men and women (Hanitsch, 2019: 1ff; UNIDO and UN Women, 2013: 16). Nevertheless research provides evidence that technological projects that integrate gender sensitivity in their processes, undoubtedly do enhance social inclusion and sustainability (Osunmuyiwa & Ahlborg, 2019:146).

In addition, there is a tendency by project designers in the energy sector who are traditionally from the natural sciences field to concentrate only on technical, engineering, and economic aspects of the projects without paying adequate attention and consideration to the contextual dynamics of the communities in which those projects are situated or implemented (Sward et al., 2021: 1ff). Connected to the above are the long-held discourses that technology is a preserve of males with little concern for women's involvement, which structurally pushes women away. Attempts by females to penetrate the sector either through training at the school level, seeking employment in the industry or participating in energy-related activities at the community level are met by a host of barriers and discourses, most of which have socio-cultural roots (IRENA, 2019: 60). As Sonetti et al. (2020: 1ff) suggest, the solutions to those challenges may require dealing with issues in the social structure that created them in the first place.

For energy projects, especially mini-grids in rural areas, women become the largest consumers and beneficiaries of the produced energy through cooking, lighting and powering small-scale business enterprises (Cecelski & Soma, 2011: 11; Sibyl & Kuriakose, 2017: 2). Thus, this demands a fair involvement of women in such projects, but their participation is ironically minimal and associated with backlash effects. Finally, most renewable energy projects supporting rural communities are either designed and funded by international donors (Skutsch, 1998: 945) or planned by investors or central government officials and just taken and implemented in beneficiary communities in a typical top-down model (Butler, 2015: 346). The problem with this model is that it tends to ignore the social realities prevailing in the target

communities. Such realities may include gender dynamics and discourses, conflicts or tensions emanating from management, consumption, competition, or scarce energy resources. In addition, sluggish dealing with gender may reawaken the hitherto latent conflicts (Warner, 2000: 9). These mistakes render these investments problematic and can negatively impact sustainability (Iyer-Raniga & Treloar, 2000: 353).

Therefore, using renewable energy mini-grids in East Africa as the point of reference, this study sought to interrogate the gender dynamics and discourses involved at all levels of renewable energy value chains with more focus on the analysis of the role played by women in renewable energies, the barriers to women participation (in comparison to their male counterparts). Furthermore, education being a key enabler to participation, then the gendered dynamics and discourses embedded in the education and training system were interrogated to establish the extent to which they influence the level of involvement of women and men. Finally, the study analyses potential gender-based conflicts emerging from the implementation and consumption of energy resources and how gender gaps and discourses can all be harmonised in renewable energy project value chains to enhance sustainable outcomes.

1.2 Research Objectives and Questions

Based on the gaps identified in the problem statement, this study sought to answer the following specific questions:

1. To what extent do women participate in the renewable energy project, and how do gender discourses and other structural phenomena influence this participation?
2. In what ways does the introduction, implementation and consumption of renewable energy electricity resources diminish or escalate gender-based conflicts in the communities?
3. How do the gendered education and training systems and associated discourses influence females' and males' entry and participation in the renewable energy value chains?
4. How can renewable energy mini-grids be sustainably designed and operated to cater for the vital gender aspects at all levels of the project cycle?

1.3 Justification of the Study

The debates about transitioning from traditional fossil-based energy sources to more clean and renewable ones have continued for some time. The desire to transition to more sustainable renewable energies has also been on the agenda of international and local policy agencies, as

evidenced by the Sustainable Development Goals (Goal number 7), the Paris Climate Change Agreement, the Africa Vision 2060, the Uganda Vision 2040 and National Development Plan (NDP) III to mention but a few. However, corporate investors in the energy sector have focused on more extensive national grid networks with less potential to reach the hard-to-reach remote and sparsely populated territories. For various reasons, less attention has been put on utilising smaller decentralised grids, yet it is argued that they have more potential to reach and serve areas without access to the main national grid networks (Sigarchian et al., 2015: 1830). Perhaps this is due to inadequate research about their optimisation and how they can be economically and socially productive to producers, end-users, and other stakeholders.

Secondly, there is a tendency for scholars, planners and investors in the renewable energy sector to ignore gender justice. For example, some investors and planners assume that everyone in the community benefits equally once the grid network is up and running and generating some profits. However, the available evidence (e.g. Farghali et al., 2023: 1384-1385) shows that such investments that do not pay attention to social factors like potential conflicts, project-affected persons, gender dynamics and power relations, and educational and other socioeconomic issues may turn the communities worse off than they found them. Worse situations arise when the projects perpetuate inequalities or escalate the hitherto latent conflicts in society, which can jeopardise the sustainability of such renewable energy projects (Månsson, 2014: 106). This study analyses ways of addressing such challenges while integrating contextual factors in the planning and operating renewable energy programmes to enhance sustainability.

In addition, though available discourses (e.g. Dagnachew et al., 2017: 184; Nouni et al., 2009: 430; Sigarchian et al., 2015: 1830) posit that planners have started embracing the role of smaller energy grids like mini-grids, studies about their sustainability are still limited. Most of the studies that have been conducted have covered the developed world where such technologies gained root earlier. Some studies have also been conducted in Asia, especially India and China. However, it is not easy to access literature or information about mini-grid operations in East Africa. The absence of such data makes it difficult for scholars, planners or investors interested in East Africa-specific data, rendering energy planning for such a region problematic. This study, therefore, attempted to provide empirically tested information to cover some of these gaps. It analyses data and theory to generate evidence-based knowledge about the dynamics of renewable energies and mainly what the integration of gender in value chains means for their sustainability. The produced knowledge will inform academicians, investors, scholars,

legislators and other policymakers on how best to plan and implement renewable energies by integrating gender dynamics that contribute to sustainability based on empirically tested conclusions.

It has to be noted that this research is a subset of the more comprehensive BMF-funded interdisciplinary project, “Africa: Research and Teaching Platform for Development - Sustainable Modular Grids for Grid Stability” (ART-D Grids), conducted by Paderborn University in collaboration with some German agencies and East African partners. The German partners included the ECOLOG Institute, Asantys, and PI Berlin. In contrast, the East African partners comprised the University of Dar es Salaam in Tanzania, Makerere University in Uganda, and the Franciscan Sisters of St. Ann in Lwak Convent in Kenya. The project's primary objective was to develop innovative approaches to electrifying remote East African regions through microgrids and their interconnection.

The project moved beyond traditional unidirectional research on energy, which has primarily focused on technical and economic parameters. Our interdisciplinary approach addressed the limitations of this conventional perspective by incorporating engineering aspects (power electronics, sensors, and demand-side management) alongside social and educational issues, technical didactics, and institutional economics in the energy sector. Our educational sciences investigated social-technical processes, including gender, conflicts, education, participation, and negotiation, which impact renewable energy sustainability. The gender discourses that this dissertation focuses on are a critical component of the social-technical processes influencing energy sustainability. A key strength of this research project was the interdisciplinary learning and knowledge sharing that enabled me, as a social scientist, to gain insight into the technical facets of mini-grids. At the same time, engineers learned about energy's socio-economic and educational aspects from our cluster.

1.4 Conceptual Framework

The study involves the analysis of gender discourses and how they intersect with other structural, socio-cultural, economic and technical realities to influence the sustainability of renewable energy projects in particular and sustainable development in general. The discourses on sustainability, gender, masculinity/femininity, and intersectionality guided this study. The concepts and their moderating power are explained below, while the centrality of discourse in this study is broadly described in chapter three.

1.4.1 Sustainability/ Sustainable Development

Discourses in sustainable development theorise that for any development intervention to have sustainable outcomes, implementors need to constantly focus on sustainability at all levels of the project value chains (Afgan et al., 2000: 603; Tsoeu-Ntokoane et al., 2023: 1-11; Wilkinson et al., 2001: 1492). If this rule, as proposed by the development discourse, is to be believed, then sustainability implies that practitioners maintain a sustainable pathway in all development interventions, suggesting players must consider all facets of the project. Achieving that goal would necessitate an approach that promotes an equal focus on technical, economic, social and ecological parameters in all the processes (Sonetti et al., 2020: 1ff; Sward et al., 2021: 1). According to such arguments, therefore, we can only claim to achieve sustainable development when we incorporate all these processes.

But what is Sustainable Development? Proponents of the sustainable development discourse provide several definitions for the concept. However, the most prominently used definition is the one from the Brundtland Commission (WCED, 1987: 603), which states that “sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” However, this definition has been criticised for being ambiguous, particularly for its emphasis on the physical environment and time, which is also not clearly defined (Iyer-Raniga & Treloar, 2000: 349). Some scholars like Turne (1988: 1-125) and Meadows & Randers (1992: 1-9) focus on the physical limits to growth, while others argue that sustainability should encompass all the social, economic and ecological variables and how these interact within a development intervention (Iyer-Raniga & Treloar, 2000: 349). Pearce (1989; 1ff) stresses that sustainable development should emphasise amplified consideration for the natural, built and cultural environments. This argument thus implies that development should generate improvements not only in the economic structure but also in the social structure, a type of development that improves people's capabilities and agency (Chambers & Conway, 1991: 22; Sen, 1999: 1-13). Meadows & Randers (1992: 1-9) contend that a sustainable community can persist over generations and is focused, flexible, and wise not to destabilise the physical or social support systems in temporal and spatial contexts. Aspects from this argument, therefore, imply that sustainable development should also promote intergenerational equity.

Implications from the above arguments are that if adequate attention is expended, a development intervention or project that does not cater for other variables in society may end

up leaving a society even worse off. Many investors motivated by the neoliberal economic drive for profit maximisation fall into this trap. Therefore, the software and social aspects of the project are equally important as the hardware aspects of the same project (Yang, 2015: 93).

The above implies that renewable energy grid developers also need to focus on the economic, technical parameters and social-cultural issues if the interventions are to be sustainable or contribute to sustainable development. Using a case of renewable grids from East Africa, this study interrogates how sustainability parameters, as mentioned in the preceding paragraphs, are integrated into project designs and implementation and how they can be streamlined best using gender as the point of analysis. For renewable energy to be sustainable, gender integration is touted in discourse, and results from this study show that it is a critical necessity in project value chains (Farhar, 1998: 230). However, based on actual practices, as results indicate, it is not an issue accorded due prominence by many renewable energy designers and even national governments in East Africa. Still using gender dynamics and discourses as the point of entry, education and training matters for renewable energies and gender-based conflicts inherent within renewable energy projects are assessed. Proper alignment of gender with all other project implementation issues contributes immensely to sustainable development outcomes, as argued by scholars and other commentators (e.g. Ceschin et al., 2023b: 1; Johnson et al., 2019: 169; Oparaocha & Dutta, 2011: 265).

1.4.2 Gender and Masculinity/Femininity

Gender is a “useful category of analysis” (Scott 1986: 1056) as it allows us to assess and understand how and why certain perceptions and discourses held against men and women are incorporated into society's social, political, and technological realities. These socialised relationships, beliefs and roles are referred to as gender. These gendered relationships are a product of institutions, beliefs, practices, knowledge, relations or cultures that promote gender as a significant basis of identity, a phenomenon that Scott refers to as a “social category imposed on a sexed body or a social organisation of sexual differences” (Scott, 1986: 1056). In other words, social characteristics are discursively considered natural and biologically determined and translate into roles hinged on the beliefs of dominant man and subordinate woman, giving rise to hegemonic masculinities (Butler, 1993). According to Connel (1999: 71-76) and Cleave (2002: 1-3), gender identity refers to beliefs, traits, and values that are socially, contextually, and diachronically dependent and form a basis for identifying the roles and capacities of men and women.

Scott (1986: 1067-1068) argues that the structure of the economy and gender relations in production intersect, leading to historically shaped experiences that define social realities for both women and men. In this view, gender is understood as a social construct rather than something biologically determined.

To summarize, Scott (1986) outlines four key elements in the construction of gender, which simultaneously reinforce gender roles and are relevant to my analysis. The first element involves cultural symbols that evoke conflicting and symbolic representations of men and women, such as 'Eve and Mary' as female symbols, especially in Christian contexts, representing goodness, innocence, purity, and tenderness, while men are often symbolized as rough, dark, corrupt, intelligent, and possessing other associated traits. The second element pertains to 'normative concepts' that reinforce these representations by defining what is considered an 'ideal' male or female, which influences social interactions over time. The third element concerns the structure of social institutions and organizations that are gendered or perpetuate processes of gender construction, including the family, labour market, academic institutions, the economy, and the state. The final element involves the construction of subjective identities through activities, representations, and collective discourses, leading individuals to adopt specific identities. These four elements interact with one another to reinforce gender construction within particular contexts (Scott, 1986: 1067-1068).

Similarly, according to Lober (1995), gender construction and learning start at birth (or sometimes before) by assigning a sex category to a baby based on the genital organs. This 'marking' culminates in the creation of identities for the baby as a girl or a boy², followed by the allocation of names (feminine or masculine names), clothing and other gender markers (Lorber, 1995: 1). These discourses and practices lead to children being treated and trained differently based on their sex; as a result, children begin to respond and behave in ways that align with their assigned gender category. This process continues through parenting, and by the time they reach adulthood, children have adopted behaviours that are considered 'normal' within their specific society. These behaviours are then reproduced in various aspects of adult

² It has to be noted that there is quite a number of people who do not follow under any of this binary classification of boy or girl, or male versus female for example the intersex, transgender and others, thus identifying people basing on that binary classification is itself problematic.

life, such as how adults act, the subjects they choose to study, their societal roles, and how they interact with the opposite gender. Scholars refer to this process of reinforcing or discouraging certain behaviours and gender markers, based on their association with males or females, as ‘doing gender’ (Scott, 1986; Witt, 1997: 253).

Gendered institutions such as the state, family, religion, and education system are crucial in shaping gender identity and maintaining social order, status, and power dynamics (Tumursukh 2001: 119-122). However, as family structures diversify with the rise of same-sex couples, single-parent households, and the increased participation of women in political and economic spheres, these traditional perceptions and institutional arrangements are increasingly contested. Although same-sex marriages and sexual minorities exist in East Africa, they are difficult to identify due to the stigma and legal challenges they face. If such households were more visible, it would be essential to examine how gender dynamics operate within them.

A significant aspect of gender that influences roles and practices is masculinity, which is defined in relation to femininity. Masculinity encompasses socially constructed traits and expectations of men, varying across communities and evolving with societal changes. For instance, in many patriarchal African societies, men are expected to be strong, intelligent, and dominant, particularly over women. Those who do not meet these expectations may be seen as “not man enough” (Asiimwe, 2013: 15). Despite these assumptions, women have demonstrated their influence and activity in fields traditionally considered male-dominated (Esuruku, 2011: 27). These gendered beliefs shape societal organization, including who participates in specific activities and professions, and how these activities are conducted.

Connell (1999: 260) agrees that masculinity is a relational and ambiguous concept because, although every society has distinct perceptions of gender, not all have an idea of masculinities. These notions dictate the behaviour expected of someone perceived as masculine. Connell also notes that expectations of masculinity often include traits such as violence, dominance, a strong interest in sexual pleasure, a passion for sports like football, and a preference for STEM subjects. Conversely, those who do not display these traits are often labelled as ‘unmasculine’ or feminine (Connell, 1999: 1ff).

Typically, these conceptions benefit men, granting them advantages such as dominance in decision-making, control over household finances, and other privileges at both household and

community levels (Cleaver, 2002: 1-25). However, men can also be disadvantaged by the pressures to conform to these dominant gender norms. For example, the need to prove sexual prowess can expose men to HIV or lead to humiliation for those who feel they do not meet societal standards. Similarly, men in professions perceived as 'feminine' may face teasing or feel undermined, leading to frustration. Likewise, as field evidence suggests (discussed in chapter four), women who challenge gender norms by participating in activities deemed male-dominated also face criticism.

However, due to the forces of modernisation, the social structure is evolving in favour of an improved role of women in society and challenging hegemonic masculinities. For example, women participate in formal education and attain higher qualifications, participate in formally paid jobs, and earn incomes that are sometimes higher than men in similar organisations. On the other hand, the loss of employment or livelihood opportunities by some men results in forfeiture of breadwinner status, reduced attainment of education of boys compared to girls, increase in female-headed households and a reduced role of the 'traditional' family. As argued by Cleaver (2002) and Nicholson (1997), such developments have threatened dominant masculinities (Cleaver, 2002; Nicholson, 1997: 27) and may shape women's involvement in particular projects or programmes.

When the notion of masculinities is analysed from the angle of power relations and hierarchies between men and women and between men and men, we get what scholars have referred to as hegemonic masculinities. On the other hand, the weaker forms are sometimes referred to as subordinate or marginal masculinities. These reflect power dimensions between gender identities (Cleaver, 2002: 1-2). However, it has to be noted that the forms of dominant or subordinate masculinities are socially and culturally constructed and, as such, differ from culture to culture and are moderated by time, history, class, race, age and economic relations (ibid). Accordingly, the relational issue here becomes critical since it is advisable to analyse hegemonic masculinities hierarchically to understand how it compares masculinity versus femininity and between men and men (Messerschmidt, 2012: 58).

In line with the above contextual and relational formation of masculinities, De-Neeve (2004: 60) observes that masculinities or perceptions of proper manhood are formed based on the contextual, social and spatial contexts of work and status in the community and social

relationships, and these relationships not only influence but also result from societies' expectations of what one should do to reflect these as acceptable expectations of behaviour.

The above discussion raises essential issues about masculinity and femininity for analysing the discourses, perceptions, choices, experiences and opportunities or barriers to participation by men and women in renewable energy projects. The concepts are beneficial in exploring the lived realities of women engaged in the technology sector (a sector taken as a preserve of men) in African societies and why they choose to join the industry. It also helps to explore why many women have found challenges in participating in the renewable sector. Could it be due to the desire to conform to feminine roles prescribed by society? How does society perceive and treat women engaged in the technology sector? Do men feel that their dominant positions (masculinities) are being 'invaded' as the number of women engaging in STEM keeps increasing? What perceptions do investors and planners have about the participation of women (and men) in different levels of renewable energy value chains? What relevancy is attached to ideas and decisions made by females and males in the various phases of renewable energy projects? And finally, what implications do all these have for the sustainability of these projects? Most of these questions are addressed in chapters four and five of this thesis.

1.4.3 Intersectionality

Intersectionality has become increasingly prominent in feminist scholarship due to its ability to analyze individuals' issues and experiences from a multidimensional perspective, avoiding the pitfalls of monolithic and superficial inquiries. As Davis (2008) suggests, this study utilizes intersectionality to explore the interplay of multiple, intertwined identities and experiences of exclusion, subordination, or oppression. Rather than focusing solely on gender, intersectional analysis considers differences and diversity among women (and men), addressing factors such as race, class, power, sexuality, status, financial status, disability, and heteronormativity, depending on the specific characteristics of the individuals being studied (Davis, 2008: 67).

Similarly, Brah and Phoenix (2004: 75) advocate for an intersectional approach, arguing that research must examine how social class intersects with gender, race, and sexuality to simultaneously influence one's social position and daily experiences. They stress that analyzing these intersections provides a more nuanced understanding of reality than focusing on a single characteristic. Their emphasis is on the multiple, intersecting, and relational nature of social realities and subordinations (Brah & Phoenix, 2004: 77).

Verloo (2006: 211) also contends that when studying gender discourses or integrating gender equality into policies, projects, or research, it is essential to consider the multiplicity of inequalities rather than assuming uniformity at the structural level. This perspective calls for focusing on and comparing specific sets of inequalities or experiences related to class, race, ethnicity, sexual orientation, and gender. Such an approach highlights the importance of examining structural and political intersectionality to understand issues of multiple discrimination and the dynamics that drive them. Therefore, the notion of a “one size fits all” approach is rejected (Verloo, 2006: 211).

In line with these arguments, Mohanty urges feminist scholars to avoid generalizing or homogenizing the experiences of women or men, cautioning against treating them as a single, uniform category. She argues that not all women—particularly in the so-called third world—are homogeneous, nor do they experience subordination in the same way, as their identities are diverse and multifaceted.

These result from differences but also interactions of race, power, wealth, education level, caste, geographical location, religion and sexuality (Mohanty, 1991: 61-62). Therefore, all these and other categorisations were considered in the research processes, including analysis.

As discussed above, intersectionality helped me with participant selection and data analysis for this thesis. For example, it helped me to reflect on the respondents’ gender, class, education level, financial status, age, position in the family or community and how or if those identities influenced the respondents’ views on different variables and questions in the study. The study also endeavours to assess how some of these characteristics and forces overlap in specific individuals and how the responses (level of participation, barriers or opportunities of entry into the energy sector) are influenced by or interact with some of those characteristics but most importantly the interrelationships of the concepts of gender, masculinity/femininity concerning success and sustainability of the renewable energy mini-grids.

1.5 The Outline of the Thesis

This dissertation is presented in six chapters. Chapter One introduces the study, the research problem, the study objectives and questions, the study justification, and the main concepts that operationalise the study. Specifically, I argued that access to renewable, clean energy, gender equality, and access to education are interlinked requirements for attaining the sustainable

development agenda and transformation of society as envisioned by the Sustainable Development Agenda 2030 under goals seven, five and four, respectively (Korkovelos et al., 2020: 1-29; UNIDO & UN Women, 2015: 1). According to discourse, therefore, to ensure that the three interlinked objectives are achieved, gender equity should be an integral part of all programme interventions. Yet conventional project implementation in the renewable energy sector has always been inward-looking, focusing on technical and economic objectives with limited attention to other social contextual issues. Scholars on gender and energy (e.g. de Groot et al., 2017: 86; Johnson et al., 2019: 169; Polansky & Laldjebaev, 2021: 1ff; Tsagkari, 2022: 40-46) contend that such scope has compounded gender inequalities in energy access, particularly in Africa, whose complex social structure is characterised by gender discourses, discursive practices and stereotypes at community and intuitional levels that embody renewable energy work and careers as exclusive male professions. The main concepts in this study, which include sustainability, gender, femininity, masculinity and intersectionality, are also explained.

Chapter 2 provides a detailed review of discourses in the theories of sustainable renewable energies and gender nexus. The main issues discussed fall under two thematic areas. The first thematic area covers the general theories on renewable energies and their necessity for sustainable development. In contrast, the second theme uncovers the gender discourses or theories related to energy participation while advocating for the need for integrating gender justice in renewable energy value chains. Furthermore, since education lays a foundation for men's and women's participation in the technical and energy sector, debates about gendered education systems and the associated beliefs and stereotypes impairing or facilitating men's and women's participation in the industry are also assessed. Finally, the chapter highlights some knowledge gaps in the literature that necessitated this investigation or validation.

Chapter 3 deals with the methodology and the research process, including the detailed literature on the methodological approach of discourse analysis and the data collection and analysis processes. Specifically, this chapter expounds on the meaning and application of discourse analysis from the philosophical scholarship of Michel Foucault and other scholars on discourse and the role of power relations in constructing 'reality'. Finally, the chapter details the data collection and analysis process. It reflects on the ethics and situated knowledge with some comments on the challenges of conducting field research during the COVID-19 pandemic in the hardly accessible remote islands of Lake Victoria.

The empirical findings from primary and secondary data are discussed and analysed in chapters four and five in line with the study objectives and questions.

Chapter 4 analyses the extent of women's participation in renewable energy mini-grids. The main argument is that despite numerous obstructions, women partake in renewable energy project cycle processes and productively benefit from access to electricity supplied by the mini-grids in various ways. However, they also experience many structural challenges that frustrate their involvement. These challenges primarily emanate from social learning patterns, which propagate the dominant gendered discourses and stereotypes that pervade most East African communities that are predominantly patriarchal. These discourses are therefore analysed further in the chapter. Similarly, chapter 5 is dedicated to discourses in the education sector and how they influence males' and females' entry and performance in STEM subjects that, in most cases, provide pathways into renewable energy professions. The central argument presented in this chapter is that the complicated education structure, discourses within the curriculum, gender stereotypes, and prejudice among the learners, teachers, and guardians constitute problems that make females' adoption of energy-related subjects (STEM) an uphill task. According to evidence from the field data, democratic gender-sensitive education approaches that integrate gender as an impact factor for transformation work to enhance gender sustainability of renewable energy, gender justice and sustainable development.

In the final chapter (chapter 6), I present conclusions and reflections on the central question of gendered discourses, the sustainability of renewable energy project debates, and how the intersectional approach was deployed in this study. This is followed by recommended interventions for lessening the gender gaps in the renewable energy sector based on the data and discussions in chapters 4 and 5, and then present the contribution of this research to the broader academic debate of renewable energy and sustainable development. Finally, I present the contribution this research makes to the body of knowledge and from these insights, I suggest areas for further study and cap with final remarks on the entire thesis.

2 Review of Literature on Discourses of Sustainable Renewable Energy, Gender Sensitivity and Sustainability

This chapter offers an in-depth review of the current state of knowledge and discourses on sustainable renewable energies and gender in line with the stated study title and the study aims. The main issues discussed fall under two thematic areas. The first thematic area covers the general debates on renewable energies and the related sustainability debates. In contrast, the second theme covers the discourses on the need for integrating gender perspectives in renewable energy value chains as argued and counter-argued by different scholars. The discussion begins with exploring the discourses on the meaning and necessity of sustainable renewable energies in achieving sustainable development. It proceeds with the discussion of mini-grids as one of the significant off-grid technologies touted in several discourses as a panacea for promoting sustainable energy access and reducing climate change. Debates on the necessity for investing in smart, innovative grid technologies, the arguments for deploying mini-grids, and the associated constraints are also analysed.

The second section covers the discourses around the roles of social-technical issues in developing sustainable energy grids, particularly the integration of gender dynamics. The role of gender is specifically emphasised for further analysis, not because it is the only important factor but because it is a central variable in this study. Therefore, the second section looks at debates on the integration of gender perspectives in renewable energy value chains, the discourses around barriers and opportunities for women's participation in renewable energy investments, and the associated gender-based conflicts and other forms of violence that may emanate from the investments, utilisation of energy sources or lack of access to electricity in society.

Since education lays a foundation for men's and women's participation in the technical and energy sector, debates about gendered education systems and the associated beliefs and stereotypes impairing or facilitating men's and women's participation in the industry are also assessed. Finally, the chapter highlights some knowledge gaps in the literature that necessitated this investigation or validation in this study.

2.1 Sustainable Renewable Energy for Sustainable Development

Most discourses on development, particularly those leaning towards economic growth, promote electrification as a key development driver. Thus, according to them, electricity is critical in human development (IEA, 2015: 1-22). Despite this assertion, in Sub-Saharan Africa, over 65% of the population lacks access to a significant source of energy (World Bank, 2014:). For example, the International Energy Agency states that the entire Sub-Saharan Africa produces a paltry 90 Gigawatts (GW), a quantity in the same range as the total amount of electricity produced by the United Kingdom, moreover a country whose population is only equivalent to 7 per cent of Sub-Saharan Africa (IEA, 2014: 27-83). Despite the low generation capacity, the power generation systems are associated with a less reliable power supply, limited efficiency and uncompetitive per unit costs of power tariffs (Sokona et al., 2012: 4).

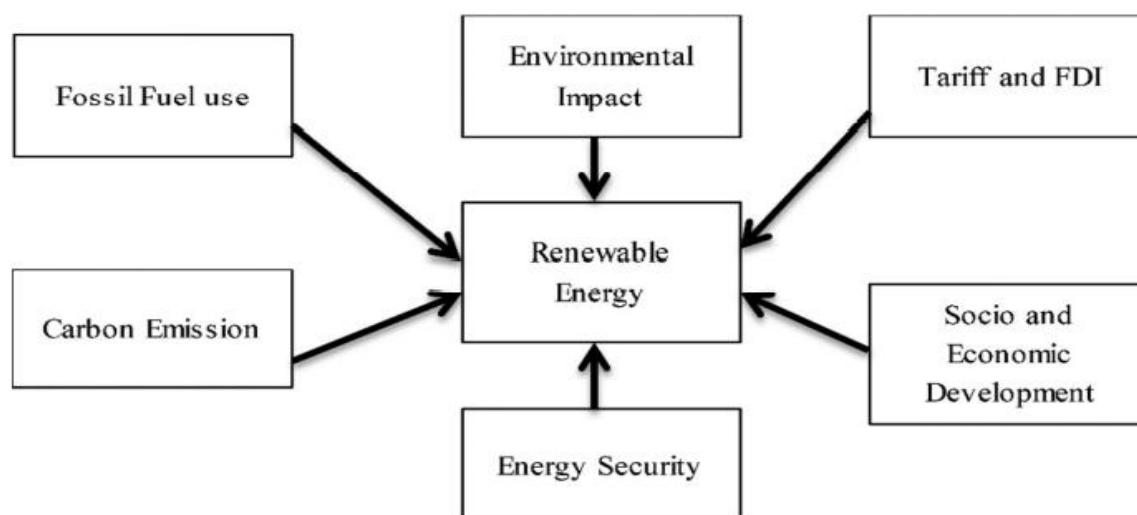
To address these power shortages and harness the benefits associated with increased electricity, the international community, under the aegis of the Sustainable Development Goals (SDGs), have committed to achieving universal electricity coverage by 2030 (Dagnachew et al., 2019: 1). They argue that this electricity has to be affordable, modern, reliable and sustainable (UN 2015a: 21). The same objectives are also re-echoed by the Paris agreement on climate change (UN b, 2015: 1-2). Specifically, matters of electricity coverage are articulated under SDG7, which addresses three aspects of global energy access, which include ensuring universal access to affordable, reliable and modern energy services, increasing the proportion of renewable energy in the global energy mix significantly, and multiplying by twofold, the universal rate of enhancement in energy efficiency (UN 2015a: 21)

It is further emphasized that this electricity has to be generated from clean and sustainable sources (UN 2015a). Fulfilling this target will require the relevant parties' deliberate and expanded multidimensional investments in grid expansion and generation capacity (Bazilian et al., 2012: 1; Lucas et al., 2015: 715).

Researchers have argued that in addition to investment in the conventional national grid networks, more innovative technologies like mini-grids and other options like micro- and standalone non-grid-based electrification systems will be sought by planners to reach out to smaller or hard-to-reach neighbourhoods (Pachauri & Brew-Hammond, 2012: 1409). These investments also require research about their operations, financing, efficiency and sustainability. Despite some of the studies, especially for the developed world, literature on

Africa, which appears to have unique characteristics and challenges, seems to be missing in most of the studies (Dagnachew et al., 2017: 184). Country-specific studies that can help develop operational and sustainability models are necessary but still lacking, especially in the Sub-Saharan context.

Figure 1: Factors driving the adoption of renewable energy sources



Source: Satpute & Kumar (2021: 23)

As the world keeps globalizing into one interconnected unit, tapping the benefits of this globalization process requires more investments in energy production, especially in the global south, where electricity coverage is still low. Despite the need for increased investments amidst a growing population, the earth remains fixed, and its size and form are inelastic. However, energy needs to satisfy power activities like cooking, lighting, industrialization, and other social and economic needs keep increasing (Edenhofer et al., 2011: 7). Therefore, the urgency to have substantial improvements in energy generation to meet the growing demands at the same time minimising the energy contribution to global warming are two competing challenges that all policymakers must face and address in the pursuit of a sustainable future (Abbasi & Abbasi, 2010: 239; Kaygusuz, 2012). Matters are complicated when we realise that over 1.4 billion people worldwide do not have meaningful access to electricity, with over three-quarters of them residing in rural communities, which are always hard to serve with main grid power compared to their urban counterparts. It is projected that unless great strides are made to address the energy

deficits, the number of people depending on unclean energy, mainly biomass, will rise to 2.8 billion in 2030 (Kaygusuz, 2012: 1116).

It has been stated that the question of improving energy use has been around from historical times, necessitated by the growing energy demand precipitated by increasing population growth. Historically, most energy demands, especially for industrial use, were met by coal, whose mining started as early as 1750. As a result, coal became the favoured energy source for powering steam engines as it produced more power than other sources like biomass-based options. In addition, it was preferred because it was relatively cheaper and considered cleaner than other available energy sources (Abbasi et al., 2010: 892).

As noted by different commentators, over-reliance on fossil-powered electricity generation coupled with high population growth in the last few years have precipitated an exponential increase in energy demand, resulting in increased carbon emissions in the atmosphere (Asumadu-Sarkodie & Owusu, 2016: 5). Growth in carbon emissions with the resultant global warming has become a significant threat to the current (and future) generation. However, their impacts may be minimized if more emphasis is placed on producing energy from clean and renewable sources. It is further argued that renewable energy systems have the potential to significantly cut down the greenhouse gas emissions from fossil fuels, thereby averting the impending dangers of global warming (Edenhofer et al., 2011: 7) and facilitating the attainment of SDGs, particularly SDG 7 (Lu et al., 2015: 432). It is also claimed that attaining sustainable development will require more concerted efforts now than at any other time before. This objective, therefore, calls for coordinated and integrated approaches that address social, economic, and environmental factors (Hák et al., 2016: 266). It further implies that responsible agencies should devote more resources to investments in renewable energy resources since they pose a lesser danger to the environment and humanity. Moreover, as Hak et al. (2016) noted, renewable energy sources can restock themselves, which guards against their exhaustion on Earth.

Furthermore, Tester (2005: 1) contends that the energy generated from renewable sources becomes sustainable, especially if other factors beyond the environment are incorporated. Sustainable energy, therefore, creates a dynamic balance between equitable access to energy-intensive goods and services to the community while preserving the earth's resources for future generations. The primary renewable energy resources “include bioenergy, hydropower,

geothermal energy, solar energy, wind energy, and ocean (tide and wave) energy” (Owusu & Asumadu-Sarkodie, 2016: 4).

Figure 2 shows a summary of primary renewable energy forms and their functions.

Figure 2: Major renewable energy sources and corresponding functions

Hydropower	Power generation
Modern biomass	Heat and power generation, pyrolysis, gasification, digestion
Geothermal	Urban heating, power generation, hydrothermal, hot, dry rock
Solar	Solar home systems, solar driers, solar cookers
Direct solar	Photovoltaic, thermal power generation, water heaters
Wind	Power generation, wind generators, windmills, water pump
Wave and tide	Numerous designs, barrage, tidal stream

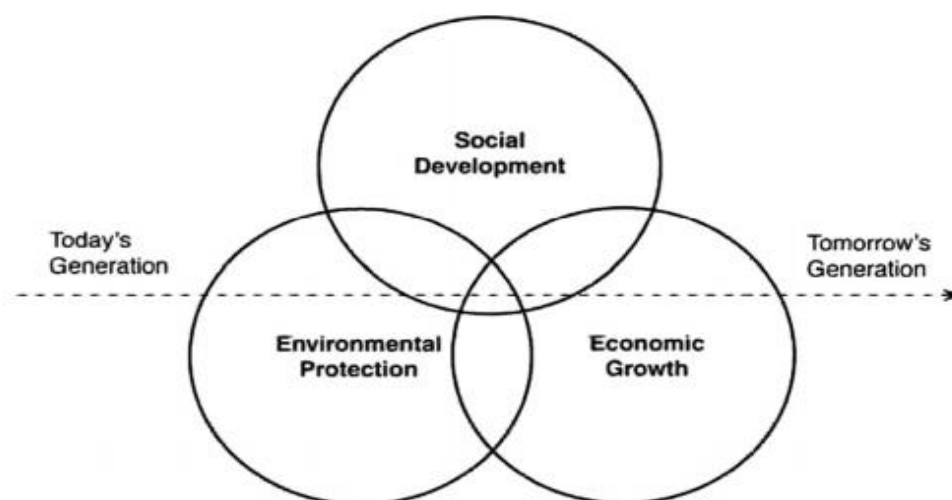
Source: Panwar et al., (2011: 514)

Renewable energy resources have gained prominence worldwide because of their merits associated with fewer emissions, less contamination, and limited fossil fuel resource application. However, to ensure sustainable outcomes and investment in renewable energy resources, the technology or resource's sustainability need to be critically examined before making final investment decisions (Liu 2014: 612-613). Similarly, Ray (2019: 517) contends that for sustainability to take root, renewable energy has to be embraced at all levels, with direct solar, wind and bio-energy being the major contributors. Ray further vouches for the mentioned sources because a large proportion of the material components are or should be recovered and recycled, and only a smaller fraction of the materials should be extracted from the earth. Therefore, according to the preceding scholars, the transition to renewable energy ought to be given the necessary support. However, this will be possible if continuous research and innovations produce affordable, cost-effective solutions. Such innovations may include studies on smart, innovative grid technologies with lightweight batteries, high-temperature superconductors and robust solar cells and electrodes (Ray, 2019: 517).

However, despite the serious debates and pieces of discourse about sustainability, there is an absence of a mutually acceptable tool to assess all dimensions of sustainability. For instance, financial costs may be used to measure economic viability but cannot be applied to determine

other sustainability parameters like environmental or social costs and benefits. The absence of these standard measures makes sustainability a complex subject. Sustainability measures are necessary to mirror the different dimensions of sustainability of the various energy resources to support decision-making concerning renewable energy investment. In addition, sustainability indicators to assess renewable energy resources' economic, social, technological, and environmental aspects need to be developed or tested (Afgan et al., 2000: 603; Afgan & Carvalho, 2004: 1328). These would help to make conclusions on sustainable development based on verifiable assessments (Liu, 2014: 612-613). Based on the above claims, a sustainable energy resource or project should address economic, social, environmental, and technological quality (Phillis et al., 2010: 15; Phillis & Davis, 2009: 1327).

Figure 3: Multidimensional and intersectional features of sustainable development



Source: Liu, (2014: 613)

Using what Elkington (1994: 90-100) termed the Triple Bottom Lines (TBL) to explain sustainability, the figure above depicts the essential parameters of sustainability and their interaction. In other words, successful sustainable development should cater to social development, environmental protection, and economic growth. In the same argument, a sustainable energy project should address all three facets and whatever subsets they contain (Liu, 2014: 613).

Based on the existing literature the sectors always given less attention in sustainable renewable energy discourse and scholarship are the social-political considerations. However, it has been noted by scholars cited in the previous discussions that sustainable development and renewable

energy are inseparable from society, and it, therefore, becomes essential to give social considerations like gender adequate attention. Moreover, whether a community chooses sustainability or a profit-first approach to any project will be determined by social attitudes, perceptions and discourses. Although many societies have some level of awareness about environmental pollution and the dangers posed by consumerist lifestyles, people also have less initiative to refrain from unsustainable lifestyles. Therefore, social acceptance becomes very critical for sustainability. People only get alarmed when big disasters like Hurricane Katrina, the Indonesian Tsunami or explosions occur (Ray, 2019: 1518). However, they also tend to ‘forget’ and move on once the effects of the disaster start to wane gradually.

Investments in sustainability and human survival are also moderated by the discourses of leaders and their international partners' political wisdom or attitudes. Whatever they decide at the local or global level significantly affects the sustainability debate, irrespective of the available scientific knowledge. The role of political support can be evidenced by the USA's recent rejoining of the Paris Climate Agreement under the Biden administration to reverse Donald Trump's actions, who had withdrawn from the agreement claiming that he had contempt for climate change and the debates surrounding it. It is argued that such policy reversal by the Biden administration allows America to enact public policies coupled with private investments that could halve carbon foot print compared with 2005 levels by 2030 (Chemnick, 2021: 1).

From the preceding, despite the presence of some dissenters, the general census and the general trajectory being followed by the current capitalist-driven industrialization and consumerist behaviours may lead to disastrous outcomes or some very undesirable situations for future generations and hence the need for sustainable livelihoods in general (Batts 2017: 1-2) and by extension the need for renewable energy (Ray 2019: 1518).

However, despite the consensus, some actors dissent, claiming that the fears about disastrous outcomes are unfounded. This group of nonconformists argue that there is no need to worry much about sustainable or renewable energy, at least for the near future. The dissenters also contend that producing renewable energy requires complex and expensive technologies that are yet to be mastered by the practitioners, making the whole process so expensive and less economical (Batts 2017: 1; Gregory 2017: 2; Kunzig 2015). Their main arguments against renewable energy are that it is unnecessary for the next few decades since fossil fuels and nuclear power are arguably still available for more extended periods to come.

The other claim is that the amount of renewable energy capable of being harvested is so little and dilute and that save for hydropower; all other renewable energy sources are weak, unreliable and depend on heavy storage equipment that is not readily available. This reportedly makes renewable energy less cost-effective and void of the claimed environmental benefits (Johnson, 2013: 1; Moalem, 2016: 2-5).

Nonconformists continue to claim that new energy (fossil) deposits are being discovered in addition to the available energy reserves, and technological innovations improve the extraction of reserves from older fields even better. Some scholars like Gold (1999: 35-55) further argue that there are still more hydrocarbon reserves on the earth than can be presumed, inferring that the flow of hydrocarbon-based fuels will not deplete fast; hence, fears about their looming depletion are unfounded. However, confirming whether the available fossil-based energy reserves can keep up with the increasing population and energy demands is still tricky despite the claims. Nevertheless, these same fears forced the countries under the UN in 2015 to draft and accept a set of goals that seek to avert climate change and propagate sustainable development by 2050 (IRENA, 2018: 23). Part of the goals is to adopt renewable energy sources, modify fossil oil-based energy and promote efficiency in the use of energy (Ray, 2019: 15-17).

Despite the arguments and counter-arguments, achieving sustainability and renewable energy targets will require a multi-pronged approach involving many stakeholders and approaches. First, as observed in the previous sections, actors need to use a multidimensional approach, including inculcating it in education systems and integrating gender perspectives in sustainable energy processes and other social-technical systems. The pro-sustainability commentators also advise that planners and investors have to transition from the traditional large energy grids to more innovative and highly efficient technologies like decentralized mini-grids that are more adaptable to rural hard-to-reach locations. They vouch for introducing smart technologies to run these systems to make them more efficient through improved communication, managing demand and supply projections and easy monitoring for both the power producers and end-users.

This study concentrates on smart mini-grids as a means of achieving the above goals of electrifying rural communities. It must be noted that despite this study being a social science-based one, it is borrowing from an interdisciplinary minigrids project with technical or engineering parameters that are intertwined with social science aspects for them to be

sustainable. Therefore, it was necessary to highlight some basics about mini-grids and the smart features and functions that reportedly make minigrids a sustainable solution. This picture makes it easier for readers to understand the type of technology mini-grids are; the essential information is necessary for a non-technical reader to understand their operations, merits, performance basics and limitations. Therefore, the following section focuses on the meaning and role of mini-grids and how innovative smart technologies are deployed to improve operation and maintenance, partly contributing to sustainability as advanced by different discourses.

2.2 Smart Mini-Grids: Meaning and Contribution to the Advancement of Sustainable Renewable Energy Solutions

Different scholars have given mini-grids various definitions, but a close look at the different definitions reveals a consensus that they provide accelerated electricity coverage at localised levels using isolated or decentralized distribution channels (Peters et al., 2019: 27). In the context of developing countries, a mini-grid may refer to electricity generation units, sometimes storage systems attached to a distribution network and supplying power to several consumers (Odarno et al., 2017: 6). Mini-grids are also claimed to have the potential to enable increased power distribution and access to remote communities, isolated habitats and island communities that would otherwise take longer to access power from conventional primary electricity connections (Palit & Sarangi, 2014: 9). Whereas some can be attached to the principal utility grid, others are operated independently of the central grid.

Available literature does not indicate the exact size of what can be referred to as mini-grids or a microgrid; however, according to Tenenbaum et al. (2014), mini-grids follow under the broader category of what is sometimes categorized as small power producers and distributors. Small power producers are run independently and supply electricity to retail consumers on a mini-grid or to the leading national utility, depending on the source of their electricity. These entities are classified according to size (for instance, 10 megawatts and below), the type of fuel they use (for example, diesel or biomass) or their technology, for example, diesel generator or solar photovoltaic (Tenenbaum et al., 2014: 9)

As noted, most off-grid communities targeted by mini-grids tend to be sparsely populated with dispersed residences and low economic standing, rendering them less economically attractive for big electricity supply investors (McHenry & Doepel, 2015: 679). More so, even public

utility companies with the mandate to offer services without a profit motive tend to ignore such settlements because of remoteness (Palit & Chaurey, 2011: 269). Often, these communities rely on unsustainable and sometimes unhealthy fossil fuels like diesel and kerosene to satisfy their energy needs since such options are more accessible to acquire and install (Bos et al., 2018: 69-72). Despite their access, however, these fuels have costs associated with volatile fuel prices, the distance involved in transporting the fuel, expensive operation and maintenance, and other dangers that these fossils pose to people's health and the environment (Sigarchian et al., 2015: 183; World Bank, 2018: 4).

With the current drive by governments to increase electricity supply to meet the sustainable development goals, particularly SDG 7, many countries, especially in Sub-Saharan Africa, are likely to resort to investment in mini-grids to accelerate rural electrification. Chikumbanje et al. (2020: 1) estimate that by 2030, Sub-Saharan Africa and other developing territories will possess numerous electric power networks that will increase electricity production threefold. This will reportedly result from governments, private investors and international agencies' efforts to achieve the sustainable development target of providing energy access to larger populations. Consequently, most power investments will likely be through mini-grids (International Energy Agency, 2017: 295).

If this projection goes as planned, the dominant discourse holds that several standalone mini-grid systems will keep emerging and, in some cases, adjacent mini-grid systems will interlink into clusters. Others may be later connected to the primary grid in instances where the central grid extensions keep expanding gradually to reach the hitherto unconnected remote communities (Bastholm & Fiedler, 2018: 648; Tenenbaum et al., 2018: 1-3; Tjäder et al., 2016: 1). The coupling of these networks is supposedly likely to improve the energy generated by these standalone grids. However, some argue that the interconnections of the hitherto autonomous mini-grids to the main grids may not be an option that many players will entertain (Batinge et al., 2017: 1-16; Levin & Thomas, 2016: 97). One of the arguments for this view is that small mini-grids, particularly those with hydro-power technology, tend to be sidelined and demobilized when the primary utility grid finally reaches an area hitherto served by a mini-grid (Tenenbaum et al., 2014: 65-83). Despite these claims, there is hope that the small grids will be retained and integrated since most of the mini-grids in Sub-Saharan Africa are powered by solar photovoltaics, whose technology and operation are not as complicated as power technologies like wind, hydropower or other energy generation systems (Chikumbanje et al., 2020: 1).

When the primary grid and mini-grids meet, Greacen et al. (2013: 10) propose six possible options that can be adopted to optimise the benefits of both. The proposed options are that the mini-grids become small power distributors (SPD), small power producers (SPP), small power producers and distributors (SPP&D), or there may be a concurrent operation of the two grids, abandonment of the mini-grids and refunding the mini-grid owners.

Thus, when the option of a small power distributor is selected, the generation components of the mini-grid are decommissioned, and the remaining network facilities are instead connected to the primary grid, leaving the mini-grid owners with the duty to buy electricity at wholesale price from the primary grid and to selling it to the mini-grid customers at retail prices (Okapi Research and Advisory, 2017: 14-17). It is argued that this option is always preferred where the mini-grid power generation uses non-renewable technologies like diesel; otherwise, where there is a combination of renewable and non-renewable technologies, the non-renewable components are decommissioned, and the renewable ones are retained due to their environmental benefits.

For the small power producer (SPP) option, the primary utility company takes complete control of mini-grid activities, including selling power to the customers, but pays for or buys all the power produced by the mini-grid. The option of the small power producer and producer (SPP &D) involves continued mini-grid operations and all its facilities, with the opportunity to sometimes export or import electricity from the primary grid, depending on its power output and demand needs. This is always the most preferred and sustainable option, especially in sub-Saharan Africa (Chikumbanje et al., 2020: 2). Whichever of the three options is adopted when the mini-grids meet the primary grid, the proponents of the mini-grid technology emphasised that the mini-grid and the primary grid and their customers will benefit from the integration improved expanded power supply.

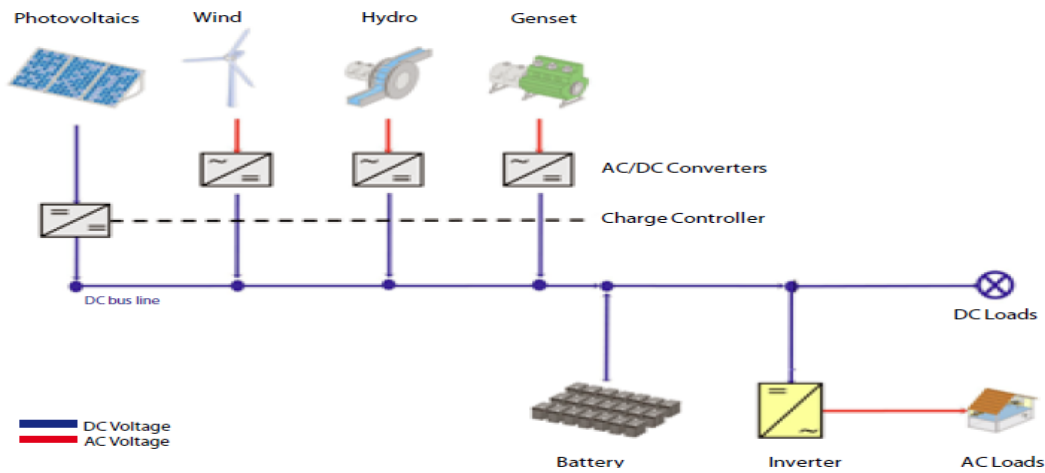
2.2.1 Optimising Mini-grids Capacity through Hybrid Technologies

According to the Alliance for Rural Electrification (2014: 41), a mini-grid can be established to be powered by one energy source or from multiple power sources, a system referred to as hybrid or coupling. A hybrid mini-grid thus involves a merger of two or more forms of technologies for power production and supplies electricity to different end-users via an independent grid. Therefore, such a mini-grid gets its power from a combination of renewable energy technologies and an engine usually powered by diesel as a reinforcement. It is argued that a hybrid mini-grid is more cost-saving and provides reliable and high-quality energy for

lighting and communication, among other numerous functions. A hybrid grid operating as an independent unit has the capacity to provide almost similar values and functions to those of the national grid (ARE, 2014: 14). In communities where the national grid supplies customers for a limited time of the day due to under-capacity, frequent blackouts can be prevented by connecting to the hybrid mini-grid as industry players contend that rural communities that rely on hybrid mini-grids have always enjoyed an uninterrupted power supply which is not the case with the urban communities that are predominantly supplied by the national grid (ARE, 2014a: 13-14; Ortiz et al., 2007:).

Available literature suggests that combining different technologies to generate power is associated with more advantages than using only one technology. Mixing renewable power sources with a diesel generator, for example, brings low-cost energy solutions to rural communities as the benefits from each technology reinforce each other. Renewable technologies do not rely on fuel to function, and so according to ARE (2014), they do not suffer from severe price fluctuations (although, as evidence shows, subventions and financing models change or may differ). Thus, combining renewable sources like solar and diesel-powered sources means energy resource fluctuations can be managed. For instance, it is argued that solar PV collectors can complement wind in seasons when there is an inadequate wind supply or pick up when hydro generation dwindles during drought. Solar energy may experience peak hours when sunshine is high, while wind sources can work when the wind is available. Storage batteries help the system to be stable by storing energy for peak consumption, which sometimes happens at night hours when there is insufficient production from solar sources (ARE, 2014a: 26).

Figure 4: Illustration of a hybrid mini-grid combining solar, wind, hydro & diesel sources



Source: Alliance for Rural Electrification (2011: 29)

In short, a hybrid energy structure will bring on board the merits of each technology and regulate its shortcomings. To allow for continuous power supply, optimize the lifespan of gadgets by minimising stress on the network, particularly the battery, and cutting down general operational expenses, diesel or gasoline generators are generally added as reinforcements.

To simplify the operation and management of the system and keep costs to a minimum, experts call for the addition of a smart Energy Management System (EMS) to the system. This EMS is usually combined with the inverter, operating battery, generator and load management devices (ARE, 2014b: 13; Hazelton et al., 2014: 223-224). The role of the energy management systems in sustaining mini-grid operations will be discussed further in the subsection section that tackles smart grids.

From the above arguments, it can further be deduced that whether the mini-grid is interconnected with the national grid or an autonomous mini-grid, or whether it is a hybrid or not, the power generation, regulation, distribution, and measurement systems together with the communication system have to be integrated so that communication and controls are effective right away from the generation point to the end-user point. This may require the installation of devices and technologies that relay messages to the producers or consumers in real time to ease management and control. This, plus other features, makes the grid “Smart”. The concept of smart grids and the discourses surrounding its relevance are explored further in the following section.

2.2.2 Using Smart Grid Communication Technology to Enhance the Sustainability of Renewable Energy Mini-grids

As stated in the previous section, advocates of mini-grid technology vouch for innovative systems that would render mini-grids ‘smart’ and optimise their benefits for customers and developers. Indeed, many service providers in the mini-grids subsector have recently attempted to integrate smart technologies into their networks to benefit from the improved communication technologies in their electricity provision enterprise. By design, smart grids are planned to include cutting-edge communication and networking technologies into their power generation and supply systems to make them ‘smarter’. It is reasoned that smart systems can help to minimize power intermittences and voltage slumps if faster and more advanced communication tools and technologies are integrated within the grids (Gao et al., 2012: 391). But what is a smart grid?

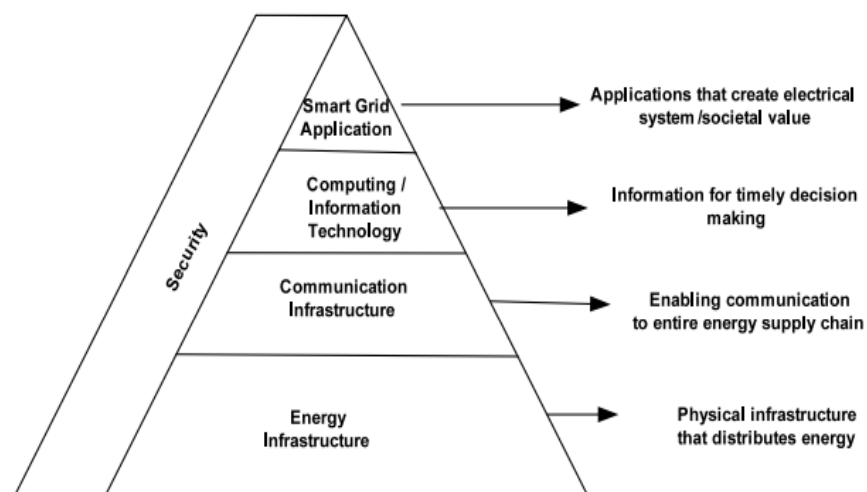
Different institutions and researchers give varying definitions of the term, but they agree that smart grids should be fitted with an information communication infrastructure to be efficient and facilitate timely decision-making. A smart grid is, therefore, “a data communications network integrated with the electrical grid that collects and analyses data captured in near-real-time about power transmission, distribution, and consumption” (Gao et al., 2012: 392). Smart grids also deploy electronics and material engineering to maintain an environmentally sustainable system (Yu et al., 2011: 49-63). Due to its capacity to collect and process data, the smart grid has the capability to deliver information that allows suppliers and consumers to plan and act in advance. This information may contain recommendations that help stakeholders efficiently manage the power at the production, distribution and end-user levels (Cisco, 2009: 1). According to Siano (2014: 461), the smart grid meticulously delivers electricity from the point of production to the end-users by deploying innovative technologies such as smart meters, energy controllers, and other communication systems and devices. It also caters for demand response (DR) by facilitating two-way communication between suppliers and consumers, which leads to a multiplicity of advantages to the system concerning operations and market efficiency. Furthermore, since it, as claimed, improves the reliability and efficiency of the whole system, including regulating the power supply, the overall average capital investments are reduced in the long run, leading to an increased return on capital (Siano, 2014: 461).

Smart grid technologies consider electricity users as an essential part of the system as they can adjust their power consumption patterns based on the information got, which can induce or

discourage power consumption (Yao, 2010: 2). Much of the benefits that accrue from the smart grid are primarily due to its potential to increase reliability performance and consumer reactivity and the promotion of better decision-making by the electricity providers and consumers (Forte, 2010: 1; Potter et al., 2009: 1-2). Based on the preceding argument, smart communication is essential not only for the electricity generation and supply side but also for the demand or end-user side since the end user side relies on the information provided to modify consumption decisions (Saffre & Gedgein, 2010: 300; Vos, 2009; Zhong et al., 2010: 1-2). The system deploys communication systems and sensors, automated meters, artificial intelligence gadgets and particular processors to facilitate this interaction. Smart meters and other specialized information communication technology products in energy supply provide benefits such as energy-saving, expanding renewable energy solutions, and facilitating consumer participation in the affairs concerning energy market management (Siano, 2014: 461).

Smart grid being a complex system, scholars have developed a conceptual architecture that describes the behaviour of the whole grid with models to analyse and establish interfaces that enable computer systems or software to transmit and make use of information (interoperability) and support the development of cybersecurity plans within the system (National Institute of Standards and Technology (NIST), 2010: 7)

Figure 5: Smart grid interactive infrastructure



Source: (Gao et al., 2012: 393)

Specific system requirements are proposed for the smart grid to be efficient and maximise benefits to power producers and consumers. For example, an advanced metering infrastructure should enable end-users to realize power prices and instantly programme their consumption (NETL, 2007: 1-20; NIST, 2010: 7-29). This also enables customers to detect and, therefore, opt for the various consumption patterns based on affordability and the grid carrying capacity (NETL, 2007: 1-20). The system should also contain software whose function is to monitor the behaviours of the different sections of the electric power system and help to align their performance to address likely interruptions (NIST, 2010: 7-20). This is also coupled with an IT network system that transmits communication messages across the generation, transmission, distribution, consumption and regulation points (Aggarwal et al., 2010: 1). These different points and their respective devices should be able to quickly and securely share information across the grid, potentially triggering requisite actions that improve efficiency (NIST, 2010).

Finally, the system should provide demand response and consumer efficiency provisions whereby suppliers and end-users adjust their power consumption when power is demanded most. This reportedly allows end-users to ‘smartly’ use their electric appliances to minimize costs (Gao et al. 2012: 393).

In conclusion, popular discourse on minigrids suggests that minigrids need to be fitted with smart systems to make them smart. Smart grids, by definition and requirements, should hence have all the features that enable them to function in a reliable, efficient, and intelligent manner. They allow electricity generation, measurement and consumption to be more dynamic, enabling pricing and permitting the gathering of electricity from various energy generation points with updated communication and computation strategies. This allows for decision-making in real-time at both ends of the system. However, these features, particularly the installation of IT networks, need not compromise privacy and other security issues. Without adequate attention to cybersecurity, malicious individuals like hackers can manipulate the system and illegally divert customers' electricity without detection (Gao et al., 2012: 393-394).

2.2.3 Role of (Smart) Mini-Grids in Facilitating Sustainable Energy Access

Access to electricity for domestic use and industrialization remains a significant challenge in Africa. By 2013, an estimated 1.3 billion people across the globe had no access to any form of electricity (IEA, 2013: 23), and predictions based on studies conducted by UNEP indicate that the situation may not change much by 2030 unless deliberate interventions are done to fast-

track the electrification process (Korkovelos et al., 2020: 1-2; UNEP, 2013: 10). This has given impetus to calls for the increased adoption of mini-grid power supply options with assurances that it will play a pivotal role in ensuring universal energy access. For instance, it is presumed that 42% of the 250 Gigawatts of extra energy necessary to attain 100% of the world coverage is projected to be generated from mini-grids (OECD/IEA, 2010: 19). Mini-grids, therefore, become a preferred option to cover this gap due to the exorbitant capital requirements for extending national grids to distant remote areas and the increasing acceptance of such mini-grid systems as a solution for hard-to-reach geographical locations. The feasible modularity of renewable energy options such as solar to address the electricity needs of small villages is also stated as an additional incentive (Palit & Sarangi, 2014: 9). The presumed positive environmental impacts associated with renewable energy mini-grids have also motivated governments to create adequate policy support and funding as a tool for accelerated power production and distribution in recent times (Bhattacharyya, 2006: 339; Nouni et al., 2009: 430).

Despite the policy support, investment in mini-grids has not been made to a sufficient level to cover this gap (Hazelton et al., 2014: 222). This is partly because some practitioners consider mini-grids a second-rate and short-term solution for rural electrification (Practical-Action, 2014: 1-12). In addition, research available contends that mini-grid deployment is also associated with technological, social and financing impediments, limited community integration, excessive consumer demands and a lack of community-based maintenance technicians (Madriz-Vargas et al., 2015a: 9).

Despite the limitations, mini-grid technology continues to occupy the middle ground of rural electrification discourse as having the potential to bridge the gap between the conventional mainstream electricity grids and the individual home systems, with elements of each option but also having their unique features. It is also reported that they are associated with reduced power costs and the supply of improved power services. They also have presumed social and environmental benefits. (Hazelton et al., 2014: 222).

The growing preference for mini-grids is partly due to the crucial and manifest desire for solutions to quicken the electricity coverage in the face of the slow pace of the national grid coverage, the unreliable and poor-quality options for individual power energy options and the growing discourse about their merits. Mini-grid options tend to be more flexible than the national grids, are modular and provide better and more reliable energy than individual stand-alone home systems (Pedersen, 2016: 570-571). In addition, technological innovations,

particularly in solar photovoltaics, which supposedly lead to reduced power prices, improved efficiency and reliability, have created an environment in which renewable energy-based mini-grids become, as literature has it, comparatively less costly in comparison to other non-grid power options like diesel generators (ARE, 2011; IEA, 2011: 23). This is supplemented by the capacity of mini-grid-based smart solutions that use information communication technology that offers seamless interactions and management of power for both mini-grid operators and end-users (Ondraczek, 2014: 605). Mini-grids, according to Yadoo and Cruickshank (2012), also play a fundamental role in poverty reduction by enabling rural communities to access relatively low-cost renewable power and more extensive capacity networks that provide 24-hour electricity access for various productive uses, leading to a wide range of sustainable welfare benefits (Yadoo & Cruickshank, 2012: 591).

In addition, mini-grids have also been praised for commanding a higher sense of community ownership than national grids. Research suggests that a sense of community acceptability is crucial for cultivating shared responsibility and support towards community energy projects (Terrapon-Pfaff et al., 2014: 809-814). This sense of shared ownership also builds a strong basis for making decisions that enhance project sustainability (Kumar et al., 2009: 1950-1951; Ortiz et al., 2012: 347-351). In addition, transparency and two-way open engagement with community stakeholders, including local leaders, as Franz et al. (2014) suggest, are essential for designing an agreeable ownership structure that aligns with local community needs. Such arrangements further enhance a sense of local ownership right from project inception and increase levels of local support, which in turn contributes to the long-term success of the grid. Mini-grids that, for instance, adopt a hybrid ownership model with management shared between private and community members have been found to have a higher chance of success due to an increased sense of ownership, including women and men's involvement that enables communities to make crucial decisions about operation and maintenance (Franz et al., 2014: 11; Madriz-Vargas et al., 2015a: 9).

2.2.4 Constraints to the Deployment of Renewable Energy Systems

In line with the globally touted discourses on the requirements to cut carbon levels and at the same time extend energy to remote areas, the governments have attempted to “decentralize, decarbonize and democratize” their energy systems, most of the time using a bottom-up approach (Soutar, 2021: 2). These drifts, also referred to as the “three Ds”, have been adopted as the result of the desire to minimize electricity costs, replace the old power infrastructure,

promote efficiency and reliability, cut down carbon emissions to mitigate the effect of the much-condemned global warming and extend electricity to the hitherto unconnected areas. While different actors deploy different technologies for various reasons, it has generally been argued, as seen in the previous sections of this chapter, that mini-grids provide a flexible structure for extending renewable energy sources with different purposes (Hirsch et al., 2018: 402). However, conventional energy grids have always been preferred because they connect several power-generating units to different loads, reduce production costs per unit, and generate power from far-off, more extensive production sources like hydropower (Barker et al., 2001: 6-8; Lovins, 2002: 117-160).

Indeed, the benefits associated with renewable energy, as emphasised in the preceding sections, appear to be reaching global acceptability because of the reported economic and environmental issues they elevate. For example, the emergence of new technologies and the economic risks associated with constructing enormous electricity transmission infrastructure have encouraged power companies to shift progressively to lighter and decentralized grids (Lovins, 2002). This shift has been catalysed by benefits associated with smart mini-grids like the ability to reschedule generation, transmission and distribution investments, power supply controls, benefits related to reduced environmental pollution, decreased energy losses, improved power quality, streamlined demand management and capacity for standby generation (Gumerman et al., 2003: 11-28; Iannucci et al., 2003: 11).

However, despite the numerous discursively stated benefits of renewable energy, spanning from the decentralized power supply, cost reduction, and reduced environmental pollution, renewable energies have had their share of challenges that have sometimes slowed down their deployment in developed and developing countries. Therefore, governments and investors need to address some of the emerging challenges if renewable energy deployment is to be deepened fast enough to achieve the clean energy targets, as stipulated in the sustainable development goals and other related global discourses on sustainability.

First, the conversation about the most trending renewable energy technologies or grids is relatively new. Consequently, they are associated with uncertainties about the legal and regulatory framework, especially in countries that have not yet enacted enabling laws and policies. For instance, the Centre for Energy (2010: 55) argues that two legal questions impact microgrids. That is, authorities tend not to be sure whether microgrids are full electrical distribution utilities and thus fall within those grids supposed to be supervised by the national

electricity regulatory agencies or if they are outside state regulation as utilities. Then, if they are exempt from state regulation, do they qualify to be regulated under other laws that govern commerce in electricity? In some countries, this lack of a clear legal framework makes it hard for investors to secure resources from funding agencies to invest in large-scale, profitable renewable energy projects. Moreover, this uncertainty quagmire tends to scare investors from committing funds and securing long-term financing from development finance companies (Burr et al., 2013: 65; Centre for Energy, 2010; Kema, 2014: 10).

Another legal dilemma several countries have not solved is the law or policy concerning the interconnection of the mini-grids to the national grid. Although in most developed countries, there are standardized procedures to be followed in integrating the mini-grids into the main grid, in many developing countries, the policies are unclear or even defer from one region to another. Therefore, power producers must deal with unclear requirements for connecting to the main grid, and legal requirements may even differ from utility to utility (DeBlasio, 2013). Such a blurred policy environment leads to unnecessary delays that become costly in terms of finances and time. Countries, therefore, need to develop proper policy guidelines regarding the design, operation and integration of decentralized grid networks and their interaction with large grid networks where interconnection is feasible or necessary (Basso, 2014: 7; Hirsch et al., 2018: 402).

The increasing number of renewable energy sources may come along with issues of unreliability or unstable power supply from electrical grids. According to Anee (2012: 2) and Potter et al. (2009: 1-2), unlike fossil-based energy plants, electric production, particularly from wind and photovoltaics, is susceptible to energy fluctuations. Although this problem can be mitigated by predictions using relevant power electronics and setting up energy storage systems within the grids, an outage of a sizeable off-grid energy system can pose challenges to the customers. Furthermore, power losses also occur during transmission and distribution from the mini-grids to the end users. Operators can minimise voltage fluctuations by installing low voltage converters; however, they tend to be expensive to purchase and maintain, which in some way compromises the commercial viability of the renewable energy mini-grids (Anees, 2012: 2; Potter et al., 2009: 1-2).

Power volatility cases also emerge when a microgrid is integrated into the primary grid. When more renewable energy sources, for instance, solar, wind or ocean waves, are interconnected to the grid, they lower the capacity of those running the system to handle the additional power

variations that come with the added sources (Halamay et al., 2011: 321). It has to be noted that these added renewable resources are non-dispatchable (cannot be switched on or off to meet variations in customers' electricity needs). Therefore, their connection implies that additional power generation sources must be kept aside as backup in power fluctuations (Potter et al., 2009: 2). Whereas wind, ocean wave, and solar fundamentally have standard features as renewable sources, they generally differ in how their energy production fluctuates, and their power fluctuations affect the primary grid differently. Integrating these sources into the power supply network potentially causes electricity fluctuations due to their energy sources' sporadic and unstable nature. Output fluctuations mainly happen because there are always fluctuations in wind speed and changes in solar radiation over time (Liang, 2017: 855-857). The resultant voltage variations caused at one end by one gadget cause a reverse reaction at another grid point, substantially weakening the grids.

Power fluctuations further lead to the impairment of some electric equipment, leading to a decrease in their lifespan (Ei-Tamaly et al., 2007: 16; Linh, 2009: 2218; Shafiullah et al., 2010: 1). These issues have presented current and future microgrid operators with some questions to ponder (Kithsiri et al., 2011: 198). However, this problem can be minimized by manufacturing and deploying strong batteries and other power storage systems; however, these batteries are also expensive, making their use less economically viable (Anees, 2012: 2). To mitigate this problem, some operators allow end-users to use their equipment to control demand-side management, thus cutting the need to deploy battery energy storage systems (ibid).

In addition, energy storage in renewable energy grids helps maintain the electricity supply's reliability. Since most renewable sources have unstable and intermittent supply, setting up reliable storage systems helps to store excess power in times of plenty supply and provide energy when there are shortages in production (Lisserre et al., 2010: 9; Ming et al., 2010: 28-31; Shafiullah et al., 2010).

To further manage the effects caused by intermittent power production, renewable energy operators need to invest in forecasting and scheduling, preferably with smart technologies. The variability of renewable energy sources can be solved by building the capacity to predict long-term weather patterns, which are essential in designing measures to guide the integration of the renewables into the primary grid but are expensive (Potter et al. 2009). These have to be aligned to limit variations and interruptions in network security. This can be done by mastering the energy source patterns for the short term and long term. Thus, precise forecasting and

scheduling systems are necessary for the reliable deployment of renewable sources and for creating a load management structure for the grids. Renewable energy prediction is also essential for demand management and proper economic planning. Accurate information that can predict output over time helps maintain market stability and reduces operating costs (Potter et al., 2009; Shafiullah et al., 2010). However, it is argued that the mentioned interventions are expensive and may push total investment costs to levels that make renewable energy less attractive.

According to Salim & Alsyout (2020: 1065), the fluctuating prices of fossil fuels that occasionally make fossil fuels appear relatively cheaper than energy from renewable energy technologies also pose significant challenges to developing renewable energy. The high costs of renewable energy accessories like solar photovoltaics and wind or thermal machinery threaten investment decisions in renewable energy. Similar situations were for instance witnessed during the COVID-19 pandemic when the cost of oil substantially fell to as low as US\$ 26 per barrel, presenting a significant cost reduction for fossil oils (Saefong, 202: 1). Though the oil prices have since rebounded to their ordinary levels, such occasional shocks in the global oil market that lead to reduced prices for fossils may create a high appetite for fossils with a possibility of reduced demand for renewables (Magazzino & Giolli, 2024: 1-2). In addition to the low fuel costs, the presumed high-efficiency levels of natural gas and nuclear energy make them attractive energy sources and options for electricity generation in the long run. These realities pose challenges for investors and governments in decisions regarding investments in renewable energy (Salim and Alsyout 2020: 1056).

To mitigate the effects of these seeming price gaps, Komor and Bazilian (2005) state that governments and other international regulators ought to make policies and laws that compel investors to increase the renewable sources in their energy mix. For example, quota systems may be instituted demanding that electricity suppliers have a certain percentage of their electricity from renewable energy sources, and companies that do not meet this requirement may be penalized (Komor & Bazilian, 2005: 1873-1180). Governments can also develop other checklists with which companies that invest in electricity generation must comply. These checklists would possess a mechanism for compelling the companies to have a higher ratio of renewable sources within their energy production system (Lewis & Wiser, 2007: 1854; Mezher et al., 2012: 315).

In summary, this section has explored arguments for the adoption of renewable energy in accelerating energy access and sustainability. The major discourses contend that if universal energy access is to be achieved, especially in rural areas, innovative sustainable solutions like mini smart grids will play a vital role as they are associated with numerous advantages. However, though basic research has been done on the technical and economic viability of these mini-grids, there are still limited studies on integrating social factors, which, according to a body of scholarship, are vital for any development undertaking to be sustainable. The following section accordingly explores the role of social factors in the sustainability of renewable energy projects, with a significant focus on gender integration.

2.3 The Case for Integrating Gender and Other Social Perspectives in Renewable Energy

This section examines discourses on the gender dimensions of renewable energy facilities, particularly how renewable energy grids and investments promote gender equity or how the benefits accruing from renewable energy services can be distributed equitably between men and women. It also looks at the gendered discourses and discursive practices in society that have consistently impacted women's and men's participation and access to renewable energy projects. Through the discussion, the concept of gender is purposely applied rather than sex. This section also discusses gendered education as a factor that facilitates or hampers women's and men's participation in energy systems.

The Paris Agreement, the UN sustainable development goals and other international treaties and legislations have set the agenda for integrating gender equality in climate change-related programmes and the basis for promoting gender-responsive actions in all interventions. For instance, Article 7 of the Paris Agreement is categorical in providing a framework for gender equity (UN b, 2015: 6). However, it has to be appreciated that although mainstreaming gender issues in climate change-related interventions like renewable energy is vital for agenda setting, implementation of actual actions is a complex affair. Indeed, implementing renewable energy programmes is an intricate technical and economic exercise and a heavily political and gendered process (Lieu et al., 2020: 1). One of the bottlenecks in mainstreaming gender perspectives in renewable energy, particularly in the South, arises from the deep-rooted gender discourses and resultant power dynamics between men and women, which facilitate exclusion and disparities in access to and control of resources in addition to decisions making. As already noted, these disparities emanate from the undisputed and entrenched practices, dominant discourses and

norms that have compounded the unbalanced gender and power relations within the social structure (Alston & Whittenbury, 2013: 3-14; Dankelman, 2010: 1-18; Scoones et al., 2015: 27). The entire value chain of implementing renewable energy projects is based on negotiated processes involving different players with their interests and perceptions of how the processes ought to move. Dominant perceptions always get priority, but these dominant perspectives and actors ignore or accord inadequate consideration to the gender dynamics and discourses in the renewable energy planning and implementation processes (Bosman et al., 2014: 45-46; Isoaho & Karhunma, 2019: 930).

Much as some existing studies might analyse similar dynamics in the global north, similar studies on how gender dynamics and discourses intervene in renewable energy, particularly among the global south countries, are scarce or absent. Gender further becomes a complex issue considering the fact that it is not just a binary category but instead an intersectional issue with overlapping and underlying aspects of power and inequality that include class, ethnicity, age, race, level of education, citizenship and other influencers (Azocar & Ferree, 2016: 1081; Cho et al., 2013: 785). This study, therefore, further explores some of these gender discourses and practices and their multi-layered influence on access to and participation in renewable energies.

Renewable energy project developers tend to ignore social infrastructure, including gender, which should facilitate the sustainability of the whole system. Kemp (1994) posits that energy systems involve the generation and demand side features in addition to complementary physical and social infrastructure. Thus, investments in the physical and technological infrastructure must be supported or may cause changes in society's policies, labour relations, and other sociotechnical elements (Kemp, 1994: 1027). Quite often, gender dimensions are missing in the design descriptions of energy projects, despite the fact that energy programmes carry great potential for integrating gender perspectives, especially if they are to have a meaningful impact on society. A close analysis of many policies and discourses on energy and climate reveals that technical and economic perspectives and their contribution to society tend to be more prominent (Kronsell, 2013: 7-8). For instance, the scientific community's strong bias on technical inclination in climate and energy-related business is evident in the 'Fifth Assessment Report' on climate change. The main report was compiled by a composition of 39 males (88%) out of the 44 authors (Hughes & Paterson, 2017: 747). A similar case is the much-publicized "shared socioeconomic pathways describing world features in the 21st century" (O'Neill et al., 2017: 169-180). This report which also became part of the Intergovernmental Panel on Climate

Change (IPCC), was authored by 11 males out of 12 authors (Lieu et al., 2020: 2). Although there might be nothing academically or legally wrong with males dominating authorship of prominent programmes and reports, it is paramount to critically question the gendered nature of the programmes, policies, projects and interventions by going beyond the gender composition of the developers, implementors but also whether they incorporate deliberate issues of social equity and gender equity in access and benefits. One of the arenas where such gender inequalities can be reviewed is the renewable energy sector.

Renewable energy value chains offer a conducive opportunity for interrogating gender equality issues since the implementation of energy projects and energy supply operations are often met with power inequalities and discourses associated with the politics of the policy processes (Luchsinger & Adams, 2009: 22; Lyster, 2015: 26). Discourse on energy planning and implementation tend to over-concentrate on the engineering parameters, and attempts to consider social and economic issues only tend to narrowly focus on investment costs, power prices, and work and employment issues without going further to examine other dimensions like gender. This narrow analysis of the social aspects results from the tendency of ‘scientists’, engineers, and economists to dominate the energy project and policy cycles (Lieu et al., 2020: 1; Luchsinger & Adams, 2009: 22). Accordingly, this may create social (and gender) injustice (McCauley et al., 2013: 1-3).

Moreover, most of the available scholarship on gender and renewable energy has classified women as vulnerable categories that deserve protection from climate vagaries (True, 2003: 375-383) at the household level (Osunmuiwaa & Ahlborga, 2019: 146-148) or just (powerless) women of developing countries that need to be provided with energy to improve their livelihoods (de Groot et al., 2017b: 86). The tendency to tie women to domestic chores is partially due to the socialised gender discourses that entrench gendered division of labour where women are associated with unpaid reproductive work within the household while paid formal employment in the formal arena is reserved for men (Terry, 2009: 20). Women are also portrayed as guarantors and protectors of the natural environment, albeit devoid of the required support resources (Arora-Jonsson, 2011: 745). In addition, the contribution of women in the technically oriented industry is principally invisible as knowledge production and processing in the field of science and technology is heavily dominated by males. Thus, the production chain in the renewable energy field is dominated by masculine-led engineering and technology

activities partially emanating from the gendered education systems and gender disparities in the STEM fields (Eagly & Steffen, 2000: 735-754; Ryan, 2014: 101).

Energy production processes are regarded as avenues of providing utility and remedies to the existing technological gaps (Crewe, 1997: 59-80). There is also the tendency to divorce technology from the society in which the technology investments are implemented, thus wrongly rendering technology a socially and gender-neutral issue (Liebrand, 2014: 31; Zwarteveen, 2017: 90). Yet, men are discursively presumed to possess inherent leadership qualities compared to women, as demonstrated by their dominance in almost all fields of society where power and decision-making authority need to be exercised (Osunmuiwaa & Ahlborga, 2019: 149-150). Situating gender perspectives in the renewable energy debate can, therefore, trigger the need to interrogate the politics of decision-making from a feminist perspective (Ahlborg & Nightingale, 2018: 5).

Power and politics are embedded in all levels where authority structures are modelled and replicated, and how some forms of knowledge give legitimacy to emerging power relations. These forms of knowledge produce (and are produced by) gendered discourses that outspread the intentions of those in power and biased knowledge (Lieu et al., 2020: 3; Oksala, 2013: 37-40; Robbins, 2012:). This understanding can perhaps explain how and why several renewable energy policy interventions and projects tend to ignore different gender dimensions, thus rendering such projects ‘gender blind’ (UNICEF, 2017: 3) or presenting ‘tokenistic gender considerations’ (Lieu et al., 2020: 3). However, if well managed, scholarship on gender and energy can always be a basis for transformative interventions and struggles to force those in authority to put gender and other social considerations on the decision-making agenda in the realm of renewable energies and other technical and social interventions.

According to Khamati-njenga & Clancy (2002: 9), energy constitutes an essential ingredient in all commercial and non-commercial spheres of society. The value and quality of energy accessible to the community, therefore, is directly proportional to the efficiency and effectiveness of productive activities in addition to the value of lives led by energy consumers and other community members. Consequently, men and women in the community ought to be given an equal stake in the implementation and consumption of energy services (Atif et al., 2021: 23). But as evidence from the literature indicates, this might not be the case as males and females do not enjoy equal access to energy investments. Along the same lines, the energy

supply is associated with different social and economic results for men and women (IRENA, 2019: 10).

The differences in energy access are partly due to the gendered division of labour and the varying perceptions regarding the benefits of energy and the potential to get and manage those outcomes based on gender relations and interests (Cecelski, 2000: 31). It is argued that negotiations based on gendered interests may influence who benefits and how the benefits are utilized. For instance, a study by Khamati-njenga and Clancy (2002) reveals that whereas male heads of households may decide to fix the electric lighting outside the house for reasons related to securing family property, women may prefer that the light be fixed in the kitchen for easy illumination of the place as they cook or carry out household chores (Khamati-njenga & Clancy, 2002: 10).

Indeed, a related study on the benefits of mini-grid electricity in Sri Lanka revealed that among the end-user households, men and women enjoyed the power supply equally, though based on different uses, particularly television and lighting (Barnett, 2000; Dhanapala, 1995). However, for unserved households in the same communities, the benefits were unequal between males and females. The benefits among the families that didn't have direct access to electricity only rotated around the ability to watch television and hire lights for specific undertakings. Enjoying TV required visiting households with television sets in the neighbourhoods. Consequently, these benefits only accrue to men since they have the freedom and time to move around, especially at night, visiting households or premises with electricity connection, an opportunity barely afforded by women (Khamati-njenga & Clancy, 2002: 10).

In addition, most of the energy investments tend to respond to women's and men's interests unequally because, for a long time, energy planning and electricity distribution have tended to focus on large-scale commercial and capital-intensive investments programmed to provide electricity for the transformation of the formal sectors of the economy and commercial production (Savacoolet al., 2012: 716) which for reasons associated with gender are dominated by men (Cecelski, 2002: 26). These investments, by design, tend to eliminate small-scale and informal sector-based personal labour-intensive enterprises ordinarily operated by women using their physical efforts and locally available inputs to benefit family subsistence.

Quite often, the majority of the activities in the household that need energy expenditure are given limited attention during the process of planning for energy. Some of these activities may

include food preparation and storage, purchase of water, and household fuel, to mention but a few (Dzioubinski et al., 1999: 4-5). In many developing countries, most of the said activities fall almost exclusively under the ambit of women in the socially constructed gender division of labour. It has to be observed that women's involvement in energy consumption is highly limited to small-scale culturally based activities, which contribute to their relative segregation in the sector. Similarly, men without a solid economic base are also excluded from penetrating or benefiting from large-scale energy use (de Groot et al., 2017: 88).

The old approach by energy planners and developers has tended to apply a gender-neutral approach to planning, which carries a risk of generating gender-twisted policies and outcomes (Kabeer, 1994: 1). This so-called blind approach is premised on the assumption that once the programme is implemented and generates benefits, men and women will benefit equally. The approach ignores the fact that there are strategic and practical gender needs that need close attention. The assumption that the needs and roles of men and women are the same, according to de-Groot (2017), is problematic, and according to the same author, this problem continues to be propagated by several development planners. Accordingly, the outcomes of these gender-neutral investments are that they may inadvertently fail to close the gender gaps and, at times, worsen the level of inequality (de-Groot 2017: 86-97).

It is also argued that planners without an intersectional approach treat community composition using a household unit as the basis of analysis, not men, women, bisexuals and transgender people, children, people with special needs or any other classifications that may consider differences in needs and capacities of people within the same households (Goetz, 2006: 71; Jahan & Mumtaz, 1996: 825-825).

Therefore, programme or project impact evaluators tend to assume that once an intervention like an energy project has improved production at the household level, food production and storage, or business and financial earnings at the household, the project is labelled successful. However, according to Sovacool (2012: 716), such conclusions of success are limited in scope as some indicators show that most of the time, even when modern energy facilities are introduced, households and business entities in rural areas keep switching back and forth between energy sources or deploying them concurrently. Moreover, it is also stated that community members tend not to discard their traditional energy sources for diverse reasons ranging from affordability, availability, reliability, and cultural beliefs about some energy sources and traditions (Hiemstra-van der Horst & Hovorka, 2008: 3342; Sovacool, 2012: 716;

Van der Kroon, Brouwer & Van Beukering, 2013: 505-506). In addition to constraining a balanced enjoyment of modern renewable energies and technologies by all, such constraints also may derail sustainability (Van der Kroon, Brouwer & Van Beukering, 2013: 505-50).

2.4 Applying Gender Analysis in Renewable Energy Planning

If the prescriptions of sustainable development discourse are to be followed, then implementing renewable energy projects will require a prior understanding of the community members' needs disaggregated according to men, women, children, and other social-cultural categorisations that constitute the target community. Therefore, the analysis needs to focus not only on the needs before implementation but also on the possible project benefits and outcomes that will accrue to men and women (and all other categories) (Shrestha, 2008: 5-13).

Discourse on gender analysis proposes diverse approaches to analyse gender roles and relations, including norms, perceptions and gender division of labour (Chukuezi, 2009: 333-335). It is also stated that gender analysis exercise attempts to find answers to questions about roles, needs and power relations between females, males and other genders. These questions may include which activities are done by men and women in the household and the community, which productive resources are owned and controlled by men and women, what dynamics underpin decision-making at household and community levels and who makes such decisions (Filteau, 2014: 396-416). Other questions may relate to how the benefits of the project intervention are distributed among men and women or other members of society (March et al., 1999: 19).

According to Kabeer (1994), gender analysis begins with examining what is happening at the household level and how this household organisation of roles connects to the broader community. It also strives to explain what exists within the household and how these dynamics interweave to influence the roles and relationships in the wider community (Kabeer, 1994). It does not attempt to focus on women alone, and its objective is not to provide evidence of how women suffer marginalization at the hands of/ or more than men. The analysis instead strives to provide an informed understanding of how societies operate based on the relationship between men and women and their interests (Cornwall et al., 2004: 1).

However, as Clancy & Roehr (2003: 44) contend, these gender interests are not just a given; likewise, the likely outcomes of renewable energy projects for men and women are not obvious. Therefore, as argued by Moser (1993: 4), deliberate efforts need to be expended to interrogate those interests and impacts. Indeed, studies by Chant and Craske (2003) revealed that on many

occasions, unsuitable interventions are executed not based on deliberate studies but just on usual assumptions and discourses. For instance, many energy planners or policymakers in the global south tend to design the projects on the assumption that women's benefits from electricity access will rotate around cooking and that, therefore, installation of energy projects will reduce time spent on firewood collection, a 'problem' (in the implementors opinions) that needs an immediate solution (Chant & Craske, 2003). However, evidence from research argues that a close look at the linkage between gender and energy consumption reveals that reducing women's energy needs to merely cooking needs is narrow and shallow in focus as it ignores several other issues concerning gender energy needs and the outcomes that accrue from energy investments (Pereira et al., 2010: 1234; Modi et al., 2006: 25-26).

As society evolves and women get involved in activities that were hitherto a preserve of men and vice versa, even matters concerning cooking have become more complex than they used to be (Davies et al., 2008: 344; Schirnding et al., 2000: 5). For example, men participate in firewood collection and make critical decisions like looking for a source of energy for cooking, including buying charcoal, energy-saving stoves or gas cookers (World Bank, 2011: 10-34). Similarly, women have become active participants in more household and community activities beyond cooking. Therefore, planners and policy implementers need to understand these dynamics without relying on narrow traditional assumptions and discourses about gender roles (Karlson & Clancy, 2000: 2-5).

Methodologically, gender analysis is conducted using different approaches and tools or frameworks, the most common ones according to literature, being the Harvard analytical framework (March et al., 2005: 32; Overholt et al., 1985: 1ff), Moser framework (Moser, 1993: 1-87), Gender analysis matrix (Parker et al., 1993: 1-25) the Social relations approach (March et al., 2005: 102) and others. The scope of this thesis does not allow for further details on each approach. However, I will later in this subchapter expound on the Moser Framework (Moser 1993: 1ff) as I find it more applicable to the East African gender division of labour and energy contexts. This is because the Moser framework classification of women's triple roles/burdens aligns more appropriately with the typical gender division of labour in rural East Africa. For example, as Moser (1993) suggests, women in East Africa are predisposed to shoulder productive, reproductive and community management roles. However, one common denominator of these analytic tools is that they are systematic tools that aid in establishing the persisting gender dynamics in a particular society (Andersen, 1992: 165-197; Buvinic, 1984:

569). Furthermore, using a set framework, the analysis tools can also help planners evaluate the potential impact of an undertaking such as a renewable energy programme on men, women and other categories of the people in the community.

March (1999: 2) defines a framework as a mixture of concepts or thoughts that aid in examining social reality, premised on a set of traditions about the structure of society, how society operates and the existing behaviours and relationships within that particular society (March 1999: 2). Such a framework also considers aspects of an issue in question, how it is understood in society, the nature and mode of questions to pose in any study and the potential remedies likely to be suggested to address the problem (Kabeer, 1995: 115; Khamati-njenga & Clancy, 2002: 12). Based on these arguments, it is possible to apply different analytical frameworks to analyse a single issue since different actors or members of the community may have diverging assumptions about the same condition. In some cases, one framework is more suitable than others based on the prevailing settings and context. Based on the foregoing, a gender analysis exercise for an energy project could, therefore, first attempt to examine the nature of gender relations and inequalities that prevail in a particular society and then point out any gendered dynamics that may crop up if a renewable energy investment is established within the community (Warren, 2007: 187-188).

It is suggested that conducting a gender analysis for renewable or non-renewable energy establishments is vital as it helps to address the key questions. Accordingly, the first question relates to needs, establishing the diverse needs of men and women to enable them to attain more sustainable livelihood strategies. The second issue is identifying constraints to participation, whereby any roles of men and women that have the potential to hamper their involvement in the energy project are explored (Doss, 2013: 2-5; Khamati-njenga & Clancy, 2002: 11-13). This is coupled with examining the stakeholders' willingness and capacity to participate in the energy intervention, considering different aspects like levels of education, agency and freedoms and others. Finally, another critical issue investigated is the level of benefits that accrue from participation by examining the diverse ways men and women (and others) will or will not benefit from the energy project in question (Khamati-njenga & Clancy, 2002: 13; Pasteur, 2002: 1).

It is further proposed by Karl (1995: 1) that gender analysis should be conducted in line with the different levels in the energy project or policy cycle, that is, the planning and design phase, the implementation/operation phase and the monitoring and evaluation phases, or any other

steps that the planners may decide to follow (Karl, 1995: 1). Focusing the analysis on all cycles of the intervention ensures that the relevant gender relations or gaps are not unintentionally missed or under-rated and that any interventions or strategies made in implementing the project are taken with a better appreciation of the potential impact of the particular energy project on women, men, children and other categories of society under consideration (Mahama, 2001; Skutsch, 2004: 3-4). Gender analysis in the renewable sector uses simple tools for collecting and processing gender-disaggregated data such that any existing differences are visible to internal and external stakeholders, confirming the reasonableness of the project decision process. This can further significantly impact the beneficiary community by putting to the fore the existing gender differences that may need further scrutiny.

To be effective, March et al. (1999: 22) suggest that gender analysis should be conducted during the planning process and continue through to other phases, which helps to ensure that gender is 'mainstreamed' at all levels. In addition, this ensures that gender concerns are treated as crosscutting and thus mainstreamed in every project and at every phase.

As observed earlier, there are standard analytical tools usually applied by development experts, like the Havard framework matrix and the Gender Assessment Matrix. (March et al., 2005: 32, 68). However, despite their comprehensive coverage in most of the development literature, Skutsch (2004: 16) argues that these frameworks become wanting when it comes to planning and implementing energy interventions. The main criticism given is that these frameworks provide no clear-cut guidelines on interventions to address gender concerns. In addition, the tools miss some basic questions like the type of energy women use or need to accomplish their tasks, what kind of energy men and women need, and the related activities. In addition, it is argued that these tools do not provide answers to questions such as what type of energy reduces women's domination, improves their productive capacity or improves their livelihoods or how the energy project can best be designed and implemented to enable women to have control of the activities and outcomes (Khamati-njenga & Clancy, 2002: 13).

Despite the availability of several analytical tools, as noted in the preceding discussions, the most commonly applied by development agencies, according to the literature on the energy-related sectors, is the one developed by Caroline Moser, which has come to be termed the Moser Framework of Analysis. This framework will be explored further in the following discussion.

The Moser framework bases its analysis on what is referred to as the women's triple role/multiple burdens and the practical versus strategic gender needs /interests (Moser, 1993: 1799-1825). The triple role concept looks at the gender division of labour and categorises the work of men and women into three major areas: reproductive work, productive work and community managing work (Skutsch & Sanogo, 2001: 9-10). Reproductive roles are defined to include all the activities that are done to reproduce the labour force in the household, which may consist of bearing and nurturing children, feeding the household, nursing the ill, teaching manners to children, helping kids with homework, cleaning and washing and other related chores. Thus, the introduction of renewable energy intervention would help to reduce workload, help women and men to save time, improve the quality of the results in reproductive work and generally improve the quality of life (Burn & Coche, 2001: 61-69). The second work category of roles is productive roles, which encompasses all activities done by men and women for payment, either in cash or kind. These activities involve the production of commodities (goods and services) for subsistence or commercial purposes. The implication of renewable energy provision for this type of work is that the energy would help to reduce workload, promote effectiveness and efficiency, and improve the value of outputs produced and all other activities involved in the value chain (UNDP, 2015: 29).

Community management tasks, which constitute the third group of tasks under the Moser framework, include all activities done for the betterment of the community, for example, charity work, self-help activities like cleaning water sources, clearing communal centres, participating in local council committees, participating in religious activities, visiting other members of the community, attending meetings at school and many others. The major burden here is that community management roles are seen as an extension of women's productive roles (Layon 2017). The introduction of electricity in the community, therefore, may improve community roles through, for example, improved communication systems and the installation of lights in the streets and community centres, hence extending the duration of communal activities into the night (Barnes et al., 2003: 1; Bensch et al., 2013: 4; Szakonyi & Urpelainen, 2015: 47).

It should be noted that in some instances, the distinctions within the three categories of work tend to be problematic as the lines separating them may be blurred. For example, for someone contesting for a political election to sit on the village energy management committee (which sometimes attracts some financial allowances), it is hard to determine whether such work can be categorised as productive or community management work. Secondly, whereas men,

particularly in many countries of the global South, are predominantly involved in productive and community roles only, women are likely to engage in all three categories, which makes them occupied for full days (Chant & Pedwell, 2008: 3; Clancy & Dutta, 2005: 2; USAID, 2005: 5). They are expected to perform a whole day's work of producing food for the family or getting employment outside the household but also doing household chores of nurturing the family and attending to community responsibilities (Longwe, 1991).

Although the Moser framework has received a more comprehensive application by scholars and practitioners, it leaves some unanswered gaps. For example, the issue of gender roles may undermine other issues that frame gender relationships. In addition, it tends to assume a stable balance and acceptance of each individual's tasks and obligations when, in the actual sense, there are continuous negotiations, contestations and concessions in the sharing of work. Finally, the framework also tends to ignore continuous changes in the socioeconomic structure over time and concentrates on gender inequality, disregarding other forms of inequality, such as caste, class, level of education, and race (Moser 2014: 20).

The theory of the triple role may also be criticised for a failure to consider the difference between activity and outcome. For instance, the outcome of child care can be realized by the mother staying at home or through a private child care facility or, in some cases, government facilities, and these are very distinct in the way they affect women or women's roles (Kabeer, 1994; March et al., 1999: 22-23).

Despite the critiques, the tool provides a good framework for analysing gender roles and relations and their implications for project activities and outcomes for men and women. It also advocates for gender sensitivity in all interventions while emphasizing that project planners and implementors should deploy approaches that promote welfare, efficiency and empowerment of men and women to meet the practical and strategic gender needs. These tools and recommendations would, therefore, be handy for renewable energy project planners and implementors if their interventions are to produce outcomes that promote gender equity and sustainability.

2.5 Dynamics of Women's Participation in Sustainable Renewable Energy: Constraints and Opportunities

The former president of Ireland, Mary Robinson, a renowned renewable energy advocate, once remarked that climate change is a man-made obstacle that requires a feminist approach to

redress (Tabry, 2018: 1). From that remark, it can be deduced that the contribution of gender dynamics and, more so, women's stewardship in global campaigns that promote the revolutionization of the energy sector and climate change adaptation is a crucial subject that requires further analysis from theoretical and practical points of view. For instance, Allen et al. (2019: 1) observe that incorporating gender perspectives in energy transitions will create more opportunities for fast-tracking energy transformation. Substantial evidence from academic research and local discourses suggests that society is characterised by a patriarchal social structure that tends to develop and reinforce patriarchal systems of power and control across many fields of society (Mikkola, 2019: 198). These dominant patriarchal social structures tend to create life worlds designed for men (Glazer, 2019: 1) and decision-making in the energy sector has particularly followed the same trajectory (Pearl-Martinez & Stephens, 2016: 17). As questions of justice, inclusion, and participation gain popularity in climate change and energy policy debates, studies on women's inclusion and participation in the energy sector also become paramount. Gender relations influence threats to sustainable development and how communities address those threats and hazards (Allen et al., 2019: 4). Along the same line, socially constructed roles of men and women tend to determine factors that influence the actors in decision-making in the energy sector and sustainability discussions (Leduc, 2010: 390; Nagel, 2015: 1; Pearse, 2017: 1).

Taking an example of climate change as a sustainable development issue, some studies have attempted to examine the distinctions between its effects on men and women and how gendered relations intersect with opinions about climate change knowledge and policy options (McCright, 2010: 76; Nagel, 2015: 1) and how public or private interventions to curb global warming may buttress or diminish gender disparities (Arora-Jonsson, 2011: 750; Ergas & York, 2012: 974). Thus, the role and participation of women in climate change action and justice need to be given more attention (Cable, 1992: 40; Di Chiro, 1998: 104-136; Rocheleau et al., 1996: 8-9). Furthermore, according to Cecelski (2000: 12), there is a strong correlation between 'women's issues', climate change and energy; therefore, the harmful effects of climate change increasingly interrupt women's livelihoods and access to energy. Consequently, scholars (e.g. Cecelski, 2000: 12; Farhar, 1998: 231; Shiva, 2010: 43) have, through research and recommendations, shown a necessity for technological innovations that lessen the harmful impact of climate change on women while at the same time advocating for increased levels of women's participation in energy transition activities.

Considering studies on the countries of the global south (e.g. Farhar, 1998), there are indicators that women are the most burdened by energy needs at the household level, for example, in the mobilisation of wood fuel for cooking, which calls for a significant emphasis on gender and the role of women in energy planning, implementation and operation (Farhar, 1998: 231). This includes tailoring energy technologies that address not only large commercial and industrial interests but also the household energy needs of rural women, particularly in developing countries. Most of the time, energy investments have traditionally focused on large-scale infrastructure undertakings that do not contribute to creating energy access solutions for most poor populations (Farhar, 1998: 230; Winther et al., 2018: 66). Policy planners who incorporate the concept of women's poverty and inequality have designed and promoted energy policies that target women's vulnerabilities while stimulating household energy access (Osunmuiwaa & Ahlborga, 2019:154). This approach can strengthen gendered perceptions relating to decision-making structures in the community by targeting women's agency in the household.

Moreover, according to Baruah (2017: 18-29), even when energy projects are introduced in a community, women's capacity to get absorbed into the newly created job positions is often curtailed by structural obstacles that hamper their education, access to property entitlement, land access and control rights, access to business finance and mobility challenges. For this reason, decision-makers need to look further than energy distribution and address bottlenecks limiting women's access to business opportunities. Additionally, analysis of the energy sector should also go beyond simply looking at the number of female employees in the energy industry as the measure of women's participation in the energy sector, something that is common within the energy gender discourse, and women's involvement in energy development reports (de Groot et al., 2017a: 89-90; Fraune, 2015: 62; Listo, 2018:). Most of the time, social and sometimes political factors influence women's access to energy resources, including ownership, involvement in productive uses and making decisions related to investment or consumption of energy resources (Fraune, 2015: 55-62).

Notions of women's love for and proximity to nature, kindness and their roles as mothers and guardians have been mainly raised in debates involving the conservation of biodiversity and sustainable energy resources (Cable, 1992: 37; Perkins, 2012: 78; Stavrianos et al., 2008: 1-15). Female conservationists often talk about nurturing children, guaranteeing safety for future generations, protecting families and maintaining a healthy and clean quality of life for all members of society (McCammon et al., 2018: 1). Beliefs about women's susceptibility, caring

character and their tendency to be more considerate about climate change are reflected in most of the scholarship on gender and climate change (Denton, 2002: 12). However, as Arora-Jonsson (2011: 744) mentions, just focusing on women's vulnerability to the impacts of global warming and women's kindness in guarding their households against climate change hazards may generate unintended repercussions of diverting attention from the gendered power relations and imbalances in all levels of society. Once this happens, the introduced projects may reinforce the existing gender injustices in the social structure.

It is argued that in the 1970s when ecofeminism became a critical area of environmental activism, patriarchy and women domination were closely linked to environmental destruction, while some argue that to gain acceptability from male peers, women movement leaders had to adopt leadership styles that were masculine leaning (Allen et al., 2019: 4; McCammon et al., 2018: 1). It is also argued that energy planners and policymakers who use a gender-neutral approach tend to inadvertently facilitate the exclusion of women's needs and their likely participation in the energy sector. However, as Farghali et al. (2023) posit, in recent times, decision-makers have made some moves to mitigate this problem in national energy planning. However, such mitigation measures are limited to household energy as they consider women to be the primary custodians of cooking and, thus, the ones concerned with the search for household fuel, and hence, there are no gender considerations at macro levels.

Another discourse, as forwarded by Khamati-njenga & Clancy (2002: 11), argues that in the global south, the primary source of energy for cooking is biomass, which is mainly dependent on firewood, charcoal, crop residues and other woody materials and that where attempts have been made to include women's needs in energy planning, the focus has tended to be narrowly directed towards addressing biomass energy-related needs. However, such a focus would be considered insufficient since women possess more electricity needs and potential beyond just cooking. Moreover, the productive roles in the community that women get involved in also require energy beyond biomass energy. Women, like men, need access to energy to engage in business and other productive uses beyond the household. It further has to be observed that though concern and attention about women's needs are gaining more attention in debate and scholarship, this concern, as Khamati-njenga and Clancy (2002) observe, may not arouse the requisite investments to address these needs and concerns. For instance, whereas many aid agencies were hitherto focusing on investments in energy-saving stoves, funding for the same

has been reduced (GACC, 2016: 1-4; World Bank, 2011: 1ff) despite their perceived efficiency in saving time and resources (Krishnapriya et al., 2021: 102).

Another discourse shows the failure of development practitioners in the energy sector, primarily politicians and engineers, to understand the meaning and relevance of gender mainstreaming in energy programming at local and global levels. Thus, according to the positions brought forward here, these planners may not intentionally exclude women in energy planning, but their seemingly gender-blind stance may technically exclude women from their energy programs and projects. Despite this anomaly, however, there has been good progress in mobilisation and practices on many fronts to create gender-sensitive energy policies, programmes, and investments. Accordingly, such interventions take cognizant of the fact that women need to participate and access the energy sector like men do, though their gendered roles still constrain the nature of women's participation. If such positions are adopted, then gender-sensitive energy programming will address the concern that women and men have different roles and practical or strategic interests that warrant consideration to ensure inclusion. However, some of these needs and priorities may parallel those of men. For instance, studies by Khamati-njenga and Clancy (2022: 11) found that for an energy project that has solar water pumps as one of the outputs, women will tend to prioritise tap water for drinking and household use, which is a practical need addressing reproductive roles, while men would prefer water for irrigation, a practical need that leans towards addressing men's productive roles (Khamati-njenga & Clancy, 2002: 11).

In addition, limited access to energy by households for domestic and commercial investments correlates with poverty levels, poor outputs, exposure to laborious work and associated health problems (Picolotti & Taillant, 2010: 1). Nevertheless, women suffer more from the consequences of a limited energy supply. Therefore, the lack of agency in affording substantial, cost-effective, dependable and clean energy that facilitates economic and social transformation is a crucial issue that warrants solutions (Reddy, 2000: 44).

Indeed, as observed before, access to innovative energy services has been prioritised in most of the local and international development discourse, and energy policymakers like the UN under the Sustainable Development Goal (SDG) 7 attests to this. Despite the efforts, most emphasis has been placed on boosting the production of energy for domestic activities at the household instead of producing energy for commercial and productive uses, though evidence suggests that investment in the productive use of energy beyond the household stimulates more economical

and social benefits to the population (Modi et al., 2006: 26; Picolotti & Taillant, 2010: 1). Consequently, boosting commercial activity in the community as Chen, (2017: 86-97) puts it, is particularly transformative for women since it increases their earnings, effectively reduces poverty, and minimizes subordination while enabling them to meet their practical and strategic needs (Chen, 2017: 86-97). Based on such discourse therefore, to promote women's empowerment, energy access activities should transcend the traditional emphasis on household energy for household use to cover energy that facilitates micro and small-scale investments beyond the family (Shrestha, 2008: 5). Studies investigating how the above goals can be achieved are, consequently, essential (de Groot et al., 2017a: 89; Fishbein, 2003: 14-15; Kooijman- van Dijk, 2008: 326).

2.6 Discourses on Energy Access, Labourforce participation and Women's Empowerment

As observed in the preceding discourses and discussion, women's failure to access adequate energy hinders domestic and commercial activities (UNDP, 2003: 14-15). Yet, women contribute immensely to social and economic activities as food producers and caregivers and handle numerous reproductive and community management work. According to the World Bank (2011: 19) women's multiple involvements in productive, reproductive and community management roles render them to have energy needs that differ from those of men, though many energy policy planners and implementers rarely consider the unique concerns, needs and contributions of women in society (Carvajal-Escobar et al., 2008: 277; World Bank, 2011: 19). It is further added that policies that do not give due diligence to gender differences and roles related to energy and business activities are highly likely to benefit men more than women, as women face substantial roadblocks and obstacles in setting up and managing business investments due to structural barriers linked to roles and perceptions (de Groot et al., 2017b: 85). This predisposition is compounded by the fact that women are often excluded from the energy planning and policy process (Clancy et al., 2003: 10) despite the available evidence suggesting that access to energy services and innovations results in not only empowering women but also reduces gender gaps between men and women (Bensch et al., 2013; Mahat, 2003: 1).

According to Skutsch (2005a: 40), energy-related initiatives and projects amazingly empower women. Skutsch outlines three goals for women's empowerment in the framework of energy projects and policies. The first goal relates to what she termed welfare needs, which refer to

enhancements to women's welfare, improved quality of life, reduced labour hours and fair working hours for women compared to the hours spent by men. This welfare goal also incorporates a reduction of health and security risks encountered during the search for firewood and severe respiratory risks associated with air pollution, mainly caused by smoke from dirty energy sources (de Groot et al., 2017a: 88; ESMAP, 2017: 40; Kes & Swaminathan, 2006: 22).

The second goal relates to empowerment, which results from the solutions to barriers that have long prevented women from participating in economic enterprise and social and political activities. Thus, this goal concentrates on enhancing women's participation in political and decision-making processes concerning the planning and implementation of energy projects and innovations and on facilitating the reduction of inequality in the public decision-making realm, for instance, through improved access to information and communication facilities (de Groot et al., 2017b; Matinga & Annegarn, 2013: 295). Skutch further gives the third goal, which relates to productive activities and states that this goal refers to circumstances in which access to energy services enhances women's productivity and creates opportunities that foster women's economic performance. This improved economic performance improves women's earnings, enhancing economic self-reliance (Kooijman-van Dijk, 2012: 534; Matinga, 2010: 92-97).

Skutsch (2005: 40) further urges that improved access to energy sources can principally increase prospects for women to enhance their earning potentials, health benefits, more study time at night and access to information. However, whether such developments culminate in enhancing gender goals, in reality, is contingent upon several other social, cultural and political contexts (de Groot et al., 2017b; Matinga & Annegarn, 2013: 295). Thus, scholars have questioned assumptions about the relationship between energy and women's empowerment. For example, Clancy et al. (2004: 9) contend that the energy supply exercise may intensify gender inequalities if the project is not deliberately focused on the specific needs of women. This can happen, for instance, by increasing the number of days women have to work instead of cutting down their work burden.

Despite the above, gender parity is attained through empowerment and arguments in support of the role of energy access in enhancing women's empowerment and transforming gender roles are abundant (UNDP, 2015: 31). This, however, is contingent upon the meaning of the discourses of women's empowerment.

The UN Women (2023: 16), for instance, looks at empowerment to mean the capacity of men and women to be in charge of their lives, that is, their agency to make choices, set their targets, gain knowledge and skills, improve self-confidence, solve problems on their own and develop independence. From the definition, one can infer that empowerment is a means and a result. Therefore, a woman is taken to be empowered when she can thrive and progress socially or economically with the power to make social and economic choices (Golla, 2011: 4). This analysis treats empowerment as a bottom-up progression rather than a top-down approach. Thus, institutions can not purport to empower women; instead, women drive their own empowerment processes (Oxaal & Baden, 1997: 1). Institutions can, however, set up a conducive environment that supports women's agency, facilitating the empowerment process. Resources like access to adequate, reliable and affordable energy supply, credit and other facilities may form part of the foundation blocks that enable women's agency and empowerment (de Groot et al., 2017a: 90).

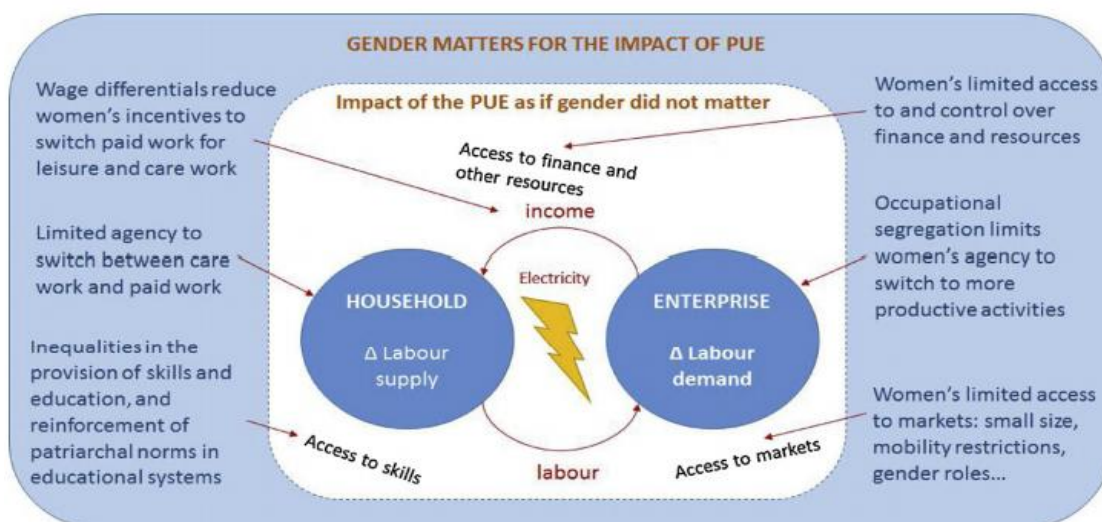
Further, providing energy to women-run investments may enhance some of the elements of empowerment discussed above by enabling fuel-switching or deployment of various energy sources to meet business requirements. Access to energy can, for instance, allow women to prolong working time by availing light for night work and to enable the preservation of goods, thus expanding the variety of goods women can sell while minimising business losses. In the long run, these amenities may lead to improved returns on investments. Based on the former claim, the energy supply enhances the availability of energy options to power their business investments, and these expanded choices at the same time positively trigger women's agency and attract positive returns in the medium and long term. Minimising gender-related work overloads, for instance, may enable women to engage in other community activities and access information and knowledge, which are critical prerequisites for empowerment (Clancy & Dutta, 2005: 8; Jensen & Oster, 2009: 1060).

It should be acknowledged that energy supply alone may not solely cause significant variations in gender roles, but it has the potential to discharge women from some of the tedious and seemingly risky tasks that they encounter in their day-to-day work while opening more avenues available for women, their households and the more significant part of the society (ENERGIA, n.d.: 1). Thus, improving women's choices, access to energy can reduce gender gaps and cause social and economic empowerment.

The above discourses are supported by Pueyo & Maestre (2019: 172), who, drawing on Backer's Neoclassical household economics and the time allocation theory (Becker, 1965: 493-517), argue that electricity provides a technological trigger to household activities. According to Becker, the introduction of electric energy sources not only improves the productive time available to the household through illumination at night, but it also improves labour productivity per hour, returns on investment activities and even creates opportunities for leisure. Therefore, the outcomes of electrification depend on whether the time saved due to electrification is invested in commercial activities or just used for more leisure (ADB, 2010: 9-10). Related to this discourse, some studies show that a properly planned electricity supply system has positive outcomes for women in terms of employment, time use in productive and reproductive work, improved earnings, and involvement in higher-paying job opportunities (Barron & Torero, 2015: 12; Dinkelman, 2011: 3078; Pueyo & Maestre, 2019: 172).

Other discourses from comparative studies have indicated that if electricity is well planned and distributed, women's opportunities improve comparatively more than men's. Those studies observe that, as a result of electrification, women's employment levels increase significantly compared to men, women seek employment outside the home when there is electricity in the household, and women's non-farm employment at the same time increasing their participation in the market activities, and proportionally more than men (Dasso & Fernandez, 2015: 14; Dinkelman, 2011: 3078; Grogan & Sadanand, 2013: 252; van de Walle et al., 2013: 4).

Figure 6: Conceptual framework for the impact of productive use of energy (PUE) on gender relations



Source: Pueyo & Maestre, (2019:178).

Substantially deviating from the conventional discourse; however, a study by Salmon & Tanguy (2016: 48-68) observed that while controlling for the interdependence of men's and women's work decisions in the family, introducing new energy sources in the household brings positive results only on the husbands' labour time. It claims that women are inclined to increase leisure and care work instead; their working time does not improve even if income levels may improve.

Similarly, a study assessing the effect of solar mini-grids in Kenya's rural small-scale businesses revealed that the new enterprises that started due to the introduction of new energy grids were predominantly male-owned (Pueyo & DeMartino, 2018: 35). The most common enterprises were barber shops, local cinema halls and doing mobile phone charging kiosks. However, this study was limited in the analysis as it did not attempt to investigate the distinctions between the outcomes for men and women business owners. The study relied on the neoliberal economics lens that views enterprises as rational undertakings aiming to maximize returns on investment and electricity as a trigger that enables the extension of working hours due to improved illumination and improved productivity through slightly advanced means of production (Pueyo & Maestre, 2019: 1722).

Since these findings were found based on only quantitative methodological approaches with a limited sample size, they would need to be verified by further using mixed methods and in the context and settings different from what Tanguy (2016) relied on to arrive at the conclusions.

2.7 Identifying Gender-Based Conflicts in Renewable Energy

Like any other gendered field, planning, implementation operation, and utilisation of renewable energy resources can become a subject of gender-based conflicts that sometimes escalate if not well handled by planners right away from project inception. However, no comprehensive empirical studies have been conducted to explore this. Researchers in the gender and energy field tend to focus on the positive benefits that accrue to women and men due to access to energy but do not go deeper to analyse the unintended outcomes or conflicts that might be associated with the investments. Treating the energy field as a gender-neutral undertaking regarding conflicts is a gap worth scrutinising since it would help energy enterprise developers and other stakeholders to understand ways of working in and with such conflicts.

First, lack of access to reliable, clean energy may in itself constitute a form of violence as it frustrates people's capacity to construct more productive, healthy and sustainable livelihoods. For instance, in places where people's study time is limited to daylight hours in the current

competitive world, where livelihood opportunities for would-be entrepreneurs are thwarted due to lack of electricity to power equipment presents a dilemma that borders on some form of structural violence³ in society. Like other forms of structural violence, lack of access to renewable clean energy poses safety challenges, too. As observed in discourses from the previous sections, it subjects people to premature death from respiratory infections from household air pollution emanating from burning wood, charcoal, kerosene and other fossil fuels (Kim et al., 2011: 425; Laumbach & Kipen, 2012: 3-9). Due to the gendered division of labour in many rural communities, this challenge affects women and girls the most. Worse still, it is claimed that several women and girls suffer from physical violence in the form of sexual assault when they walk in poorly lit spaces during night hours or move to the forests to fetch wood fuel for cooking. Even simple acts like going to the toilet in darkness at night can expose females to some forms of danger (Lahn, 2019: 1).

Therefore, gender-based conflicts and related violence need to be understood and incorporated into developing renewable energy projects or other community-based energy interventions. Failure to conduct proper conflict analyses at the start of the project can culminate in negative social consequences, for example, if the health risks, including gender-based violence, are not explored and integrated within the project designs. For instance, according to ESMAP (2018: 55), when new construction workers enter the community to set up energy supply infrastructures like mini-grids or any other electricity grid system, demand for sex workers tends to increase, which leads to the proliferation of sex work, human trafficking (especially for females), disease transmission, particularly HIV/AIDS and other sexually transmitted diseases. This is common, particularly in societies that do not have or have weak policies or laws to address such issues. In addition, Sibyl & Kuriakose (2017b: 4) contend that households that may realize an increase in incomes resulting from employment in the construction of mini-grids may also see increased expenditure on alcohol that may culminate in family disintegration

³ Structural violence in this context refers to the definition given by Johan Galtung (1969: 167-191), which addresses a form of violence where systems and institutions (including discourses) in the social structure harm members of society by preventing them from meeting their physiological needs. Although less visible, this form of violence can be more destructive and cause deaths that would not happen if societies were equal with less forms of deprivation

(Sibyl & Kuriakose, 2017b: 4). Conversely, other discourses assert that expanding energy access through the supply of clean and efficient energy sources can help minimize gender-based violence in the community (ESMAP, 2018: 55).

In addition, establishing large-scale renewable energy grids, for example, constructing transmission lines, may lead to the dislodgment of some members of the community and sometimes whole villages, with different effects on men and women (Cormack & Kurewa, 2018: 94-96.) This may be exacerbated by the fact that rural societies in developing countries are characterized by unequal gender norms, inheritance customs and property laws that do not allow women's access to land titles. Where women have land access rights, they lack control rights and can only own land through men or kinship groups. Therefore, even when compensation for the lost land is paid, women may not directly benefit, although they will have lost their livelihoods (ESMAP 2018: 6). It is also common practice for some husbands to use compensation money to marry new wives and push the old ones out of the family since most lack joint land ownership rights and therefore suffer losses in circumstances where the marriage relationship gets terminated (Kabumbuli, 2016: 67-68; Kimani, 2018: 1).

Further, in countries where women lack land ownership rights, renewable energy projects that require expansive land coverage, like expansive solar plants or wind turbines, are always more controlled by men than women (Elwell et al., 2014: 26). Establishing the large-scale infrastructure may necessitate the displacement of traditional energy sources like biomass energy that would have always been the source of income, livelihood and food for women. Worse still, as evidenced by some studies on energy projects in Kenya (Cormack & Kurewa, 2018: 89-107), these women whose livelihoods have been displaced may never access the generated power apart from seeing the supply lines in their communities. Some of the compensation methods may also be constrictive to women. For instance, where compensation targets only those who have lost formal employment in the paid sector, women may suffer deprivation since the majority are primarily employed in the informal unpaid sector (Pearl-Martinez, 2014: 67). To mitigate these potentially negative impacts, energy planners should understand and appreciate the community's prevailing energy sources and find out women's and men's specific uses, interests and limitations (Sibyl & Kuriakose, 2017: 4).

The need to integrate specific needs and interests is further explained in discourses from Rewal (2017: 17), where it was discovered that in some societies, the use of solar cookers meets resistance because solar cookers require cooking at midday when the solar irradiation is at its

highest, yet such a time does not match the typical time for family meals in many cultures. In addition, it is argued that many women prefer cooking indoors, yet some solar cookers require them to cook from outside (Wilson & Green, 2000: 59). The main argument given here is that cooking outdoors can lead to the breakdown of women's social capital, especially in societies where the fireplace is seen as a space for socialisation and where many family discussions are handled as the cooking occurs. The fear of breaking this social space or office may reportedly lead to some women resenting the use of solar cookers. This leads some to argue that the actual value of electricity for such (seemingly) poor women lies in other functions like the provision of light in open spaces to reduce safety challenges and other mechanical tasks like the operation of milling machines plus other productive uses that take place outside the household (Clancy et al., 2003: 13).

Decision-making processes within the household about energy choices and use can also create contestations that trigger gender-based conflicts. For instance, in most rural households, as advanced by discourses from Makan (1995: 26-36) for instance, the gendered allocation of labour tends to dictate differing energy needs and use to men and women depending on their domains of influence and interest. According to such dictates, women, in most cases, dominate activities in the kitchen. However, if energy usage involves some financial expenditure, men join the decision-making process, for example, on the type of technology or appliance to purchase. As a result, men will likely decide to purchase items like batteries, TVs, and other recreational equipment, and these men will always want to control these facilities, often excluding women. This may result in some forms of friction between the partners, especially where women demand more space in the decision-making or control of these facilities (Makan, 1995: 26-36).

Men can also determine the choice and uptake of technologies in what is taken as women's sphere in the kitchen. For example, it is reported that men in Zimbabwe tried to veto the use of solar cookers by their partners since technology designs, manufacture and decisions surrounding the deployment of cookers were seen as a male domain (Nyoni, 1993 cited in Clancy et al. 2003: 10). In the same spirit, some husbands also get uncomfortable with how their wives will spend the time saved after adopting quicker cooking technologies, while others consider it a prospect for their wives to get involved in more productive roles (Wilson & Green, 2000: 60). Likewise, some women may be concerned with the new energy technologies because they suspect that time saved in one field may lead to overworking in another. For this reason,

some women may deliberately withhold their cooperation and participation if they realize that the renewable energy provided in their community may tend to increase their workload and suffering (Clancy et al., 2003: 11).

2.8 Gendered Education as a Constraint to Women's Participation in Renewable Energy and Other Technology-based Fields

Searching for the cause of the tilted gendered dynamics within the renewable energy value chains and the associated low participation of women cannot be complete without digging deeper for possible roots. One such root to examine is the education/capacity dynamics by exploring how education is offered, the nature of curricula, the subject preferences and the gender discourses surrounding women's and men's participation in education. Education attainment consequently determines how men and women participate in projects in general and renewable energy projects in particular, as the following discussion explores.

According to the Asian Development Bank, enhancing gender-balanced participation in the renewable energy sector requires improved access to education and other skills training opportunities for men and women conducted at all levels, right from lower education to top-level entry into the energy industry (ADB, 2018: 2). Reportedly, the most critical requirements for accelerating women's participation in developing and managing renewable energy solutions are increased sensitization about the available opportunities and increased capacity building to stimulate their technical and management skills (Shankar et al., 2019: 57). According to IRENA (2019: 48) the required knowledge and skills manifest in different forms and are acquired at various levels. For example, certain forms of knowledge are necessary for young learners to appreciate their potential in the technical fields, while other skills are needed to set up, operate and maintain the mini-grids or other decentralized energy grid solutions. These skills require prior education or experience, depending on the expertise required. Some other knowledge and training can be acquired on the job or in work settings in the field (IRENA, 2019: 48). However, to achieve this balanced workforce in the energy sector, the nature of education has to purposely be streamlined to reduce gender variations and disparities that tend to discriminate against girls, especially in the science, technology and engineering fields. In this way, gender disparities, even in other fields, are minimized while contributing to the long achievement of sustainable development.

UNESCO (2016: 1-2) argues that attaining the 2030 sustainable development agenda will necessitate the propagation of transformative and innovative skills and empowered people, mainly through inclusive and sustainable education (UNESCO, 2016: 1-2). For education to achieve this, there is a need for deliberate initiatives to eradicate inequalities in education access and attainment and elevate the quality of education with the improved level of knowledge, skills, attitudes and conduct to guarantee inclusive and sustainable communities. Likewise, this education has to promote balanced participation by boys and girls in Science, Technology, Engineering and Mathematics (STEM) subjects as a vital requirement for transformation as it reinforces the sustainable development goals. In addition to other fields, STEM education is necessary for preparing learners to enter the renewable energy sector and other technology-related careers. In addition, as argued by UNICEF (2017), deliberate efforts have to be invested in promoting girls' participation in STEM education since gender stereotypes have made it seem like it is an exclusive domain for men (UNESCO, 2017: 59-70).

According to Lee & Pollitzer (2016), promoting gender equity in STEM education is not only a social justice issue, but the inclusion of women's and girls' access to technology education enhances scientific breakthroughs and improves the quality of STEM outcomes as it enhances innovativeness and minimize potential biases while increasing robust knowledge bases and solutions (Lee & Pollitzer, 2016: 19-22; Marginson et al., 2013: 140). In addition, women have reportedly demonstrated their potential and skills in various advanced technological fields (Svitil, 2002: 1), and maximising the developmental contributions of STEM requires that these skills be tapped too, as leaving them out would constitute a significant loss not only for women but also for men and society (Blickenstaff, 2005a: 384). Whereas the gender gaps in the science and technology fields appear to be narrowing in many countries, as demonstrated by some studies (e.g. Hyde et al., 2008: 494-495), they still pose a considerable challenge. Despite more women penetrating the STEM labour force than in the past, the level of involvement of women in the STEM fields is still comparatively low in many developing countries (Ceci et al., 2014: 75; Deloitte, 2016: 1-2).

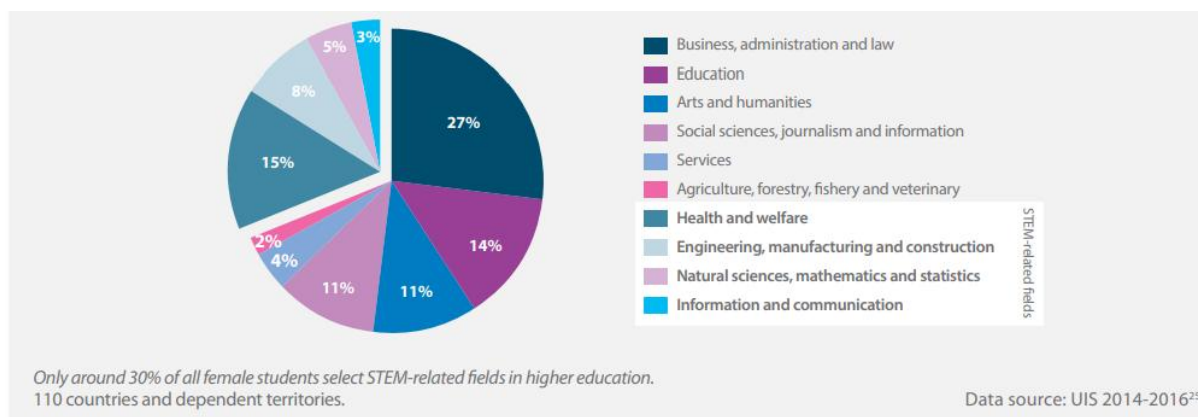
The gender fissures in STEM participation in schools start to emerge in lower secondary education as students select their choice of subject specializations to pursue at high levels of schooling (Kolmos et al., 2013: 340-358; McDaniel, 2015: 122-133). At this point, more girls start dropping science subjects than boys do. In addition, in many situations, girls tend to

diminish interest in science subjects more than boys at the same age (Marginson et al., 2013: 135-140).

The above discourse is illustrated by a longitudinal study conducted in the United Kingdom that revealed that at the age of 10-11 years, boys and girls showed a similar preference for science subjects, with 75% of the boys and 72 % of girls revealing that they found it interesting to study science. However, by the time the same cohort made 18 years, this percentage dropped to 33% for boys and 19% for girls, based on their participation in the uptake of science subjects in advanced education. In this case, many boys reported dropping sciences as they joined high school, while girls reported dropping sciences much earlier in lower secondary school (Kerney, 2016: 1-3; UNESCO, 2017: 19). A similar study conducted in Sweden found that students mostly made decisions about their career prospects by the age of 13, and after that, it would be difficult to divert them from humanities to sciences (Lindahl, 2007: 1). Those pursuing STEM subjects at the upper secondary education levels usually proceed to STEM-related degree courses in post-secondary studies (Deloitte, 2016: 1-2). However, it is also argued that exposure to STEM and intentions may not necessarily guarantee that the student will continue with STEM studies. For instance, females may opt not to pursue educational programmes that lead to careers where fewer women are employed or occupations that people perceive to be difficult to combine with family chores (OECD, 2016: 15-21). Despite the absence of worldwide data to enable comparisons, data from the studies on “Trends in international mathematics and science” conducted over time indicate that in most countries, boys dominate in science and mathematics at the advanced level (Mullis & Foy, 2015).

Consequently, male learners dominate engineering, manufacturing, and construction studies and, to a lesser extent, other disciplines. On the other hand, female students dominate health, arts and humanities. Despite the above findings, though, it has to be appreciated that women are currently pursuing natural sciences and mathematics in relatively more significant numbers due to substantial increases in women's enrollment in STEM subjects (UIS, 2016; UNESCO, 2017).

Figure 7: Distribution of female students' enrollment in higher education by study field-world average



Source: UNESCO (2017: 20).

Although recent studies have revealed a tremendously increasing number of women in higher education, gaps still exist in men's and women's educational and career occupations (Barone, 2011: 157). As noted in the previous sections, gender divides emanate from the entrenched differences in educational pathways, which translate into different educational achievements and labour market opportunities. These decisions on education pathways start early or before adolescence, with boys more likely to select mathematics and science subjects and girls' choices bending towards arts and humanities pathways (Charles & Bradley, 2009: 924-927; Pinxten et al., 2012: 541). To explain the gendered variations in choices, researchers have concentrated majorly on differences in capacity, with males assumed to have more competence in math and nonverbal activities and females possessing more competence in verbal reasoning and writing (van der Vleuten et al., 2016: 181). Although competence may be a strong determinant of the kind of specialisations young learners are likely to choose, there are contestations among scholars who argue that ability has an insignificant correlation with how boys and girls make decisions about their educational choices (Ceci & Williams, 2011: 3161; Rieggle-Crumb et al., 2012: 1049-1050). The primary determinant for girls' and boys' choices can instead be attributed to the social environment in which children grow up, composed of peers, parents, media, schools and other social systems that communicate cultural beliefs about the normative male or female behaviours (masculinities and femininities). As children grow, they consume these gender roles and beliefs, shaping their worldview. However, although researchers often explain gender ideology as an essential factor in the choices of boys' and girls' educational choices, Charles and Bradley (2009: 924) argue that the role of gender is often assumed and not

empirically tested. In addition, based on the available literature, the underlying factors explaining the relationship between gender ideology and educational choices for boys and girls remained under-explained, and more work was needed to be done to understand this. (This study investigated those factors, and the empirical results addressing that question are discussed in Chapter 5). What seems to be clear, though, is that over-representation of men or women in particular education fields or occupations has the potential to construct and reinforce boys' and girls' ideologies of what is considered to be ideal feminine and masculine character later on influences dominant gender roles and beliefs and discourses that increase gender gaps in the different fields of society (Geerdink et al., 2011: 575-596; van der Vleuten et al., 2016: 183).

Regarding employment in the sector, women remain significantly underrepresented in science and technology. For example, a study conducted in the United Kingdom revealed that in 2010, only 15% of the first-degree graduates in the Engineering and Technology sector were women (HESA, 2011) despite women constituting 57% of all university students and 46.4% of all the people employed in the formal occupations. Secondly, a similar study by Powell et al. (2012) found that of all women who complete their studies with an engineering and technology qualification, only 51% proceed to get jobs in the sector where engineering is the principal trade compared to 70% of the men who join (Powell et al., 2012: 541). These differences result from gendered beliefs and discourses that influence career choices among men and women. However, studies also reveal that women in science and technology maintain clashing positions that, for example, make them hold the gendered myths about women's appropriateness for work in the technology fields while at the same time holding beliefs that the field is open for all with interests to join (Powell et al., 2012: 542). Nonetheless, society has many discursive barriers that curtail women's entry into engineering, and those barriers majorly rotate around socialization processes inherent within the social structure (Schreuders et al., 2009: 105). This gender divide is also a product of the dominant nature of masculinities prevalent in engineering and technology, coupled with systems that make it hard to challenge long-held social norms (Powell et al., 2012: 542).

Indeed, decisions concerning one's career are moderated by many variables in the broader social structure, but dominant norms and long-held stereotypes or concerns about other people's views may also influence people's choices or paths. For instance, Taconis & Kessels (2009: 1115), in their study about influencers of career choices among students in the Netherlands, discovered that young people perceive peers who study natural science-based subjects as less

attractive, unpopular, poor at socializing, less innovative, and less sensitive but more intelligent than those studying social sciences. Some of these discourses influence how people think and choose careers in the short and long run. For example, studies have consistently revealed that when young learners are requested to talk about their job prospects, boys refer to the usual stereotyped masculine occupations, while girls select the stereotypically constructed ‘feminine’ occupations (Leuze & Strauß, 2016: 802; Seehuus, 2023: 5; Siann & Callaghan, 2001: 90).

Despite the above findings, studies (e.g. Seehuus, 2023: 5-6) have found that several women, particularly those from communities with lesser structural challenges, have come out to contest the dominant beliefs to study disciplines that society regards masculine, such as engineering and technology. This can be partly explained by the fact that gender inequality and equity have become popular discourses/concerns, and several women have come to perceive that they can enjoy equal opportunities with men in all fields. Therefore, the assumption that engineering and technical subjects are masculine fields contradicts viewpoints that hold that women and men have equal competencies and abilities (Phipps, 2007: 768-772). It is also held that women who pursue educational pathways and work in the STEM sectors are delighted with their entry into male-dominated sectors and gain gratification from competing with their male peers (Gill, 2008: 398). Therefore, such women relish challenging the dominant male conventions (Powell et al., 2012: 541).

2.9 The Influence of Gender Discourses in Educational and Occupational Pathways in the Technology-related Fields

One of the primary bases for the gendered distribution of the workforce in technology and, by extension, in the renewable energy sector lies in the gendered stereotypes and discourses that influence people’s lives throughout their growth and development. Therefore, subjecting these stereotypes and their role to further analysis is imperative.

Gendered norms and stereotypes are learned early in child development (Fournier-Tombs, 2023: 131), and although people can later make career compromises, it is difficult to compromise socialized and entrenched gender roles (Cerbara et al., 2022: 1-15). Gender stereotypes or discourses get entrenched because they are learned early in the family, educational institutions, media, and other social spaces (Mishra et al., 2012: 45-53). For instance, in children's movies and reading materials, girls are portrayed as being tender, sympathetic and primarily handling less valued assignments (Kimmel, 2011: 247-288).

Instructors in schools may also influence their student's self-perception and the choice of subjects they select (Margolis & Fisher, 2002: 112-114; Muntoni & Retelsdorf, 2018: 212). The instructors' perceptions about 'acceptable' conduct and roles for males and females and their perceptions about engineering/technology can encourage or discourage girls from pursuing engineering-related studies (Barker & Aspray, 2006: 20-22).

Like any other social phenomenon, stereotypes and discourses do change over time, as witnessed by the swelling number of women in higher education. For instance, an increasing number of women are graduating from universities, and in some countries, the number of women participating in higher education outstrips that of men (Niazi, 2024: 1).

As enrollment numbers increase, the percentage of women participating in technological studies would also be expected to increase by similar proportions, but this is not the case. On the contrary, though, the number of women graduating in law, nursing, primary education and other disciplines that discourses brand as 'feminine' is rising, which signifies that gender stereotypes still have some influence on these patterns (Clayton et al., 2009: 154). Of course, no universal stereotypes are linked to women or men since what is masculine in some communities might be considered gender-neutral or feminine in a different society (Wajcman, 1991: 1ff). However, as enrollments in the technology disciplines increase, it is evident that women's involvement, though improving, is not following a similar pattern (Trauth et al., 2003: 7; Zwarteveen, 2017: 78).

The disinclinations and preferences may be regarded as inherent to females if one takes an essentialist opinion on gender; however, a good body of research on gendered stereotypes reveals that females and males acquire these attitudes through social learning. Social learning may result from cultural practices, gender roles and the discourses dominating society (Gorski, 2002: 23-27). Several girls struggle to self-assess their suitability for science, engineering, and technology studies and occupations (Nielsen et al., 2001: 118; Reilly et al., 2022: 1-16). This is reinforced by media content that portrays men as genetically more suited for technology careers, further dissuading women from choosing technology-based pathways (Ikkatai et al., 2020: 1; Rani & Bharati, 2018: 727). Society, family, peers, instructors, and other social systems may also propagate the ideology that science and technology are not fields for women, even though the same girls may have performed very well in science subjects in their lower classes. However, such stereotypical dispositions also diminish girls' self-confidence and poor performance, compounding the discourses and perceptions that women are not meant for STEM

studies and related careers (Gürer & Camp, 2001; Grosch et al., 2022: 1ff; Ikkatai et al., 2020: 1).

Moreover, women who excel in sciences may attribute it to luck or exceptional hard work while blaming failures on incapacity, yet men regard their success in the same field as a result of natural capability. Some women also report suffering from being taken as impostors and feel invisible and isolated when they engage in the technology fields (Clayton et al. 2009: 155). Some are also subjected to sexual abuse, male humour, gossip, and patronizing behaviour from their male peers in the sector while undermining their knowledge and contributions (Margolis & Fisher, 2002:112-114; Froehlich et al., 2022: 1-5; Rudman & Phelan, 2008: 61-66).

Whereas there have been some initiatives aimed at stimulating the participation of women in engineering/ technology disciplines, like the award of scholarships, affirmative action in enrollments, and other grants to females to study science, some of these initiatives sometimes become counterproductive. For example, some girls may misconstrue their selection to be a product and, therefore, a favour because of their gender, not their academic potential and other capabilities (Clayton et al., 2009: 154-156). Because of the stereotypes, girls and young women are also disturbed by the competing needs of wanting to appear suitable and caring (as they have been socialized to be) and the need to succeed in their disciplines (Clayton et al., 2009: 154-156). In the end, these stereotypes, coupled with related discourses, may act to demotivate women and promote the increasing gender gaps in the engineering technology sector in general and renewable energy fields in particular. The situation is not helped by the dominance of men in the decision-making positions at the household, community or national level. Men, indeed, appear to enjoy benefits from these unequal relations. It is argued that men have a lot to lose from pursuing gender equality because men, collectively, continue to receive patriarchal dividends from a gendered status quo (Connell, 2005: 1808).

2.10 Conclusion and Gaps

In this chapter, I attempted to explore and analyse the role of renewable energy grids and the importance of innovative decentralized technologies like mini smart grids in extending energy access to remote areas that the main national grids cannot efficiently serve for various reasons. The role of integrating social perspectives like gender in renewable energy value chains as one of the ways to ensure sustainability has been explored. The issue of women's participation in renewable energies, for instance, barriers like conflicts and gendered education that hampers

women's access to engineering and technology-related fields, is also examined to appreciate some of the underlying structural barriers that hinder or facilitate the access by women and men to the renewable energy subsector.

Based on the arguments and discourses in the literature analysed in the chapter, it can be observed that renewable energy and mini-grids are phenomena whose scholarship is picking attention. However, specifically for mini-grids, most available literature only covers the West and parts of Asia, especially where mini-grids have gained greater penetration. No substantial data about mini-grids in East Africa could be identified. In East Africa, power generation using mini-grids is low, and no comprehensive studies have been conducted about the few existing mini-grids.

Literature linking the technical and social issues in microgrids was also not substantially available, though some literature highlighting gender and the benefits women derive from general energy access was available. However, there are some contestations by different scholars about how energy access improves or complicates gender inequalities. Furthermore, the interventions to improve women's participation and reduce the gender energy gap are still scanty in the available literature.

For instance, while some scholars argue that access to renewable energies minimises women's work burden and improves their participation in productive activities, others claim that introducing renewable energies and other forms of electricity increases women's work burden by prolonging their working hours in reproductive roles. Even when women participate in productive activities, men appropriate the accruing benefits due to cultural reasons. It is also argued that this access instead increases the gender gap instead of reducing it. Literature also reveals that even when communities are enabled to access energy in their communities, sometimes even at no cost, they continue to use their traditional sources of energy; for example, women in Kenya continue to collect firewood even when they were supplied with free cookstoves- why do they continue? The available literature did not provide the answers to this. These claims created controversies that needed to be investigated further through empirical studies.

Methodologically, most of these conclusions were arrived at by researchers using quantitative research methods. One may hope that quantitative figures could have been studied further by qualitative in-depth discussions or interviews to validate these quantitative results. However,

there is no evidence to show that this is done. Although discourse plays a critical role in shaping gender relations in society, no studies seen so far have investigated or comprehensively interrogated the role of discourses in determining males' and females' levels of participation in renewable energy. Therefore, more studies were needed to apply qualitative data or a mixed methods approach to interrogate existing studies and the study results. This thesis has attempted to do so with results comprehensively discussed and analysed in chapters four and five.

The gender analysis tools found in the literature are generally designed for broad application across various project cycles and are not specifically tailored for analyzing gender in the energy sector or for mini-grids. These tools typically suggest collecting data on the time contributions of men and women to different activities, as seen in the Harvard matrix, or examining gender differences in access to and control over resources, as outlined in the Moser framework. However, planners need frameworks that can be systematically applied to analyze specific situations and enable informed, responsive decision-making. Much of the existing literature on access and control overlooks the critical role of energy, raising concerns about whether conventional gender analysis tools are sufficient to capture the energy-related aspects of women's livelihoods.

In addition, existing literature does not clearly articulate the aggregate outcomes of women continuing to rely on their energy inputs and biomass fuels. While some newspaper articles look into the effect of smoky kitchens on women's and girls' health, other issues like conflicts/violence-related linkages are not well researched. For example, although the amount of time women spend collecting and carrying heavy loads of fuel is often noted, the damage these loads inflict to women's well-being is not well documented. This situation can partially be explained by the fact that most of the activities done by women and children in rural areas fall outside the national computing statistics, which renders these activities 'invisible' since no data is captured. The absence of data means no visibility, and lack of visibility means no interest is aroused (Huyer & Westholm, 2007: viii). The invisibility of gender-energy-livelihood issues (due to the absence of data) denies decision-makers the opportunity to grasp their significance fully, and so policies and strategies fail to address the issues fully (Clancy et al. 2003: 10ff)

Finally, considering gendered education, literature about the gendered ideologies that influence girls' and boys' choice of subjects that consequently determine future careers in or outside engineering is shown. However, there is scanty or no literature exploring how those ideologies are reinforced in the school setting and curriculum. Furthermore, the available literature does

not explain how those stereotypes and discourses could be confronted to increase the female uptake of technical subjects and reduce the gender gaps in STEM and renewable energy studies or careers. Also missing is the link between gendered education and women's participation in non-technical activities of renewable energy grids.

Therefore, the above gaps and contestations in the literature and the stated study objectives determine the issues and questions that this study empirically investigates, using appropriate concepts, methodologies and data collection tools. The methodological approach, data collection and research process are discussed further in the next chapter.

3 Research Methodology and Methods

This chapter discusses the thesis' epistemological and methodological approaches, including the ethical and reflexivity issues and the challenges encountered during the study. Specifically, this qualitative study deploys discourse analysis together with the conceptions of gender, masculinity, femininity, intersectionality and sustainability to examine the influence of gendered discourses on the sustainability of renewable energy projects in East Africa with the principal goal of identifying the gender gaps in the energy and training sector whose fixing would promote gender justice and contribute to the sustainability of the renewable energies. Field studies were conducted in East Africa using in-depth interviews, focus group discussions, non-participant observations and document reviews to answer the main research question: *How and to what extent do gender discourses and discursive practices in East Africa influence the gendered participation and sustainability of the renewable energy projects?*

To address the above question, interviews and focus group discussions with participants and key informants who directly or indirectly deal with the renewable energy sector in East Africa and beyond were conducted. Their responses regarding experiences, perceptions, discourses and practices create a better understanding of men's and women's experiences regarding their participation in the energy sector. In addition, discussions with students and analysis of textbooks helped to provide more insights into how a gendered education impacts men's and women's entry and participation in renewable energy-related subjects and careers. At the same time, interactions with power consumers and developers enabled a better understanding of other factors affecting energy projects' sustainability. Because of the centrality of discourse in this study, this chapter provides detailed literature on the meaning and application of discourse and discourse analysis in this thesis.

3.1 Discourse Analysis: Meaning and Application

To critically analyse the underlying gender dynamics, knowledge, power relations, perceptions and practices influencing women's and men's participation and the sustainability of renewable energy mini-grids, I deploy a discourse analysis as presented by different scholars but majorly building on Michel Foucault's works. Discourse analysis, in this case, enables me to critically investigate models in which knowledge is formed and validated by society as the absolute truth (Dittmer, 2010: 275; Simberg-Koulumies, 2021: 15), and it is, therefore, the appropriate instrument for examining the pertinent questions of interest in this study. Furthermore, this form

of analysis treats discourses not only as images of the dominant structures within society but also as producing, reproducing and modifying them (Phillips & Jorgensen, 2002: 60; Simberg-Koulumies, 2021: 15). Therefore, since this thesis examines discourses and related practices from multiple view standpoints, the intersectional character of discourse analysis and its capacity to explore presentations, misrepresentations, and associated power relations (Fairclough, 1995: 24-25) supports this thesis's main focus and approach.

Influenced to a great extent by the works of Foucault, the concept of discourse is prominently used in the social and educational sciences (Allen, 1999: 227-232) to analyse and investigate the dynamics involved in producing knowledge through language and its impact on social practices. However, giving clear meaning to discourse becomes complex due to the numerous and overlaying ways Foucault (1972) utilises the concept. Nevertheless, findings from this study agree with Foucault's argument that discourse can be summarised in three overarching meanings: One, all meaningful acts of speech or writings that have an impact on society; two, a group of statements or texts that appear to have a mutual or common theme that provides them with a unified effect, and three, the rules and structures that reinforce and direct the unified, coherent and dominant statements that are produced (Foucault, 1972: 5ff). Discourses also include attitudes, how specific topics are addressed within a society and social practices embedded within the conventions (Foucault, 1972: 5ff; Phillips & Jorgensen, 2002: 60-95).

Similarly, Unvar & Rahimi (2013: 12), in their analysis of political presentations, argue that discourse analysis focuses majorly on how particular ideologies and beliefs are presented and how attitudes are produced, propagated, inculcated, adopted and essentialised through text or speech. One significant way to construct and neutralise philosophies and beliefs is through the bipartite labelling of positive self-representation and negative other(s) representation. Speakers and writers thus deploy diverse linguistic approaches to present their ideologies, beliefs, values, aspirations and feelings.

It has to be noted that discourse analysis is a dynamic field evolving within several academic fields, including those in which typologies of understanding and modes of analysing discourse initially gained fame, such as linguistics, anthropology, and philosophy. Its application has grown to other disciplines like communication, cognitive and social psychology and artificial intelligence (Kendall & Tannen, 2001: 548). Due to its multidisciplinary nature, the terms discourse and discourse analysis have been interpreted differently by different scholars in diverse fields.

For some scholars, especially in linguistics, the concept of discourse may involve communication beyond explicit sentences, including metaphor, intonation, social cognition, and societal structures (Rozzaq & Ratnadewi, 2016: 9), while for others, like Fasol (1990: 1ff), discourse is synonymous with language use. All these characterisations of discourse rotate around specific instances of language. Therefore, from the preceding, the term discourse goes beyond just a word noun to cover an amalgamation of linguistic and non-linguistic social protocols and philosophical conventions that construct power or social realities (Kendall & Tannen, 2001: 548ff).

While analysing discourse in this study, further consideration was extended to other interpersonal meanings like allusion, parallelism, repetition, formulaicity, dialogue, and tempo since they can only be used within some concrete framework or context (Norrick, 2001: 86; Tannen, 1987: 574). These tools also determine the nature of the conversation or style of presentation (Tannen, 1984). The scope of discourse analysis in this thesis also covers other features like inference, implicatures, presupposition, maxims of conversation, relevance, politeness, speech acts, and other related markers (Brinton, 2001: 138). Discourse analysis also involves "the linguistic analysis of naturally occurring and connected spoken or written discourse" (Stubbs, 1983: 1) while transcending individual sentences, the connections between sentences, and other local or international features that serve to tie sentences or sets of messages together.

Further, it is argued that discourse analysis is related but different from pragmatics, which is the branch of linguistics dealing with language use and the contexts in which it is used, including such matters as deixis, taking of turns in conversation, text organisation and presuppositions (Brinton, 2001: 138). Unlike linguistics, which has conventionally focused on reviewing single sentences or isolated bits of speech (Stubbs, 1983), discourse analysis includes reviewing multiple messages and how they combine to constitute discourse. Stubbs contends that discourse analysis can be used to generate meaning from recorded conversations, experimental data, written texts, and even fieldwork observations.

Unlike the other scholars of discourse analysis who tend to understand discourse analysis from the traditional way of looking at texts, speech and others, as highlighted in the preceding discussion, Michel Foucault, a prominent scholar of discourse analysis, adds the aspect of power relations and knowledge production in his analysis of discourse. In other words, power and standpoint may determine the nature of discourse and the related knowledge and truth

produced (Foucault, 1972: 5ff). Therefore, the subsequent discussion focuses more on Foucault and his ideas, which have come to be called Foucaultian discourse analysis and, more than other fields of discourse analysis, are applied as this study's main methodological and theoretical approach.

3.1.1 The Foucaultian Discourse Analysis

Without total disregard for other fields of discourse analysis, this study relies heavily on the principles of Foucaultian discourse analysis in the examination of primary data and secondary data for this thesis. Moreover, as stated earlier, gender construction, discourses and related practices that constitute this study's primary focus and context rhyme well with the principles laid out by Foucault's examination of discourse.

Foucault also introduces what is referred to as the discursive field. According to Jenkins (1996:31), the discursive field examines the relationship between language, social institutions, subjectivity and power. These discursive fields comprise various rivalling and opposing discourses with different power levels to generate meaning and shape social institutions and processes (Jenkins, 1996: 31; Weedon, 1987: 100). Thus, Foucault presents discourse as:

ways of constituting knowledge, together with the social practices, forms of subjectivity and power relations which inhere in such knowledges and relations between them. Discourses are more than ways of thinking and producing meaning. They constitute the 'nature' of the body, unconscious and conscious mind and emotional life of the subjects they seek to govern (Weedon, 1987: 108).

It is, therefore, a form of locally socialised power that can assign to or create forms of subjugation or resistance (Diamond & Quinby, 1988). Thus, while applying Foucaultian discourse analysis in dealing with the variables in this study, as noted in chapters 4 and 5, I appreciate the reality that there exist some discourses that limit the production of knowledge, opinions, perceptions and variance and some discourses that allow 'new knowledges' and differences.

This thesis, therefore, entails finding out how some knowledge or opinions get or maintain prominence in society while others fail or just get muzzled. Furthermore, questions about who gets dividends from this knowledge, the relationships created by it, and how they influence gender relations in renewable energy systems are tackled. This relationship has much to do with power or (dis)empowerment (Jenkins, 2008: 108). Indeed, observations in the empirical chapters show that the gendered power relations and practices surrounding this relationship offer more patriarchal dividends to males in East Africa, who strive hard to maintain this

relationship through entrenched discourses. These relationships also determine the extent to which males and females penetrate and participate in renewable energy activities.

Foucaultian application of discourse, therefore, is the one that initially introduces the concept from a dualistic point of view. It is a practice that applies to group actors instead of individual actors and is embodied within the broader social structure or social spaces (Diaz-bone et al., 2007: 2). As observed from the interactions with participants in this thesis, discourses significantly influence individual and collective behaviour since they are discursively constructed and established (Butler, 1993: 191-198; Foucault, 1997: 777-795). Foucauldian interpretation of discourse applies more to a broader or macro-level than a micro-level, even though it impacts socialised individuals and their relations within a broader social space.

In addition, Foucault creates controversy on the concept of meaning. To Foucault, it is advisable to dissect the facts and the circumstances upon which the discourse manifests rather than focusing on the content that may be hidden within and the changes that discourses have created or reinforced (Diaz-bone et al., 2007: 11; Keller, 2008: 73-107). A close examination of Foucault's work, therefore, reveals that while explaining the discourse analysis, his focus is hinged on crucial questions whose meaning merits further examination. For instance, “the first question is about the object or area of knowledge that is discursively produced; second, he queries the logic to which the terminology and knowledge constructed; third, he asks who authorised it; and finally, he asks which strategic goals are being pursued in the discourse” (Diaz-bone et al., 2007:11). The research processes for this thesis laboured hard to generate and process data according to these questions. According to Keller (2008: 73), however, applying Foucault's ideas about discourse in empirical research tends to bring a language predisposition that may distort Foucault's interests in the power-knowledge realm. Despite such a concern, Keller strongly advocates applying and situating discourse analysis and empirical discourse investigation in sociological studies.

Furthermore, Foucault warns against reducing discourse analysis to only spoken or written texts, instead vouching for other factors like dispositifs. Indeed, the discussion and analysis in this thesis attempt to amalgamate the linguistic discourse of texts with a sociological study of social contexts, an approach that looks at the institutional arrangement of practices and how they interweave with the social structure (Hamann et al., 2019: 51-52). Therefore, the dispositif is the constitutive intersection between power and knowledge that Foucault has vouched for in

his numerous social and historical themes, the most notable being his study on governmentality that has been so popular in the recent past (Foucault, 1977: 1ff; Schneider, 2007: 1-31).

Thus, as pointed out, in applying discourse analysis in this study, great effort was expended on examining the relationship between discursive and non-discursive practices in the communities of focus. The examination generated a deeper and more advanced understanding of the analytical scope of the different knowledge, practices, and outcomes. This open scope facilitated the consideration of aspects like power, body, daily activities and subjectification while conducting empirical research, as these aspects do not depend only on institutional speech. In addition, in line with Wrana and Langer (2007: 1-22), the analysis goes beyond public speech to private talk or personal feelings and opinions as part of the analytical focus (Wrana & Langer, 2007: 1-22). Thus, approaching field data collection and analysis with a discourse analysis approach helped to tailor the orientation of this thesis to the likely boundaries of discourse; knowledge, power, everyday practice, the body, and the subject and generation of the theory, further essential in terms of understanding discourses and their impact (Wrana & Langer, 2007: *ibid*)

Foucauldian discourse research also encompasses the connections between the normative derivatives of knowledge, their impact on interactions and individual thoughts and discursive practices emanating from those interactions (Fasold, 1990: 1ff; Bührmann & Schneider, 2007: 108-141; Diaz-bone et al., 2007). The concept of discursive practice in the context of Foucauldian research is further explained;

While examining the concept of discursive practice, anthropologists like Bourdieu (1990: 80) have argued that practice refers to performance and action in our daily lives, covers current times and the future, and is intertwined with context. It is a situated and continuous lived experience within an environment (Young, 2010: 5). Discursive practices and statements are constructed diachronically with changes occurring over time, implying that previous accounts or statements shape the context of the formerly enacted statements. In addition, the existing statements have to subscribe to the set guidelines, which is a product of the earlier statements. According to this argument, if they do not follow this pattern, then they may not create an effect and may not be acknowledged or even considered in the social field as constituting worthy discursive practices (Dreyfuss & Rainbow, 1983). According to Diaz-bone et al. (2007: 11), these practices must be understood as a product of socio-historic dynamics that give birth to discourse as a field of knowledge and a constitution of rules in social structure. Hence, these rules account

for the organised and pre-structured modes of applying concepts, referring to objects, or structuring the ways of speech. In this way, we can refer to these modes of forming statements as discursive practices (Diaz-bone et al., 2007: 11). Indeed, such discursive practices have a more significant influence on the gendered relations and influence the participation of males and females in energy programmes and other fields like education, as observed in chapters four and five this thesis.

As noted from the above arguments, discourses depict social realities. This depiction constitutes modes of creating a dominant understanding of 'reality' in society. Discourses, therefore, cannot be detached from society but represent a method of examining society and its actions through knowledge. The different forms of knowledge we use to explain or comprehend reality or society are created in intricate power relations in which various players or structures labour to create a 'dominant interpretation of reality or truth'. As such, discourse is associated with hegemony, where those with power tend to dominate the 'truth' about the world (Spivak, 1987: 154; Van Dijk, 2011: 11).

3.1.2 Foucaultian Discourse and Gender Research

Like many social constructs, gender, gender relations, femininities and masculinities and the associated power relations are discursively constructed in society over time. Foucaultian discourse analysis as a methodological tool does well in enabling me to unpack the role of power in discourse construction within the social and institutional contexts (Van Ness et al., 2017: 103) where gender lies. Since gender is the central concept of this study, I find it imperative to explore the relationship between Foucaultian ideas and gender.

In her study of person-centred and experiential psychotherapies, Kefalopoulou (2021: 107) confirmed that social construction or prevailing social realities play a significant role in framing what it means to be feminine or masculine and what is expected of each. These expectations further translate into women's and men's capabilities and agency in society. Likewise, Butler (1990: 4) places discourse and discursive practices at the centre of gender construction in her definition. She views gender as the repeated stylization of the body, a series of repeated actions within a strict regulatory framework (Qin, 2018: 427) that gradually solidify, creating the illusion of a natural, inherent identity. This thesis argues that if the political genealogy of gender ontologies is successful, it will dismantle gendered perceptions substantiality (Butler Judith, 1990: 4). The discursive division of people into males and females, taken as an understandable

universal subdivision based on their bodies is rooted in social constructionism and power relations (Bilton et al., 2002: 1ff; Proctor, 2008: 85). In this case, a dichotomous contrast between females and males becomes the controlling construction. This perception culminates in the creation of reproductions of what is socially perceived as standard identity, standard roles or normal behaviours for men and women in their respective communities (Bryson, 2005: 1ff.). It has to be observed that these binary classifications create dominance and subordination as the socially constructed forms of knowledge entrench the power relations between females and males in particular societies since, as Foucault puts it, “power and knowledge directly imply one another, that there is no power relation without the correlative constitution of a field of knowledge, nor any knowledge that does not presuppose and constitutes at the same time power relations”(Cichoblazinski, 2021: 10, citing Foucault, 1977b).

Feminists like Irigara (1985: 1-21), especially while deploying a critical discourse analysis approach, provide an affirmative action scheme expressing their contestation of other models that separate themselves from social structures. The outcomes of their study can be used for structural and cultural transformation efforts in the quest for parity between men and women (partly the goal of this study) through advocacy and critical power by deploying language in texts and speech. As this thesis observes, culturally, interpretation of texts and speech may create discrimination, resulting in subjugation, denial and even subjectification of women by men through speech, texts, music, songs, poetry and other forms of interactions. Thus, discourses constructed by portraying men and women in contrasting positions in the social structure continuously undeniably impact the socialisation process (Mills, 1995: 1; Kogut, 2005). This is very particularly true of the field study findings from this study, as detailed more in chapters four and five of this thesis.

For instance, in their study of discourse on women and sports in Greece, Kouvoura et al. (2015: 95) help underscore discourses' role in constructing gendered identities quite well. One of the respondents in the study affirms the gendered reproduction of 'ideal' femininities; for example, when she states that,

the successful and feminine athlete, I think it's very sexy for a woman to participate actively in a sport and at the same time to be able to maintain her femininity visible to the world. Because truth be told, if a woman loses her femininity, she ceases to be a woman, and this looks very ugly, especially to the male population (Kavoura et al., 2015: 95).

Like several other findings from the field data for this thesis, the above quotation indicates that the discourses on ideal femininity demand women to act 'feminine', implying they have to subscribe to socially prescribed characteristics. These discourses further place women or men into hierarchies and intersectionalities and classifications of 'normal' women versus 'non-normal' women. The 'normal' woman is more glorified than the one who has resisted living and behaving according to the socially accepted standards of femininity. Still, taking the example of women in sports, discourse in identity formation renders a woman to be accepted and branded as a competent sportswoman and sexy woman – a marker of achievement (ibid). These socially reproduced standards of femininity influence the life worlds of women in sports (Kavoura et al., 2015: 94). Women who can live up to the social standards that conform to societal expectations of femininity gain more acceptance and enjoy more publicity and approval (Kavoura 2015). The case is not so dissimilar with women in renewable energy and technical-related fields in East Africa who are considered not feminine enough or possess supernormal abilities beyond those possessed by a 'normal woman.'

The social constructivist argument deployed in this study concurs with other gender and discourse researchers that the notion of gender is culturally constructed and reinforced, and gendered identities are, to a large extent, products of interaction (Kendall & Tannen, 2001: 548). This argument is further supported by Goffman's study, where he argued with illustrations picked from advertisement messages that gendered identities are concretised through the exhibition of postures that normalise women's subordination, for example, kneeling, getting support and guidance and smiling more often and more widely than men (Goffman, 1976: 25-84). Furthermore, in agreement with Goffman and findings from this study, Butler (1993: 191-194), in her analysis of discourse and performativity, stresses that continuous local actions create and nurture gendered relations through the recurrence or quotation of previous domineering sets of rituals or practices. These arguments are corroborated further by other researchers like Livia & Kira (1997: 10), who investigated the correlation between gender construction and language and Kotthoff & Wodak (1997), who explored the linkages between Butler and Goffman's works (Kendall & Tannen, 2001: iii).

It is indisputable that many women worldwide have questioned the inequalities and their domination and demonstrated agency to negotiate their relations with men. However, as evidence from the field confirms, compared to men, women continue to occupy less powerful

positions in society primarily due to gendered roles that are socially and discursively assigned to them (Sutherland et al., 2016: 385).

Despite the many studies conducted on gender inequalities in society, there is a marked absence of empirical studies that assess how discourses and gender disparities intersecting with other forms of discrimination are maintained within the technology and renewable energy sector. In addition to other philosophies of discourse, this study, therefore, deploys a Foucaultian discourse analysis to investigate how gender power is constructed and reconstructed through repetitive patterns of interaction in the technological and renewable energy sector. Consequently, gendered discourses, perceptions, stereotypes, myths and cultural practices frame males' and females' constructions of their roles and perceptions and are comprehensively investigated further while considering matters of complexity and intersectionality.

3.1.3 Application of Discourse Analysis in this Study

Based on the above discussion about the meaning of discourse and, by extension, the Foucaultian discourse analysis as a methodological tool, I found this theory helpful for this study, especially while analysing social phenomena like gender relations and other perceptions and attitudes and their impact on the sustainability of energy projects in East Africa. Gender construction is shrouded in power relations with related forces of dominance and the production of knowledge on social realities, and therefore, the Foucauldian discourse analysis becomes an excellent tool for investigating these gendered relations and their outcomes.

In summary, this study applied discourse analysis to examine the contribution of discourse in moderating participants' actions, perceptions and attitudes and how they shape women's and men's participation in different activities in the renewable energy value chain. Discourse analysis was also used to establish the regulatory and institutional frameworks that directly or indirectly influence the production, circulation, or communication of thoughts, opinions and beliefs by people in communities of interest. In addition to individual participants, discourse analysis was used to examine textbook content to assess how far the textbooks' language and illustrations might influence learners' gender biases about subjects and career choices in the energy sector. In summary, it aided in unpacking the discursive practices that maintain specific structures, rules, and perceptions about women and men and their basis of inequality and how some of the forces driving inequality have been considered 'normal' and unchallengeable over time. It is these 'rigid and 'normalised' beliefs and entrenched forms of domination that have

often hindered women's participation in renewable energy projects and other technological investments due to the structural imbalance these forces propagate in society.

3.2 Data Collection and Research Participants

The primary data collection was conducted with participants from 16 villages hosting mini-grids, targeting households connected to the grid and those not connected. Nine active mini-grids were selected from northern Uganda, five villages/mini-grids were from the islands in Lake Victoria in central Uganda, and two mini-grids are based in Tanzania. Of the two mini-grids in Tanzania, one is based in the Dodoma (central) region in central Tanzania and the other in the Tanga region (Northern Tanzania). Apart from one mini-grid in Tanzania run and managed by the community, the remaining mini-grids (15) are privately owned and operated by private developers whose motive was to make a return on investment and, therefore, operate on commercial principles (Details of participant location, numbers and corresponding methods are summarised in table 1 within this subchapter). However, in the same grids, there are local committee structures or agents whose principal purpose is to conduct community mobilisation work, especially to mobilise new customers for new connections, but with minimal decision-making powers. In addition, the management committee for the community-run mini-grid in Tanzania possesses more decision-making powers than other committees for privately owned mini-grids. The sampling methods for mini-grids/villages selected were largely purposive and convenient, whereby the mini-grids were chosen based on two factors: the prospect of collecting more reliable data due to the expected cooperation from the leaders and developers in addition to easy physical access to the geographical regions where the grids are based. Such mini-grids were also selected because of a signed memorandum of understanding between the parent companies and the ART: D Grids project that sponsored this research.

Apart from mini-grid communities, other participants were chosen from three universities, all based in Uganda, in addition to three secondary schools, all from Uganda and three primary schools, two from Uganda and one from Tanzania. In addition, participants were also identified from two technical training institutes, especially those teaching Electrical Engineering and other technical courses. Participants from universities included females and males, especially those undergoing or pursuing courses related to Electrical engineering or other energy-related courses on one hand and another group pursuing humanities. Likewise, secondary school students were a mixture of those studying STEM and Humanities/Arts subjects. Participants from technical

institutions were also students perusing technical courses, as fewer or no students pursue humanities in such institutions.

In addition to students, selected teachers and instructors from all the academic institutions involved were also interviewed. In the case of primary schools, interactions were only done with the teachers and school principals. Engagements with participants from educational institutions aimed to explore the gender discourses, related barriers, stereotypes and opportunities available for entry into the energy sector (Muntoni & Retelsdorf, 2018: 212; Powell et al., 2012: 541). The lecturers, teachers, facilitators/supervisors involved in delivering education and training to these trainees/students provided additional information to that provided by the learners for purposes of data corroboration and validation (Cole, 1997: 61).

The textbooks and curriculum from the selected primary schools were also critically analysed to investigate the possibility of gendered discourse in the textbooks and how they influence learners' biases in their choice of subjects and career goals (Sovič & Hus, 2015: 495). A systematic analysis of the teaching and learning materials investigated whether textbooks might contain gendered discourses that influence learners to form cognitive models that create dichotomies between masculine and masculine professions. Moreover, these perceptions are reinforced by the examples, names, terminologies, illustrations, drawings, quizzes and assignments in the textbooks and other instructional materials or literature. Indeed, the results of this analysis largely reflect and corroborate this theory, as discussed further in chapter 5.

In addition to prior considerations, the microgrids selected were those with a high concentration of consumers and those with the potential to offer rich data necessary to address the research questions. Also targeted were mini-grids with a history of success with suitable lessons about sustainability to be learnt. However, additional grids with experiences of failures and conflicts were also studied to establish the reasons for failures and conflicts. Experiences of such mini-grids help to answer research questions about conflicts and sustainability and generate recommendations for improvement.

The fact that these grids/villages studied are located in different countries and even in different regions within those countries presents a rich diversity of cultural norms and discourses, identities, governance systems and other variations within the community structure that enrich this study. Furthermore, as stated earlier, both beneficiaries of the energy from the mini-grids and non-beneficiaries were considered to compare their views and other existing dynamics.

The individual participants who were interviewed were selected using purposive sampling techniques to target respondents with characteristics relevant to my data interests and conveniently accessible (Andrade, 2021: 86), time and willingness to engage in the interactions that would produce rich, reliable and valid data. Other considerations also included gender, class, position in the household, level of education and position held in the village. Also, some employees (women and men) working in the renewable energy sector were interviewed because of their positions. Therefore, purposive sampling was preferred since the nature of the information required necessitated purposively identifying participants either dealing with mini-grids or having adequate knowledge about their activities as they are not a common topic in the target communities.

Other key respondents were also identified within the NGOs implementing energy-related programmes, the investors within the energy sector, the officials from the Ministry of Education, the Ministry of Energy/Rural Electrification Agency, and the Ministry of Gender and Social Development. These officials were based either at the central or local government level. In addition, freelance energy technicians or professionals, especially females, were sought and interviewed. These key informants were selected because they possessed expert information (McKenna & Main, 2013: 115) about the gender discourses, policies and practices within the energy sector and interventions to address some of the identified gaps.

The main data collection methods include focus group discussions and interviews, using interview schedules and key informant guides (A table detailing these interview schedules is shown in the next section- 3.3). Using multiple data collection methods or triangulation was essential for strengthening data while enhancing the credibility of outcomes. Different methods also enabled the tailoring of particular data collection methods to the nature of the participants at hand, in addition to allowing different interpretations and denotations to be included in the data analysis in addition to tailoring particular data collection methods to the nature of the participants at hand (Hox & Boeijs, 2004: 593-599; Leech & Donovan, 2023: 485-490; Shanks & Bekmamedova, 2018: 203). I personally conducted the interviews and focus group discussions without using data collection assistants so that all responses and nonverbal clues were captured, as nonverbal clues and facial expressions are important parts of human communication and essential sources of information in discourse research (LaFrance & Mayo, 1978: 71; Schneider et al., 2022: 1-2). Some additional data was generated from the general data collection questionnaires of the Art D: Grids Project in East Africa. Details on the data

sources and corresponding questions are explained further in section 3.3. In most of the data collection in rural areas, I worked through interpreters since most of the participants didn't know English. However, the challenge with interpreters was that, in some cases, they would summarise the information from the respondent, and I feel that some vital details were left out. On a few occasions, when I could find respondents whose local language I understood, I would interact with them in the local language. However, the challenge with this was that it became difficult to listen to audio in the local language and transcribe it in another language (English) during data transcription. In this case, too, I feel some distortions are created, and some words, phrases, and other speech markers might not have come out precisely with the same meaning as the original respondent meant.

For reasons related to cultural norms, mixing men and women in the same focus group discussion hinders some women from expressing themselves freely (Asimwe, 2013), so it was more appropriate to separate their focus group discussions, especially in the mini-grid communities. In addition, whereas men could be available any time of the day, women would be conveniently accessed only in the afternoons when they are from the garden work and done with preparing lunch for their families but at the same time early enough not to get late for the time of preparing supper. This idea of gendered timing was given to me in advance when scheduling appointments with the participants in one region, but it seemed to be the case for every rural mini-grid community visited. Whereas this timing gave women more time to interact with me, it was also disruptive in that, in some places, we would spend morning hours literally doing nothing as we waited for such an appropriate time to reach. In other words, it wasn't cost-effective in times of time.

More focus group discussions were held with participants from education institutions, particularly with university students, secondary school students, students from technical institutions, and primary school teachers. As stated earlier, participants from primary schools were only teachers but not learners, while for universities, secondary schools and technical institutions, in addition to focus groups with learners, individual interviews were held with teachers/instructors and school leaders (Details of numbers and methods are summarised in the next table- Table 1). These groups of respondents were deemed to have gone through relevant experiences in the schooling value chain that have, over time, exposed them to the appropriate knowledge required to answer the questions for the education section of this study. Organising focus group discussions aided in collecting deeper and more comprehensive data and in

comparing how participants interact or bring out issues in groups and how they respond when interviewed as lone individuals. Focus group discussions also elicit the collective construction of social knowledge and everyday discourse, which is helpful when collecting data involving discourses (Caillaud & Flick, 2017: 155).

Table 3: Research Participants and Corresponding Methods

Region/ Institution	Respondents Categorisation	No. of respondents		Data collection methods
		Male	Female	
Central Uganda (3Minigrids managed by Company A)	Local leaders in 3 minigrid villages	3		Interviews
	Country Manager for the minigrid company	1		Interviews
	Minigrid committee members for one minigrid	9	2	FGD
	Community members/customers (males)- 1 group for each mini-grid	24		FGD
	Community members/customers (females) 1 group for each minigrid/village		26	FGD
	Key customers in productive use of energy	2		FGD
	Minigrid technician	1		Interview
	Customer care/sales assistant for the minigrids		1	Interview
	Government administrators (Community Development Officer and Senior Assistant Secretary	2		FGD
	Programmes officer for an agency providing business support services to minigrid clients	1		Interview
	Official from the Ministry of Gender		1	Interviews
Central Uganda (2 Minigrids under Company B, in Island communities)	Local leaders in 2 minigrids in Lake Victoria	2		Interviews
	Mini-grid resident technician	1		Interview
	Country Manager for minigrid company	1		Interviews
	Customer care/sales assistants		2	Interviews
	Community elder (who invited minigrid investors)	1		Interview
	Customers/clients running PUE enterprises	3	4	Interviews
	Minigrid local committee members	2	6	FGD
	HIV and gender equity organisation partnering with the mini-grid on PUEE ⁴		3	FGD
Central Tanzania (1 community- managed mini- grid)	Mini-grid Technician	1		Interview
	Local leaders, current and former	3		Interviews
	Mini-grid customers- running business	1	2	Interviews
	Mini-grid committee members	3	6	FGD
	Community members (connected and not connected)		13	FGD
	School principal	1		Interview
North Eastern Tanzania (One)	Mini-gridTechnicians (Area Managers)	2		FGD
	Local leaders (for the five served villages	3		FGD
	Minigrid customers	1	1	Interviews

⁴ PUEE means Productive Use of Energy Enterprises

privately owned minigrid				
Northern Uganda (09 minigrids owned by a private developer)	Technicians for the grids	2		Interviews
	Power agents/sales agents	6	3	Interviews
	Energy Customers	2	1	Interviews
	Government leader/administrator	1		Interviews
	School Principal	1		Interview
Academic Institutions/ participants	Consultants working with the education sector	2		Interviews
	Primary school teachers	3	3	FGD
	Secondary school teachers	2	2	Interviews
	University students	6	12	FGD
	Students from technical training institutes	6	9	FGD
	Instructors in technical training institutions		2	Interviews
	Principals of technical training institutions	2		Interviews
		103	95	
Total		198		

In total, the total number of participants who interacted with the study was 103 males and 95 females, giving a total of 198 participants. Of the 198 participants, 142 were covered using focus group discussions, while 56 were from interviews. In addition, of the total respondents, 149 were from the minigrids cluster (including leaders, customers, developers and employees or partners), while 49 were participants from (or related to) education institutions.

As observed in the table, the significant methods for primary data were focus group discussions and interviews. Consequently, data sets from focus group discussions were compared with similar data from individual interviews and other texts from secondary data. These comparisons revealed that when dealing with matters of gender discourses and other socially constructed variables, participants, particularly females, could speak more and provide more information than when interviewed as private individuals. This view is supported by studies by Mendelberg et al. (2014: 291). However, the challenge was that these interactions made some participants digress beyond the questions at hand, with the likelihood of causing difficulties in consolidating and harmonising the different views. Analysis of such data may also be more tasking (Hydén & Bülow, 2003: 305), and indeed it was.

In addition, the non-participant observation method was used to supplement and enable a deeper understanding of the information gained from other sources (Ciesielska et al., 2017: 33-55). Some non-participant observation sessions were used to collect data by directly observing activities on construction sites, business enterprises connected to or powered by the mini-grids, the existing mini-grid installations, and actual meeting sessions for the leaders of mini-grid management structures. In all these observation sessions, the level of participation by women

and men and other dynamics influencing their participation, including discursive practices, were observed and written down for further analysis. Other social-technical dynamics that might, either way, affect or communicate indicators of or threats to the sustainability of the mini-grids were also observed.

Like in interviews, actions, gestures and behaviours were observed at different levels of data collection to infer perceptions, discourses, feelings, experiences and interpretations of how issues of gender, masculinity/femininity played out in project designs, people's actions and discourse and ultimately, their implications for sustainability.

In addition to primary data, secondary data were reviewed to get more ideas and relationships that could not be obtained from the field or to corroborate field data. The sources of this secondary data included previous research papers, journal articles, textbooks, newspapers, government and NGO documents and reports, minutes of mini-grid management committee meetings, mini-grid beneficiary/customer lists, training manuals, monitoring reports, mini-grid load profiles, agency websites and others and school textbooks and curriculum.

Finally, in addition to formal data collection methods, informal methods like discussions with others outside the grid-covered villages supplemented data from the formal methods. These included discussions with family members, listening to radio talk shows about renewable energies or gender, and listening to other people's stories and speeches in mainstream and social media, as long as they had themes I considered relating to this study. Through this method, some valuable insights were captured and incorporated into the primary data collected.

Due to limits in sample size and the sampling techniques, the goal of the study is not to generalise findings to the whole region but to generate deeper information, insights and conclusions that can be used to test or generate theory and contribute to the current or future studies, debates and policies regarding the adoption and sustainability of renewable energy resources.

3.3 Research Questions and Information Sources

To answer the main research question, I probed deeper into the participants' stories and perceptions through their narratives of experiences, views, benefits, levels of participation and even grievances. The different objectives, their corresponding questions, information sources and methods are summarised in the following matrix. However, it should be noted that the

questions outlined only acted as a guide to trigger discussion points. In most cases, the discussions went beyond the stated questions for further probing (Bejeno, 2021: 50), especially on points that I felt were intriguing or required further inquiry.

Table 4: Research Questions, Data Sources and Methods

Research Objective	Probing Questions/Issues	Sources of information/informants	Method of data collection
To Examine the extent of women's participation in the designs, planning and implementation of renewable energy projects, the structural impediments and strategies to bolster participation	What is the approximate number of males and females in the village?	Local leaders	Individual interviews
	What activities do women participate in the energy microgrid project (considering all phases of the project)	Women	FGD ⁵ , Interviews
	Who makes the significant decisions in the households	Men, women	FGD, Interviews
	Which group (men, women, children) spends more time on electrical appliances	Women, Men	FGD, Interviews
	What roles do women play in the operation and maintenance of microgrids	Women, Local leaders, Mini-grid operators	FGD, Interviews
	What role do men play in the operation and maintenance of microgrids	Local leaders, Men	Interviews
	Are there some women operating as electrical technicians around the village? (experiences, benefits, challenges)	Local leaders, Women	Interviews
	Has women's time usage changed due to connection to the electricity grid?	Women, Men	FGD, Interviews
	What new business enterprises were initiated by women as a result of electrification? (more details and experiences)	Women, Local leaders, Mini-grid operators, NGOs	FGD, Interviews
	Changes in labour market participation by women after connection to the grid	Women	FGD, Interviews
	What are the beliefs/ stereotypes/ discourses that limit/encourage women's participation in energy-related activities/occupations?	Women, Local leaders	FGD, Interviews
	Are there locally trained technicians to maintain the grid? How many are female, and how many are male? (To explore more experiences of female technicians)	Local leaders, Mini-grid operators	Interviews
	How can gender be mainstreamed for balanced and inclusive electricity access and use in a microgrid project?	Women, men, Government officials, documents	FGD Interviews, Document reviews

⁵ Focus Group Discussions

To establish and map out the gender dimensions of conflict arising from the implementation and consumption of renewable energy resources	What is the primary source of energy in the household?	Women, men	Interviews
	What benefits do households get from the utilisation of power? (compared to the situation before connection)	Women, men	FGD, Interviews
	What problems do households face due to the absence of an electricity connection? (for those not yet connected)	Women, men	FGD, Interviews
	What problems are faced in the process of searching for and utilising alternative sources of energy	Women, men	Interviews
	What kind of misunderstandings (if any) between spouses result from how power is used at home?	Women, Men, Local leaders	FGD, Interviews
	Which conflicts/unfavourable situations arose during the inception or operation of this mini-grid?	Women, Men, Local leaders	FGD, Interviews
	To explore the implications of these conflicts for men and women in the community	Women, Men, Local leaders	FGD, Interviews
	How did you participate (if at all) in the planning phases of this mini-grid project?	Women, Men, Local leaders	FGD, Interviews
	Was there a needs assessment, stakeholder mapping, or impact assessment before constructing the microgrid in the village?	Grid Operators, Women, Men,	Interviews
	What is the distribution of women and men involved in the conflict resolution structures in the village (microgrid-served area)?	Mini-grid operators, women, men, local leaders	FGD, Interviews
	Are there cases of unfulfilled promises by the mini-grid owners,	Women, Men, Local leaders	FGD, Interviews
	What mitigation measures are in place to address the adverse outcomes of the microgrid project in the village (How gender-balanced and inclusive are they?)	Mini-grid operators, Men, women, Local leaders,	FGD, Interviews
To analyse the gendered dynamics in the education and training sector influencing women's and men's participation in the renewable energy value chains	What subject combination/study programmes are you pursuing?	High school and university Students	FGD,
	What motivated you to select that subject combination/Study programme?	Students	FGD
	Was that choice your preferred choice from your early years in school? (with follow-up questions)	Students	FGD
	Did you get some career guidance officials/ mentors to explain the implications of your career choices?	Students	FGD
	Were there some teaching methods that influenced you to choose particular subject directions? (follow-up questions)	Students	FGD
	Did some beliefs/stereotypes/discourses in the community or at school influence your subject combination/Study programme? (with follow-up questions)	Students, Teachers, women, men, School leaders, Document reviews	FGD, interviews, Document review

	How do you find the teaching methods to be gender sensitive or insensitive?	Students, teachers	FGD, Interviews
	Do you find learning aids and examples gender sensitive?	Students/teachers	FGD, Interviews
	Did some teaching methods influence your choice of subject (humanities or Sciences)? (with follow-up questions)	Students	FGD
	How do the teaching methods address the needs of females and males?	Students, Teachers	FGD
	How does the teaching curriculum and its delivery mainstream/ integrate gender issues (curriculum content, design, delivery, examples, learning aids, timetabling, etc.)	Students, Teachers, School leaders, Textbooks	Document review, Interviews
	Are there any exceptional opportunities /incentives given to students in your study programme/ school due to their gender? (with follow-up questions)	Students/Teachers School leaders	Interviews
	Are there some challenges you face in your programme due to your gender?	Students	FGD, Interviews
	How can gender issues be packaged and integrated into curriculum design and delivery?	Students, Teachers, School leaders, Policy documents	FGD, Interviews, Document reviews
	How best can the teaching and learning exercise be gender sensitive and inclusive?	Students, Teachers, Documents	FGD, Interviews, Document reviews
To formulate an inclusive model that caters for all facets (Educational, Technical, Social and Economic) of sustainability in the renewable energy grids	How best can energy projects be designed/operated to be more sustainable?	Mini-grid operators, Local leaders, experts ⁶ , documents	Interviews, Document review
	How can renewable energy/technology education be made more sustainable?	Teachers, Experts	Interviews, Document Reviews
	How effective are the affirmative action initiatives to promote women in STEM education? How can such initiatives be made effective?	Students, Teachers, Experts	Interviews
	Are there industrial training/internship opportunities for women in microgrid installations? What can be done to benefit women and men fairly?	Mini-grid operators, Students	Interviews

⁶ Experts, in this case, refer to CEOs of Minigrid companies, local government and central government officials, Education leaders and consultants, officials in the energy sector, and other identified individuals deemed to possess expert knowledge.

	How can the learning aids be designed to promote gender sensitivity and inclusivity?	Teachers, students, Experts	Interviews, Document reviews
	How can the harmful discursive practices and stereotypes against women's participation in STEM careers and occupations be addressed?	Experts, Women, Men, Students, Teachers	FGD, Interviews, Document Reviews
	How can energy supply strategies be aligned with gender sensitivity?	Experts, Men and women, Grid operators	Interviews, Document reviews
	How can energy systems be designed to address different needs, capabilities, contexts and stakeholders?	Experts, Mini-grid operators, Women, Men, Local leaders	Interviews, Document reviews
	How can electricity supply be designed and implemented to promote affordability and entrepreneurship by men and women?	Energy experts, Mini-grid operators, energy consumers, documents	Interviews, Document review
	How can barriers to equal access and utilisation of electricity be strategically addressed?	Energy experts and officials	Interviews, Document review
	What are the outcomes of the microgrids/ electricity on the; a) businesses, b) livelihoods, c) environment? d) education and learning in the community	Local leaders, women and men, Mini-grid operators, Documents	Interviews, Document reviews, Observation
	How can microgrid projects be designed to balance technological, social and economic objectives?	Mini-grid operators, men and women, experts, documents	Interviews, Document review, Observation

It has to be noted that during the actual conduct of interviews and focus group discussions in the field, the above questions were used as a guide to facilitate the process and to trigger in-depth discussions. Therefore, in some situations where a respondent gave a short response, other follow-up questions would be asked to continue probing further until I felt the question/issue had been comprehensively answered. In other situations, respondents would speak a lot and delve into extensive narrations or arguments in case of focus group discussions. As a facilitator of the processes, I would keep picking from questions to keep the discussion focused. In many other situations, depending on the response, other (follow-up) questions not necessarily listed in the table above would be asked, especially when further probing a particular issue.

In addition to the respondents mentioned in the table, other key informants or experts were interviewed to gain information on various regulatory and policy issues and recommendations. These informants included chief executives of mini-grid companies, local government and central government authorities working with or close to the energy sector and education experts in government and non-government organisations.

3.4 Data Processing and Analysis

Data from individual interviews, focus group discussions, notes from the observation, secondary data, memos and other informal sources were processed to create meaningful patterns and conclusions.

Following qualitative data analysis traditions (Adu, 2019: 1ff; Saldana, 2013: 1-40), after field interviews and focus discussions, I transcribed the audio recordings to ensure that every piece of data was carefully listened to and captured without missing any details and clues while ensuring excellent reliability (Gibbs, 2002: 16; Mininni, 2020: 117; Yin, 2015: 163-184). Data transcription from interviews and focus group discussions was done using f4 transcription software. The f4 transcription software is convenient as it is purpose-built to quickly and efficiently transcribe recorded audio or video discussions (Jones & German, 2016: 347-355). Since data were collected at different intervals, even transcription progressed continuously as more new data were collected. During data collection, other field notes, memos, and valuable observations were noted down, which were later considered along with the transcribed data.

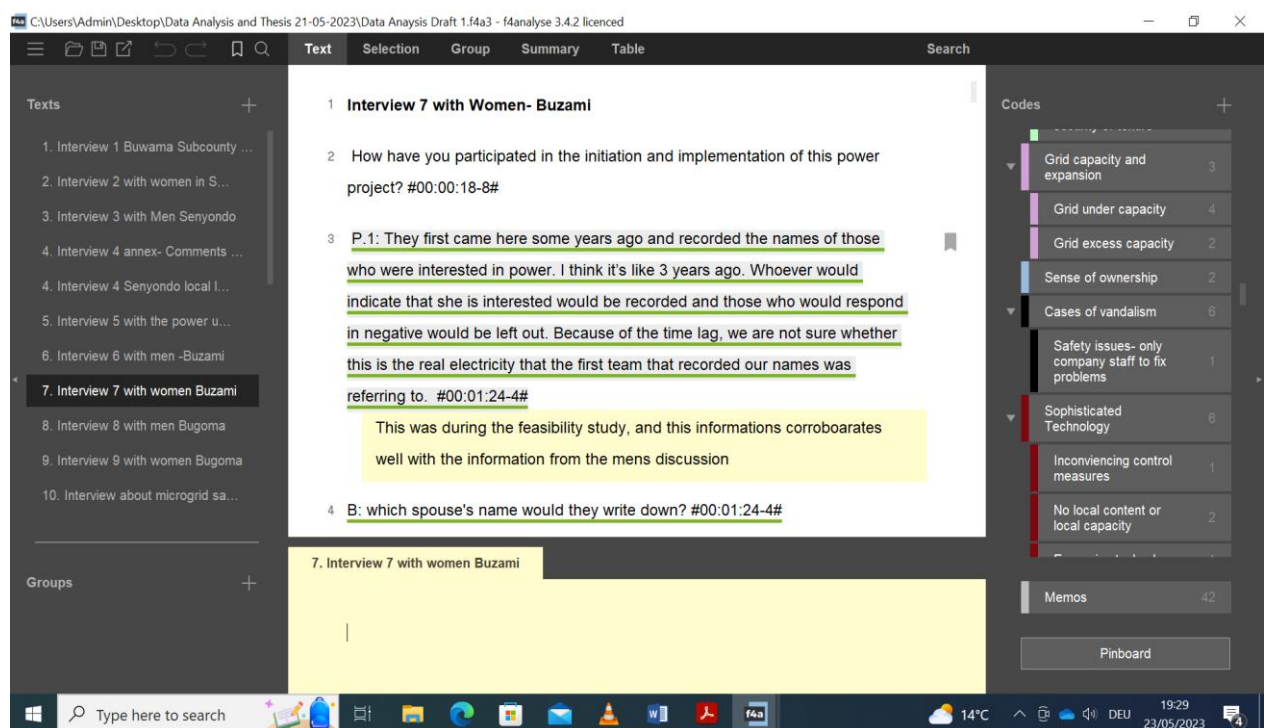
Transcribed interviews and focus group discussions were carefully reviewed to identify key categories and themes in the data and how they relate to the main research question. Reviewing involved reading all the generated responses repeatedly to understand them better, correct mistakes, fill the data gaps where necessary and create more clarification. In some cases, this also involved going to the field to re-interview particular respondents where I felt more information or clarification was needed. I also kept notes on all my data sources to keep track of variables like gender, level of education, location of the village or mini-grid or other relevant groupings to get relationships or interconnections. The above process followed a systematic, though not linear, process that involved initial data transcription, refining, open coding, axial coding, and creating categories and themes, as the proceeding paragraphs expound.

Data coding and categorisation were done using a mixture of software-based and, to some extent, manual methods. Though manual methods might require much time (Saldana, 2016: 1-

40), I found it necessary at the later stage in the coding, especially for creating categories when it became essential to visualise all codes further and more critically, and the computer screen space would not allow viewing all the codes simultaneously. Nevertheless, after data transcription using f4 transkript software, all the data was reviewed to ensure accuracy, completeness, and relevant gaps in the data to be filled. Some gaps required contacting the participants again with further questions or seeking clarifications. The transcribed text files were then exported to the f4 analyse software data repository for additional coding and further analysis.

The 'f4 analyse' software has several interactive sections, toolbars, and commands that make the coding exercise quicker, more systematic, and more logical. The primary sections of the f4 analyse platform include the files section, the text section, the codes section, and others that may or may not be used depending on the research method, goal and skill (Jones & German, 2016: 341-355).

Figure 8: Illustration of the interactive desktop platform for f4analyse software



Screenshot of the f4analyse working interface captured during the coding process for this thesis

Once the transcribed data files or texts were in the system, the next step was to start the coding process, that is, the process of labelling and organising data in ways and formats that make it

possible and easy to identify themes in the data and the linkages or relationships between the occurring themes (Elliott, 2018: 2851).

To simplify the coding exercise, I first transferred smaller samples of data files and texts, read them, and then studied them carefully to develop codes and systematically label each piece of text. Next, the codes would be named and described, and accompanying memos and comments would be written down where necessary. Then, I kept adding more data files or texts, rereading them and coding them by either assigning them to the already created codes or creating new codes depending on the relationship of the data with the existing codes. As I progressed, this entailed revising and refining the codes for more accuracy and consistency.

Since I wanted the codes to emerge from the data and since there were no pre-existing codes or availability of the codebook, I opted for inductive coding, where codes were created based on the insights from the data itself. This further ensured that the codes were as close to the data as possible with limited subjectivities (Linneberg & Korsgaard, 2019: 262; Saldana, 2016). As stated earlier, as the coding process progressed, I kept adding new codes and modifying the code description as much as necessary. Once all the files' necessary data was coded, I tried reading through everything repeatedly to eliminate inconsistencies and identify the data pieces that might have been overlooked in the earlier sessions.

Once the coding was complete (or seemed to be complete), I tried to organise the codes into a coding frame to create a flowing organisational structure of the codes. I opted for the hierarchical code structure instead of the flat structure since the hierarchical code frame makes it easier to derive intuitions from the analysis (Adu, 2019: 143-146). Hierarchical codes also make it possible to view the frequency of the occurrence of a particular code, which creates direction, generating insightful relationships and conclusions about the common themes in the data (Peters et al., 2022: 4). The f4 analyse software enables this function by dragging codes and placing them in positions where one wants them to be or even merging them with existing codes if they are too similar. Likewise, while coding, I kept creating sub-codes from primary codes. Sub-coding or meta-coding simplifies the creation of meaningful relationships and insights. Otherwise, a coding frame with all codes aligned at the same level might make inference generation difficult. Sub-codes also improve the quality of the analysis (Williams & Moser, 2019: 45-55).

After I was contented that I had done comprehensive coding with the sufficient organisation of codes into a coding frame, the next step was to align codes with the main research objectives and research questions that guided this study. This alignment facilitated grouping the codes into categories and themes, thereby saving data analysis time and eliminating the stress of figuring out which code belongs to which question" (Adu, 2019: 122). Throughout the data analysis process, I systematically read the data to identify indicators and assess how they answered the research questions, then created the codes and described the code developed. This enabled me to generate codes that capture the data's underlying meanings and relate them to the research questions.

After organising the codes under each research question or anchor, the next phase was to generate categories and themes from the codes. Categorisation entailed scrutinising the features of each code, reviewing commonalities and points of convergence among the codes and sorting them based on what they have in common to create clusters of codes or categories (Charmaz, 2014; Creswell, 2018: 184). In creating categories, some dominant categories associated with the most participants or had a very high frequency became categories or themes. As I did with codes, I also generated subcategories under the main categories because subcategories helped me to establish the unique characteristics of categories or themes while compiling the final report addressing the main research questions (Adu, 2019; Dey, 1993: 137-138). To precisely respond to the research questions, further attempts were made to move beyond categorising the codes to connecting the categories based on the established relationships between them. Potential relationships were assessed by scrutinising the connections between the categories, and the identified relationships would be further compared with data for validation (Charmaz, 2014). The main criteria for comparing categories with others were looking at what they represent, the empirical data and codes they are linked to and their meaning (Freeman, 2017: 15-37; Strauss, 1989: 164). These steps enabled the creation of groups based on categories or themes that helped me to create valid and credible findings, arguments, discussions and conclusions for the final results chapters addressing this thesis's research questions as presented in chapters 4, 5, and 6.

It has to be noted that apart from coded responses from interviews and discussions, field notes on non-verbal expressions, mood, frustrations, joy and gestures from respondents that I had noted during data collection and processing were also incorporated and analysed to infer more vital meaning as Tubbs & Moss, (2008: 1ff) and Phutela, (2015: 43) suggest. These notes and

memos from the field and the coding process were critical in providing more clarity and insights into the data.

In summary, as Zina O'Leary's (2010: 184-281) guidelines suggest, the data analysis process involved identifying key issues, discourses and biases in the primary and secondary data while noting down impressions in the form of notes and memos and then reducing or compressing the raw data to better understandable groups or codes. Then, I searched for patterns and interconnections by mapping and building categories and themes based on the emerging topics and assessing how they related to the research questions and theories. This process enabled me to build theories or compare the data to theories to verify or disapprove the theories used.

However, the above steps might appear linear on paper, but in practice, the entire process involved going forward and back through primary and secondary data and even field notes to facilitate more clarity and understanding of the codes, themes and interrelationships with the questions and theories (O'Leary, 2010: 184- 281).

3.5 Limitations and Challenges Encountered

In most of East Africa, especially the rural areas where the targeted mini-grids are located, most people and, consequently, the study participants are always working either in informal and formal employment or are busy working on their farms. This kind of schedule made securing appointments for comprehensive interviews/discussions that last longer than an hour challenging, especially with women. To address this challenge, I always scheduled meetings with participants around evening hours and weekends for those who could not afford the appointments during regular working hours. Secondly, this research exercise took place when countries faced the COVID-19 pandemic challenges that resulted in travel restrictions to some countries or regions within the countries. This posed unpredictable challenges in accessing some targeted communities that host mini-grids during lockdown periods. For instance, for almost the entire year of 2021, most of the countries in East Africa were classified by the World Health Organisation and the Robert Koch Institute as COVID high-risk countries (Robert Koch Institut, 2021) and therefore, accessing them became difficult. In the case of Uganda, travel restrictions were later lifted, although researchers had to provide a COVID risk mitigation plan to the ethical review committees, something that we did before getting ethical committee approval.

To address the challenge of restricted movements, I used a flexible approach where data collection would occasionally occur when the restrictions were lifted, and the exercise would be halted whenever authorities reinstated lockdowns.

In addition, it should be noted that mini-grids were located in hard-to-reach remote areas, which presented access challenges in terms of transport means. For example, whereas most grids in Uganda were located in the islands deep inside Lake Victoria, majorly accessible by lightweight open wooden canoes, those of Tanzania were located in very remote areas that did not have direct access by conventional means of transport. In all cases, alternative means of transport were sought, and in the end, the places would be accessed either by boats or usually expensive motorcycle taxis (locally referred to as *Boad boda*).

One of the most unusual things was that participants had to wear masks and observe other social distancing protocols during interviews and focus group discussions. Did this have a bearing on the flow and intensity of the discussions? I cannot be sure, but perhaps yes, since some participants expressed discomfort in conversing while wearing medical masks. However, further research might be needed to investigate whether and how social distancing protocols impacted the data quality for researchers who conducted studies during the COVID-19 pandemic protocols.

Despite the above-highlighted incidences, the research process progressed smoothly with no significant challenges affecting this study's pace, quality and validity.

3.6 Ethical Issues, Situated Knowledge and Reflexivity

It was evident that participants were always eager to discuss subjects relating to family relations and gender, particularly gender justice issues, women's participation, femininities, masculinities and related discourses. The reason for the interest is that when discussing gender relations, men and women come out to debate vigorously to defend their power positions (Asiimwe, 2013: 13). Therefore, tensions, disagreements, counter-accusations, emotions and moments of humour would arise during focus group discussions. Therefore, as a facilitator of discussions, great care was taken to minimise tension or personal attacks during focus group discussions while allowing participants to speak out freely.

Participants were also informed that their views and perceptions would be kept confidential and that no harm would arise to any participant due to their opinions or participation in the study.

In addition, mini-grid or institution-specific data collected from different mini-grids and academic institutions were treated carefully and confidential during this thesis' writing to avoid exposing it to competitors or other parties. In the discussion of results, the participants' identities have been kept anonymous to avoid exposing them to (any) possible victimisation; however, pseudonyms and other forms of description have been allocated instead. In addition to pseudo names, acronyms that especially represent mini-grids, villages, and other institutions have been applied. In all circumstances, great care has been taken to ensure that no random reader can easily match particular responses to a specific participant or village.

Still, before entering particular communities and sites and engaging participants, efforts were always made to inform the local leaders and relevant officials or agencies in advance, explaining the purpose and scope of the study so that they were fully aware of our presence in the community. In some countries that appeared to be highly sensitive about the presence of foreigners in their territory⁷, this approach puts the researchers and the participants in a safer and more comfortable situation.

During field interviews, I recorded (with a sound recorder) the proceedings to maintain lively and interactive discussions. The recordings enabled me to listen well to the discussions and listen to the data many more times later during data processing and report compilation. Before using recorders, permission would be sought from participants first, and for those who felt uncomfortable being recorded, only written notes were taken. Permission was also sought to quote names in report compilation, but where permission was not granted or where, in my judgement, the statements appear sensitive, pseudo identities are used or names omitted altogether.

At a personal level, I have participated in some feminist-related studies and debates for some time and have consequently developed some elements of feminism. Naturally, this makes me question my neutrality when dealing with debates and discourses concerning men and women. However, throughout data collection, serious efforts were invested during interactions so that "I listen to myself first" self-monitor where necessary (Dunn et al., 2010: 1385; Huettig & Hartsuiker, 2010: 347) before speaking/responding to participants to minimise personal biases

⁷ This belief is based on the many questions immigration officials would subject us to at the airport in addition to the several warnings we would get from our hosts about security sensitivity.

and prejudices. Similar biases were minimised during coding and report compilation by relying on data and literature, not personal perceptions and sentiments.

Reflexively, the research process has enabled me to carefully reflect on the multiple experiences of women and men, particularly the different struggles women in the communities and in academic spaces face when negotiating their power. As someone who identifies with the cause of women's emancipation but is nonetheless not a female and not suffering any form of gendered oppression, I provide a different positionality in this study. However, it is essential to note that gender justice struggles are not novel to me. My first job after my undergraduate degree was as a Community development officer in charge of the Gender desk in a local government in rural Uganda, and most of my work revolved around dealing with gender discourses and discursive practices that placed women in disadvantaged positions. This later shaped my direction for graduate studies and consequently influenced my motivations and values, which informed the research purpose. Therefore, the primary motivation for this research is to analyse the gender discourses and how they eventually influence the participation of women and men in the renewable energy sector. Indeed, different commentators contend that gender justice and sustainability can only be realised if the gender gaps in the renewable energy sector are minimised (Clancy & Roehr, 2003: 44; IRENA, 2019: 1ff; Karlson & Clancy, 2000; Oparaocha & Dutta, 2011: 265; Skutsch & Clancy, 2006: 59-68).

Due to that background and positionality, I critically reflected on my position throughout the research process, which enabled me to maintain neutrality and sensitivity while dealing with the research participants. I maintained this while simultaneously trying to appreciate the role research can play in changing the plight of the oppressed, in this case, the rural women and female students struggling to find their position in renewable energy activities and careers, aiming to enhance gender justice and sustainability. Thus, reflexivity enabled me to deal with these participants not just as data sources but as fellow and equal human beings (Bejeno, 2021: 60-61; Lindo-McGovern, 1997: 1).

4 Women's Participation in Renewable Energy Project Processes: Discourses on Opportunities and Impediments

According to Bishoge et al. (2020: 121), like any other project that aims at empowering the community, the participation of all categories of people is paramount if the same project is to be sustainable. According to the argument brought forward by this discourse, therefore, for any project like renewable energy mini-grids to succeed, women's participation and attention to other aspects of gender equity are essential (Fraune, 2015: 55; Karl, 1995: 1ff; Smith, 2011: 1014). Therefore, I accord special attention to women since, according to discourses from scholars (e.g. Bishoge et al., 2020: 124; Pedersen, 2016: 570-587), the absence of electricity and other forms of energy in rural areas of East Africa affects them adversely more than other community members. As the ones in charge of preparing food for the family and other household chores as per the local discourses governing the gender divisions of labour, then energy deficiency translates into women walking long distances looking for firewood, operating in darkness at night and suffering respiratory health disorders due to excessive smoke, among other concerns (IRENA, 2019: 10, 56-74; Shailaja, 2000: 45).

Consequently, one of the objectives of this study was to assess the discourses shaping the level of women's participation, the impediments therein and the strategies being undertaken to contest the discursive barriers. Indeed, the comprehensive interviews and focus group discussions in the field revealed that the participation of women in energy activities is a double-sided matter. In other words, despite numerous discourses, women partake in renewable energy project cycle processes and are productively benefiting from access to electricity supplied by the mini-grids in various ways. However, they also experience a host of structural challenges that frustrate their involvement. These challenges primarily emanate from social learning, dominant gendered discourses and stereotypes that pervade the communities in which they live. This section, therefore, discusses in detail the nature of women's participation, the discourses and practices influencing this participation (or lack of it) and the existing attempts to contest the status quo.

4.1 Level and Scope of Women's Participation in the Mini-Grid Processes

Despite the available discourses (e.g. Clancy et al., 2003: 5-19; Fraune, 2015: 55; GACC, 2016: 1-14; & Mininni, 2020: 1ff) (and primary data from this study) presenting a host of challenges undermining women's involvement in renewable energy in particular and the technology sector

in general, findings from primary data reveal that women play a vital role in the mini-grid development operation processes. However, this participation is riddled with numerous structural challenges and discourses that affect this participation (as detailed later in the chapter). Firstly, as MacArthur (2016: 631) puts it, most well-intentioned projects do or should begin with feasibility studies and community engagements with the local people (MacArthur, 2016: 631). Indeed, for a few mini-grid projects where I conducted consultations⁸, women constituted a fair proportion of people whose views were sought. Though not explicit, at least their opinions about whether electricity constituted a real need, their capacity to use and afford electricity and the type of suitable productive use enterprises were sought by the operators. However, at the household level as opposed to the business enterprise level, whenever the project staff (data collectors from the mini-grid installation companies) would find a husband and wife at home, they would only consult the man and ignore the woman. Whenever they found the wife alone at home, they would consult her but record the husband's name in the database or registration book. It is only in female-headed households where the name of the female was documented. Asked about why the data collectors would record the (absent) man in the database even after collecting the views from women, all participants in the group discussion unanimously responded that "it is because the man is the head of the family, and this has been like this since the beginning of the world". Such discourse is not uncommon in several African and Asian communities (Annan et al., 2021: 1-3; Arestoff & Djemai, 2016: 70). Asked why man is the head of the family, the argument was that is how God decreed and changing that order would not be possible (FGD with women in BZ, Paragraphs 1-13). Despite a few discourses and stereotypes about the relevancy of women's views in the house and society, most of them reported that they were consulted, and it is hoped that their opinions were considered in the design of the said mini-grids.

Moreover, women also work as administrators for most of the mini-grids visited. Out of the 11 mini-grids that had operational, physical, and administrative premises, 8 had female administrators. The administrators also act as the focal persons for the mini-grid activities in the community. As focal point persons, they handle sales, marketing, communication, customer care and general mobilisation for the mini-grids. They said they seldomly handle technical-related issues, though, as that is seen as a preserve of male technicians. Like the common

⁸ Note that some mini-grid projects commenced operations without conducting real community consultations

gendered division of labour and discourses that suggest that females are more suited as front desk and salespersons (Langan et al., 2019: 466; Skelly & Barger Johnson, 2011: 59-70), there was a general consensus among respondents that in rural community centres where customers and clients reportedly take long to understand and appreciate innovations, women are the most skilled to handle such businesses efficiently as observed by one of the administrators at mini-grid in one of the island communities in central Uganda:

I: So why do you insist that women do customer care work better in the mini-girds?
#00:23:43-8#

P: Definitely, women do it better, but you can find a few men who can also do it. Because the men have a problem getting angry very fast, and customer care work in such a disorganised community requires much patience. Some dissatisfied clients come here very annoyed and uninterested in listening to explanations. However, a woman can easily find ways to cool a disgruntled customer. I tell him please, sit down; let us talk first. Such a customer might have reported his complaint a long time before and feels it has taken longer to fix it. You find as a customer care officer, you had also reported that same matter to your bosses, but they didn't act. Thus, such a customer comes for the second time; he just quarrels without listening. For example, a person who deposited money on mobile money to purchase power and has taken some days without getting credited gets bitter. Such a person will claim that even when no electricity is being consumed, you continue charging me; where does my money go? However, such allegations of chopping their money when the power is off are not always true. But you know these technology-based payments are hard to be understood by our ordinary people. Remember, some of the people at the landing site are evil characters. Others come when they are running away from criminal cases committed elsewhere as the landing site collects all sorts of persons, including wrong ones. However, because I want that person to continue using our electricity, I maintain a calm demeanour as a woman. Very few men, if any, can manage to handle such situations. Our male staff cannot manage that level of tolerance. Men get angry very fast. Some of these customers come with ignorance and abuse us. But as women, we manage to calm them down, and they go back with a smile, something a man cannot manage to do #00:26:04-1#” (Interview with customer care at KS Mini-grid, Paragraph 55 - 56).

Beliefs that women are better performers than men in customer care and other administrative work are a question of discourse and perception (Skelly & Barger Johnson, 2011: 59-70). However, despite that, it has led many females to occupy such positions, and mini-grid enterprises are no exception.

In addition to administrative work, women were praised for serving diligently on the local energy management structures or committees in grids where such committees existed. These committees serve many purposes, including mobilising customers, cleaning the solar panels, maintaining the safety of mini-grid infrastructure, and mobilising and enforcing tariff payments. Depending on location, these structures are variously referred to as power agents, power champions, and energy committees, but the functions are essentially the same. For example, in

the SD mini-grid in central Uganda, all five members of the mobilisation committee were women, and their duty was to mobilise customers for new connections in exchange for an in-kind payment of some power units. A discussion with the energy developers in the area revealed that these women have actively brought many new customers on board. In the SL mini-grid of Tanzania, the energy committee chairperson was a woman whom the residents reported to be very active in steering the committee and energy activities.

Regarding meetings and community training on energy-related topics, it was reported and observed that women tend to participate passionately and in more significant numbers than men. According to one local leader, women have a higher urge to attend meetings, listen attentively, and seek knowledge on community development matters than men, and that is why their productive energy use enterprises reportedly grow faster than those managed by males. In one of the local meeting sessions to discuss energy and other issues, where I participated as a non-participant observer during data collection, women actually attended and passionately talked and gave their views despite the presence of men. This revelation was, however, contrary to the popular discourse and belief that African women do not participate effectively in meetings where they are mixed with men due to reasons of patriarchy and culture that teaches women to accord respect to men. Respect, in this case, extends to keeping quiet and not challenging men's views or speaking loudly in public (De Paola et al., 2021: 1; LeFlouria, 2015: 1-10; Nfah-Abbenyi, 1997: 1-13).

However, despite their reported (and observed) efficacy, it was argued that women could only comfortably participate in activities during the daytime hours. Any activity beyond evening hours is reportedly for only men as women are required to be home during the evening and night hours, and returning home late is regarded as a form of disrespect to the husband, irresponsibility and promiscuous behaviour, though the same does not apply to men. According to one of the respondents, this is a thorny obstacle to women's agency and an impediment to their participation, as revealed in the proceeding statement by the chairperson of a male-only energy security committee for a mini-grid community in central Uganda;

P1. This place has more women than men, but most of these women are married. You see, even just moving with a woman coming from a meeting raises suspicions; she might be suspected of having a sexual affair with you or another man, leading to marriage breakdowns. So, as a man, it may not affect you, but the woman will be affected. Alternatively, even though it may not affect the two of you, the husband will be affected. So, it is tough to get a woman from her home and move with her at night in the work of protecting the community resources. Mr Isma, would you allow your wife to move? (*big laughter.*) So, we decided to work without women. Those

who will emerge later as *kyakulasajja*⁹ (women who purportedly conduct themselves like men) or single mothers, then we shall work with them. #00:15:40-4#" (Focus group discussion with energy security committee- SD Mini-grid, Paragraph 38).

Such belief plays directly into the power relations discourses that still elevate a man at the expense of a woman to the extent of limiting women's freedom of movement in the name of morals while giving all the freedom to men. Even the so-called moral standards set out by the community only target women.

Despite such discourses, it was noted that some females who overcame these barriers directly participated in the initial construction of one of the mini-grids in Uganda, but this reportedly surprised many residents as they scarcely expected it. These females were university students of electrical engineering who participated in the initial installation. Of the six engineers who did the civil works, three were females, and three were males. In addition, outside the mini-grids, several female electricians are emerging, and they are reportedly doing quality work (Asif & Barua, 2011: 5066; Dickerson, 2015: viii, 196). Females are, therefore, achieving some strides despite the dominant discourse that electrical engineering and related technology work are unsuitable for women. Though community members might be inclined to scrutinise the quality of females' electric work, this study didn't find any evidence of anyone scrutinising the quality of males' works based on gender. Such minimal contempt for males' quality of work could be due to the general discourse that electric work is essentially masculine.

Furthermore, such discourse deprives women of opportunities to participate in various trades even when they have the requisite skills. Matters get more worrisome when some presumably enlightened male engineers also maintain and reinforce the myths that females cannot do quality work in engineering-related fields. For instance, in one of the interviews with a manager of a mini-grid enterprise in Uganda, while asked why they seldomly employ women in their company, his response was that:

Honestly, it was not necessary to involve women because that was not their job. Yes, they got involved in cleaning the ground at the solar plant. They could not climb and clean up the solar panels as men did because the machines were big, and women could not manage them.

⁹ *Kyakulasajja* is a derogatory name or identity given to women who purportedly behave and conduct themselves like men. These codes of conduct are a subject of community constructions and discourse. However, in most times such women are just confident and independent thinking women who refuse to be bottled into a set of society prescribed feminine conduct and standards. Such women are taken to be irregular and unruly.

Nevertheless, we still believe that such technical work is not meant for women, although a few can manage it. Otherwise, when the plant was being set up, you could see that no work was meant for women. #00:01:42-1#" (Interview with a manager of a mini-grid in Uganda, Paragraphs 7 – 8).

Like in the previous paragraph, the biggest challenge here is stereotypical perception. In this case, the biased perception is coming from a person deemed to have more exposure and would be presumed to transcend such prejudiced theories about women's capacity (I am not claiming that educated and exposed people are immune to stereotypes and biased perceptions). However, there were also examples of discourses that cast women as amiable stakeholders, thus facilitating their entry and participation in some activities, albeit with limitations. The following section looks at some of those discourses that increase (some) opportunities for female participation in the industry.

4.2 Discourses that Women are More Dynamic, Authentic and Committed at Work.

Despite the biased theories expressed in the previous quotation, several respondents expressed consensus that on occasions where women are allowed to participate, they act with honesty, zeal, and diligence and accomplish tasks with better results than their male counterparts. While attending one of the meetings with local leaders of one of the landing site communities in central Uganda, an inquiry was made as to why women tended to be more present in most of the mini-grid meetings organised, and it was expressed that women are more enthusiastic about what they do and that when they love something, then they perform with zeal. This argument reportedly contrasts with men who (allegedly) may go to a meeting or community function with different motives from those stated on the meeting agenda. They added that, as a community, they have realised that women are good managers in community development activities and productive use of energy enterprises. For instance, it was observed that women control activities like fishing, though men physically enter the lake to catch the fish. (According to local discourses around the fishing communities, it is taboo for women to enter the fishing boats as doing so would cast a bad omen, rendering the whole exercise for the day unsuccessful.).

It was also revealed that so many houses at the landing site belonged to men, but the only two houses in that community that had approved architectural and physical plans belonged to women. This does not imply that men were ignorant about the importance of an architectural plan for a building, but they looked at it as either a waste of money or just adamant about

following proper regulations, while women had to seek building permission because of their desire (according to discourse) to be authentic. Indeed, a study conducted by Anita et al. (2020: 1787) revealed that despite the pressure to maintain family and work-life balance, women are more careful and diligent in conducting business compared to men. This discourse is further supported by several participants interviewed for this study.

Participants argued that that motivation to work hard amongst women is partly driven by the burden of having to cater for household needs coupled with large numbers of children that men have tended to neglect currently, unlike in the past when men took responsibility for providing for their families (Interview with the chairperson of SD village, paragraph 7). Participants in the discussion claimed that a mere random visit to any household in the community and asking children about who, for instance, provides their school fees, most would respond that it is their mothers. Therefore, the need to shoulder child care together with the supposed proactive character motivates women to work harder and get involved in different activities when electricity gets connected to the area, as women also do not despise jobs but are conditioned to multitask instead (Kamberidou, 2020: 1; Szameitat et al., 2015: 1-26). However, it was too reported that this multitasking by women with associated earnings reinforces laziness among men who, when faced with financial challenges, abandon all family responsibilities to women or rush to sell family land instead of working hard to earn. They allegedly just prefer living like “slay kings”.¹⁰ Thus, had it not been for the fact that the energy companies dictate whom they employ, the local leaders would be interested in engaging more women than men in managing mini-grid activities due to their enterprising acumen and diligence (FGD with males in SD- mini-grid paragraph 38). The above discourses were re-echoed by a customer care worker for a mini-grid in Lake Victoria in Uganda when she observed that:

As women, we also need to do such jobs in the energy industry and demonstrate to society that we are capable. Assuming I was a recruiter and dealing with applicants, in instances where one man and one woman have applied for the same job, I would be inclined towards recruiting a woman. Do you know that women are more committed to work than men? As a woman, even if we are seated here and I hear that the customer is having problems with power, I get concerned so much because women understand well what it means for a household to stay without electricity for a day. I feel like running so fast to fix the problem so that the customer doesn't stay long without power. But when you tell these male technicians, they take their time because they don't care much, and we cannot push them because we must respect them as men. But

¹⁰ Slay king is local jargon in Uganda applied to men who want an easy life without toiling and want to appear modern even when they are just naïve.

women always want to see everything moving ideally. Sometimes, we are incapacitated, but we often want our customers' concerns to be addressed so fast. Excuses like I will handle your issue tomorrow, are unfamiliar to women. But for men, they don't rush at all. He just says, let the customer be patient; we shall handle her/his issue tomorrow, even when it is urgent. #00:36:23-8#" (Interview with customer care of KS mini-grid in central Uganda, Paragraph 74).

Related to the above was the discourse that women are more diligent and honest and act according to expectations whenever given assignments and contracts. They are honest and honour contracts and are not driven by illicit motives as men tend to be. Due to the need to finance numerous demands beyond their means, men act dishonestly when given work by clients. In the words of a female lecturer who also teaches electrical engineering at a technical institute in Uganda:

Women perform very well in their jobs, those who qualify become better at the workplace, and people who understand their capacity prefer to give them work. You know women are faithful and honest; they do not conspire to steal or fail to honour contracts. When a woman decides to do work, say laying cables in the building, she does it how it should be. Like on the side of cables and other electrical accessories, female technicians will buy the right ones in the right quantities. On the contrary, males will always buy less because they want a change to keep in their pockets. Secondly, they tend to take on many contracts simultaneously, and when they mix this with other society's demands, they lose concentration on work compared to women. Men love money so much and have many responsibilities because of the nature of our society, while others are polygamous and have to spend on three or more wives, etc. Therefore, if you give a job to a man, say to do the electrical installation in the building, he will immediately ask for a deposit and start spending it before starting on the job. For women, their pressing responsibilities rotate around their households and children. Men have many children, wives, parents, and other social pressures, which make them overspend beyond their means. #00:48:05-9#" (Interview with females at MTB institute in Uganda Paragraph 67)

As some respondents claim, the above-reported commitment is accompanied by women's affinity for knowledge and continuous learning, which keeps them informed about new developments and projects in the community. One of the local leaders (male) for a grid village in central Uganda reported that the moment the local leaders announce an upcoming training or community meeting, even before the day reaches, women are likely to approach the organisers with questions regarding the nature of the prospective training content and the level of preparedness, including logistical arrangements to ensure that the training becomes successful. They become anxious and will demand to know the specific program of the day because they are enthusiastic about community development programs. Conversely, males seldom act like that; instead, they complain about how they are tired of the various government programs (Interview with the local leader KT Mini-grid- paragraph 38). According to accounts of another village leader in northern Uganda, men who hesitate to participate in community development

meetings and training are the main cause of the existing poverty in the area since, according to him, "he who gets tired seeking new knowledge invites poverty" (Interview with the local leader of LP Mini-grid village).

4.3 Negotiating Benefits from Mini-Grid Electrification by Women: Labour Force Participation

Having looked at the level and scope of women's participation and the gender discourses modifying their participation in the mini-grid projects, it is evident that women participate in many ways, albeit mainly in non-technical jobs. The next issue to discuss then is how the introduction of electricity in rural communities impacts women's labour force participation and other intrahousehold negotiations. In the first place, participants overwhelmingly reported that the introduction of mini-grids accelerates access to the power supply in rural settlements, which the electricity from the national utility companies could hardly serve. The general consensus, therefore, was that electrification increases women's opportunities to connect power and improve their labour force participation. One of the mini-grid operators in central Uganda revealed that most of the applications received for new connections are from women and that even behind those applications brought in by men, there are women in the background who push them as men tend to drag their feet. Consequently, installing electricity in the business premises reportedly leads to increased working time for women as they can now open their business enterprises for more extended hours because of access to light and increased customers. It was also observed that several women, especially at landing site communities, use their residences for small businesses, and these, too, increase their working time, while those running bars reported working trans night on some days when patrons come in large numbers:

Time utilisation has changed a lot. We now work for many more hours. We would be working in darkness those days, and by 7 pm, we would go to bed. However, now I can work beyond 10 pm. Only that there are few people around this side, so walking home late in dark spots is risky #00:01:59-6#" (Interview with Musawo, a female shop owner in a village mini-grid on an island in Lake Victoria, Paragraph 9).

However, returning home late has been associated with domestic conflicts, as discussed later in this chapter. The increased working time, together with the surging number of customers, therefore, motivates women to expand their business units, as revealed by participants in a focus group discussion with women in BM village:

We have started doing different business enterprises and improved the ones we already had because of this power project. For example, I operate a saloon and have just been connected

after completing all payments for connection. So, I plan to buy hair dryers of many types, which will significantly improve my business performance. My colleagues who connected power earlier earn big #00:01:44-5#” (FGD with women in BM, Paragraph 3).

Similar experiences about improved business opportunities are emphasised by another respondent in a different village and different mini-grid:

If you look at the nature of this place, you can see that it was remote, and electricity improved many things for us in this area, especially regarding income generation. For example, we didn't have fridges and would use ice to preserve our soft drinks or drinking water. But after getting power, we were able to buy fridges. This has simplified our businesses, and we can now serve our customers with quality products in a short time. #00:00:47-3#” (Interview with a female shop owner in a mini-grid village in central Uganda, Paragraph 5).

However, as argued by Clark (2021: 1ff), this increased working time by women may constitute an additional work burden to women who already suffer from heavy workloads resulting from the triple constraints of productive, reproductive and community work. In this case, the gains made from increased participation in the market and improved returns on business enterprises may be outdone by the increased pressure on women's time. For instance, most of the power connections made in the mini-grids, especially in northern Uganda, only cater for lighting. Electric lighting increases working hours, which may force women to handle productive activities during the day and then embark on household reproductive roles at night when it gets dark outside (IRENA 2019: 52, 115). Whereas such an arrangement accords women more agency regarding time usage, it can possibly escalate the number of hours they work daily on productive and reproductive chores. A similar study conducted in Madagascar, for instance, established that the provision of electricity only allowed girls to have more time on take-home school assignments but did not enable them to reduce time on household workload, indicating an inverse correlation between the provision of electricity and women's labour time (Clark, 2021; Daka & Ballet, 2011: 2869-2872). Moreover, most households in the mini-grid villages are relatively poor and can hardly afford to purchase appliances like electric cookers, washing machines, dishwashers and other household appliances. Therefore, renewable energy interventions that couple electrification with the supply of such appliances would help free women from heavy reproductive workloads and allocate more time to productive activities in the market or enjoy more leisure.

Nonetheless, access to electricity still provides some opportunities to women, especially in productive energy use. As seen in the preceding discussions, many productive energy-use enterprises sprung up, increasing women's labour participation, especially in enterprises that local discourses refer to as ‘feminine enterprises’. These commonly revolve around shops

selling simple but highly demanded products among the low-income earners that dominate the mini-grid communities. For example, it was observed that women dominated the sale of cold drinks (because of the introduction of refrigerators) and operated popcorn roasting machines that were electrically powered. They used power to make fruit juices using juice blenders instead of in pre-electrification days when they used rudimentary methods like using polythene papers to squeeze the juice out of fruits. Women also use power kettles, which quickens the process of preparing breakfast for the family, especially in the morning when children go to school. Previously, they would take longer to light charcoal stoves to do the same work, and delays would sometimes cause quarrels and conflicts with their spouses.

In addition, this research observed women using electricity to run other enterprises like food kiosks and restaurants, silverfish drying and processing, hair salons, ground nuts and sesame processing, and running bars. The alcohol business is reportedly a highly cherished enterprise among landing sites/fishing communities. Concerning the alcohol business, the availability of electricity adds flavour to the enterprise as power allows proprietors to pay for TV and music for the customers, enabling patrons to party throughout the night. The availability of many customers automatically leads to increased sales, revenues and profits. The notion of women investing in the bar business reportedly has the added advantage of attracting more male patrons; some might not necessarily be interested in taking alcohol but just come with other intentions. When this researcher interrogated the respondents about what such intentions could be, the reasons given were a reproduction of stereotypical discourses about masculine-feminine relations:

Several men might go to the bar or any other business owned by a female who is not interested in buying but is interested in love affairs with the female bar owner or waitresses, even when the women are not interested in love. That is why, in many bars, women are employed more as waitresses. Even when a man is not interested in drinking alcohol, he will come and spend some money, at least buying for others, as a way of signalling to the woman that he is capable and hoping to win her favour gradually. #00:16:35-1#” (Interview with SN mini-grid local leaders, Paragraph 39 - 40)

The above discourse might sound frivolous, but a further inquiry confirmed that such scenarios are common in Uganda, especially within small alcohol kiosks in busy trading centres. Indeed, a visit to many bars around busy landing sites reveals many skimpily dressed female bar attendants who are pressured to dress in such a fashion by their bosses to attract ostensibly more male customers.

With the increased working time, expansion of business enterprises, and availability of electricity comes economic efficiency and more marginal returns to capital, especially when compared with the situation when the same business enterprises were running without electricity. To better analyse economic efficiency associated with rural electrification, I discussed with Maama Racheal (not her real name), a proprietor of a retail shop selling cold drinks that included beverages, juice, water and beer, and she noted that before electricity was connected to her business premises, she spent 10,000¹¹ shillings (approximately 2,5 Euros) daily purchasing ice blocks to chill the drinks. Furthermore, since her business operated daily, this would translate to 300,000 shillings per month and 3,650,000 shillings per year. With the construction of the mini-grid in the community, Maama Rachel spends approximately 50,000 Uganda shillings monthly on electricity bills. It has to be noted that this electricity is used to power the refrigerator and for other functions like lighting, charging the phone and the radio. With a monthly expense of 50,000 on electricity, it implies that she saves 250,000 per month of the money she used to spend on purchasing ice. Still, it is evident that Maama Racheal is involved in what is discursively referred to as feminine enterprise in that community.

According to her, it does not necessitate rigorous investigations to assess the contribution of electrification to women's economic efficiency. "In short, we have had electricity here for around five years, which means with the monthly saving of the would-be ice money worth 250,000, I have saved approximately 15,000,000 (3,750 Euros). If you save such money only on ice costs, you are in good business" (Interview with Maama Racheal – KS village). It has to be noted that apart from cost-cutting on ice, leaving other factors constant, the availability of electricity reportedly increased customer volume and operational time per day, which translates to increased sales volume and profitability. The economic and social benefits of the mini-grid introduction to the communities are summarised in the words of Musawo (not the real name), a retail shop operator in a landing site village in central Uganda:

There is a vast difference between now and before. Before this electricity came, we were suffering a lot; we were in darkness, and we would buy ice daily, which would get finished in one day, and the other day we would fail to get it. Now, the ice is history; we no longer need it. The darkness was very disruptive to us as women. For example, we would have to buy kerosene for our *Tadoba* (improvised lamps), but now we no longer use *Tadoba*; we use electricity to light, which is enough. The light also allows us to work at the business premises for extended hours. The darkness was also dangerous for our security especially moving back home from

¹¹ The exchange rate for a shilling at the time of data collection was 1 Euro to 4000 shillings.

work, and sometimes, we would be attacked. Now everything changed. Our livelihoods indeed improved #00:01:37-5#” (Interview with Musawo KT, landing site, Paragraph 7).

In summary, there is evidence that the introduction of mini-grids in rural communities accords women more opportunities to participate in different labour force activities that improve their economic efficiency and livelihoods. Women are also fairly accorded opportunities to serve on committees that make decisions regarding mini-grid operations where such community structures exist. However, the gendered social structure interwoven with the gendered discourses and related practice places several roadblocks to practical women's participation. The following discussion will delve into the details of those barriers identified during field studies.

4.4 Discursive Impediments to Women's Participation in Mini-grid Value Chains

Despite some discourses painting a promising picture in the previous section about women's participation in mini-grids, it can be deduced that most of their participation is in economic and social spheres. Women's presence fades concerning technical activities like practical mini-grid installation and other technical jobs. As the proceeding discussion shows, this is due primarily to structural barriers, gendered discourses and practices and division of labour that tend to alienate women from technical work. Some of those discourses are highlighted further below.

4.4.1 Discourses on Inimical Stereotypes and Perceptions

One of the discourses brought forward in the field is about the ‘natural’ divide that allegedly exists between the jobs meant for females and males. In this gender classification of roles and professions, jobs relating to energy work are discursively allocated to males. As a result, in extreme circumstances, some communities believe that women cause bad omen when they cross the line into male jobs, for instance, climbing a house to install a solar panel or some other technical work. Among some tribes, for example, among the Baganda, where part of the data was collected, if a woman crosses to such jobs that ostensibly belong to men, she faces ostracisation and is given sarcastic nicknames, all pointing to the accusation that she has failed to tow the correct feminine line. This fear of retribution consequently jolts females from venturing into such fields at and after school (FGD with University students in Uganda, Paragraphs 14-17).

In addition, there is a general discourse that females are physically and intellectually weaker than males and as such, particular jobs like in the energy sector are professedly not meant for women since they require a higher level of physical energy. Such beliefs work to amplify gender biases. Evidence of such discourses is evident not only among males but also in the opinions of some females, like the one quoted below:

P.1 I told you from the beginning that we women are a weaker sex. Even the Bible states it. There are certain things we can do and those that we cannot manage. That is how society is. Even when I might have studied with a man in class and both of us have degrees, a man will be made a manager, and I'm given a lesser job even when I used to score better grades than him. That is the belief in our society that women are not bosses where men are. However, few who have managed to access big offices have performed well, even better than me #00:26:20-9#” (FGD with women in BZ mini-grid, Paragraph 65).

Such discourses are reinforced when revered literature, such as biblical accounts, also back such stories. During discussions, several participants, females and males, kept referring to the creation story, stating that the woman was created from a man's rib and was given a weaker bone to perform lighter work, while the hard work was reportedly decreed to be performed by men. “God recognised this and caused Adam to fall into a deep sleep. He then took one of Adam’s ribs from him, which he fashioned into a woman, Eve” (Genesis 2:21-22). In countries like Uganda, where 82% of the population profess to follow the Christian faith (Uganda Bureau of Statistics 2022), the influence of such discourses /scriptures on women's agency may not be ignored. As a result, as one respondent in the field put it:

Women resort to only simple jobs like teaching, nursing and catering, thinking they are not fit for other careers like engineering. Even women with gifted brains who are indeed qualified in electrical engineering keep shying off from the jobs because they fear community perceptions. They fear what society will think about them #00:13:18-9#” (Interview with Mwanje Paragraph 42).

Though not explicitly stated, such acts of branding jobs like teaching and nursing as simple might be because they (possibly) don’t involve excessive physical strength. As observed before, physical strength is discursively attributed to masculinity, implying that jobs assumed not to involve excessive physical effort may be marked as feminine.

However, Mwanje does not find it a problem to engage females in electrical work or even give them assignments. He instead opines that the community has set rigid perceptions that need to be transformed to catch up with trends in modernisation. Indeed, Kazemi (2000: 453-455) concurs that rigid perceptions set rigid codes of conduct and conditions that prohibit specific behaviours, and any attempts by females to move beyond those codes is tantamount to committing an abomination. Such ‘abominations’ that have made it difficult for some women

to free themselves concern restrictions on climbing, dressing, driving and riding bicycles or motorcycles. As noted by several participants, society associates electricity-related work with climbing poles and buildings, yet climbing among Baganda women (central Uganda) is seen as an abomination, a red line that few females might be ready to cross in the name of performing a job. The community's elders also seem not prepared to tolerate what they term as such 'embarrassing behaviours.' An example of this can be seen in the following opinion.

As I told you, if people found a woman hanging herself up there on a pole connecting cables, it would make her appear funny and embarrassing. So, she is not supposed to climb a pole or a house. I have never seen a woman even do simple wiring of a building. Women are not supposed to ride bicycles or climb trees like mangoes, so automatically, even climbing an electric pole becomes terrible. I would not allow my daughter to climb a pole even if she studied electrical engineering. I do not want it. I would not allow her to climb a building at a construction site and start laying bricks. I would not want her to ride a Bodaboda. I think if women are to get involved in electrical engineering courses and occupations, they should be trained to do specific parts of the job and leave men to perform other parts of the job too, not leaving the whole course open for women but also not leaving the entire course for men alone. They should identify specific activities that do not involve climbing and give them to women. #00:09:05-6#” (Interview with Musawo, Paragraph 27 - 28).

These beliefs, like any other community perceptions, are rooted in children's socialisation process while growing up. However, a reflective interrogation of climbing reveals other dimensions that society has used to control women's agency in patriarchal societies like Uganda (Hopwood et al., 2018: 140). For instance, climbing is associated with virginity loss, which is also associated with respect and marriage; and for that reason, girls are cautioned against climbing right from a young age:

P.1 When we were growing up, they would tell us that it was taboo for women to climb. However, in retrospect, I think they were protecting us. Even climbing trees, mangoes, etc., was discouraged. They would say girls should not climb because they would break their virginity, which is highly valued in society. It is highly valued, and if you lose it, you lose respect. They would instead tell us to pull and elongate our clitoris to be sexier in bed when the right time for marriage comes. Moreover, losing virginity would make getting married very difficult, especially in families that still have strong cultural beliefs. Moreover, if they see you riding a bicycle, they say that one has already lost your virginity #00:38:09-3#” (FGD with females at MTB Technical Institute, Paragraph 58).

Indeed, if riding a bicycle can presumably lead to loss of virginity, then climbing an electric pole and connecting cables would, in the opinion of the protagonists, deplete all the virginity that was remaining. Moreover, this belief discourages many girls from taking such occupations. Instead, as reported, they adopt and conform to these community discourses, either believing

them to be right or for fear of backlash and other consequences associated with noncompliance. Not following the 'correct line' renders one to be branded a delinquent or social rebel by community members (Chilisa & Ntseane, 2010: 617-632; Mulvey & Killen, 2015: 681).

Related to climbing are the discourses of dressing. The dressing code is used to buttress society's definitions of masculinity and femininity, and according to many cultures in East Africa, being feminine means restrictively wearing dresses, skirts and other related 'feminine' clothing. It is, therefore, disgraceful (according to discourse) for girls to wear trousers, pants, overalls, and any other clothing taken to be masculine (Cardella, 1994: 1ff; McCabe & Ross, 2012: 1-23).

Moreover, working on some energy-related tasks would require a woman to wear trousers as it becomes hard to climb a pole or do other heavy work while wearing long dresses or skirts as dictated by the local norms. "Women wearing trousers, mini skirts and dresses not long enough to cover the knees are considered disgraceful and immoral" (Uganda Radio Network, 2022: 17). Such demands have made many young females shy away from joining the electricity industry as it would make them dress like men or appear indecent (FGD with women in BZ mini-grid- paragraphs 74-77). However, the issue of dressing in pants is embraced by many young ladies, and others use it as a demonstration of defiance against the many cultural restrictions placed on women (ibid). Even men who reportedly try to dress like women or display other behaviours that discourse attributes to femininity, like plaiting their hair and applying make-up on their faces, are shunned and branded as criminals.

However, as reported by respondents, even in circumstances where females are qualified and competent enough for jobs in the energy sector, like installing electricity on the premises, they still face trust issues among the public as the clients may not believe them to be competent enough. When participants were asked whether they would hire a female to fix power on their premises, the responses were mixed. Some argue that they would only allow deploying a female when there is no male technician with similar skills or when the female technician is already an employee of a credible company that vets its employees. Others, particularly female respondents, agreed that for solidarity reasons, they would allow a female technician to work on their premises but were quick to add caveats like:

Me, I would feel proud to see women doing such jobs, and if I need someone to fix my premises and a female technician comes, I would happily give her the job. But I would not give her the job if she were my co-wife because that would be dangerous. Also, if she is such a beautiful girl and I have a husband at home, I still cannot allow her to work

at my house because you also know how men behave. I would not want to lose my husband to these young girls in the name of installing electricity, no (*while shaking her head sideways in disapproval*) #00:21:06-3#" (FGD with female participants in BM Mini-grid, Paragraph 43).

Sentiments like the one revealed above introduce us to another discourse of female clients' fear of losing spouses to female technicians and physical beauty constituting intervening factors. It was also noted that bias against female technicians subsists when dealing with the technician for the first time, but after observing her abilities and skills, it does not matter whether female or male technicians do the subsequent assignments. Another notable factor was that generational differences in opinion regarding the stereotypes were evident throughout the discussions. For instance, though the older generation participants demonstrated fanaticism to preserve their cultural beliefs and norms, the younger generation participants seemed ready to transcend the discursive restrictions and practices and explore available opportunities without any recourse to cultural norms, as one young female participant in a focus group discussion reveals:

Yes, women suffer losses and miss opportunities because of archaic cultures and beliefs. For example, if I climb and fix a cable and I am paid some 20,000 shillings, I go home when I am happy, and nothing on my body stops me from doing that kind of work. However, because of those roadblocks of religion and culture restraining us, I see it as a deprivation of opportunities in this competitive world #00:31:50-0#" (FGD with women at BM, Paragraph 76).

Similar sentiments were re-echoed by a participant in a different focus group discussion;

What is wrong with me studying electrical engineering and climbing that pole? Anything wrong with it if I am to earn money from that work? (*while looking at her older colleagues with her eyes wide open*) In this generation, I don't believe there should be such things as specific jobs for women and men. That is outdated reasoning, sorry. #00:13:04-9#" (FGD Interview with women BM Mini-grid, Paragraph 37).

Two female participants in different villages gave the two opinions above. However, a common thread between the two youthful participants and other participants in a similar age bracket was that they all belonged to a younger generation than the rest of the group participants and held liberal views. Likewise, in all other discussions and interviews, the older generation appeared conservative and defensive of their cultural norms and practices, while the younger ones expressed discomfort about the same. Indeed, with the era of modernisation, coupled with the neoliberal capitalist dispensation and globalisation, the friction between 'progressive' and traditional beliefs and practices might get fiercer (Annesley & Scheele, 2011: 335-336; Holter, 1997: 22,92; Kolarova, 2006:1241, 1244).

4.4.2 Discourse, Socialisation and Gender Division of Labour and Roles

Discourses on the gender division of roles held by the different communities significantly affect women's participation in the energy sector (Bouzarovski, 2022: 761-762; Martin, 2000: 554). The discursive roles and practices are transmitted to children as they undergo different stages of growth and development, often by gendered parents and guardians (Deutsch et al., 2001: 1001-1002; Kane, 2006). For instance, as argued by the social learning theory (see Bandura, 1986: 1ff), children observe behaviours, actions, roles and other discursive practices that constitute part of the knowledge they acquire as they grow. Thus, in most African societies where children develop much of their formative training from the family and social systems, it becomes possible for them to believe the discourses that there are unique roles, jobs and behaviours for females and others for males, and definitely, energy-related roles are a domain of men according to such society codes. Crossing from one set of roles to another is often structurally tricky as it is met by the backlash effects (Rudman & Phelan, 2008: 61-79), including male gossip, ridicule, ostracisation, exclusion (Taconis & Kessels, 2009: 1128-1129) and sometimes branded imposters (Gürer & Camp, 2001). These grooming processes, which in turn facilitate the reinforcement of these discourses, are highly esteemed in some communities. For example, among the communities in central Uganda, formal classes are organised for young children (particularly girls) to master the so-called feminine roles and responsibilities. Expressions from the field discussions with participants evidence the above:

And that is how even we train our daughters. So, for example, if a visitor comes into our home, we tell our daughters to kneel and greet them; therefore, that girl grows up already knowing how to behave well, and we teach these manners more to girls than boys because a boy is not supposed to kneel. So, we keep teaching them similar forms of conduct so they can become responsible and respectable women in the future. As a parent, if your child portrays behaviours that are atypical to their gender, you get embarrassed #00:06:18-6#" (Interview with a female respondent in a mini-grid village in central Uganda Paragraph 20).

The role of history and diachronic socialisation in the creation of discourses on feminine and masculine work can further be explained by the dialogue below:

I: So why do you say that you could not allow your daughter to seek employment from the mini-grid project developers?

P: You see, how we are groomed while growing up determines the kind of work we do. It does not allow us to appreciate such kinds of jobs. It would, therefore, appear awkward to see a woman climbing up doing electrical installations. I think electrical technician work is for men because they are the ones who can climb. Even if women were to be involved in electricity projects, they should do work that does not include climbing. If a woman is climbing up, maybe she should wear an overall, but even still

with it, she appears funny up there. (laughter). That is why our ancestors decided that women should not do such work. Women should do works that involve, for example sitting in the office #00:08:18-7#” (Interview with Musawo, Paragraph 26).

During the growth process, children learn and form categorisations and discourses that they rely on to interpret messages from their close surroundings and process their gender identity, which keeps developing throughout their life cycle (Bem, 1981: 354-364). As the formation of these schemes is highly facilitated by the social environment in which human beings thrive and learn, the local culture in the family and the behaviour or actions of the people around the children play a critical role in cementing these beliefs and stereotypical discourses (Witt, 1997: 253).

Because children get conditioned to these stereotypes or discourses when they are still young, they get internalised and entrenched as a regular part of people's lives, with long-term implications for beliefs and opinions and consequently affecting other future opportunities or the type of work and roles they are likely to appreciate (Ellemers, 2018:275-276; Halpern & Perry-Jenkins, 2015: 527). According to Cerbara et al. (2022: 1), as age increases, the adherence to male roles decreases for both boys and girls, while boys continue shunning the female roles they had adopted while still younger.

As seen in the previous quotation (by Musawo), such methods of grooming and training illustrate how the continued mastery of gender discourses is already noticeable from childhood and how it may influence females and males to develop their gender identity consistent with social expectations. Any attempted deviation from the ascribed roles, identities and occupations raises eyebrows among community members and peers, leading to consequences like nicknaming, ostracising, bullying and victimisation. When such dichotomisation of the masculine and feminine occupations gets institutionalised by the government and other employment agencies, then getting jobs by those who refused to subscribe to stereotypes but instead opted for careers that are not sexed get challenges finding jobs (Heilman, 1983: 269-198).

For instance, in October 2021, the Ministry of Health of the government of Uganda issued a directive that all males should stop working as midwives. The Permanent secretary (technical head of the ministry) instructed all males working in labour wards to be re-designated to other positions despite pleas from mothers that male nurses always “handle them with outstanding care” (Bagala, 2021: 4). Without necessarily judging the merits and the demerits of the minister’s directives, listening to the entire speech and the gendered biases therein reveals that

when top decisions makers within state institutions are victims of gender stereotypes, the state apparatus and the public services sector contributes to the discursive construction and performance of gendered systems and practices (Bishu et al., 2019: 1-2; Bly et al., 2000; Kelan, 2008: 427, 445).

4.4.3 Discourses on Sextyping and Body Politics

One of the common themes that kept emerging whenever participants tried to account for the tepid involvement of women in mini-grid installation activities was that mini-grid and electricity work is allegedly incompatible with female bodies as feminine bodies are (according to discourse) inherently soft, slender, tender clean and sanctified. The other argument was that females' bodies are smooth and not meant for rough and dirty civil work, as such work would compromise the femininity of their bodies. Generally, various discourses on the objectification of the female body and its suitability or unsuitability for some occupations and not others were evident. I provide an example of this opinion:

You see, some of these jobs require some behaviours and gestures like being romantic, *kwemolamola*¹² (seductively rolling eyes), and boys are not good at it, but girls do it well. That is why we train more girls for the hospitality industry; for example, when organising a hotel room, a woman gives such activity more time and attention than a man. Men are not good at fashion. That is why they should opt for such technical careers. #00:31:33-6#" (Interview with the manager for a youth skills training project in Uganda, Paragraph 74 - 76).

Such philosophies that attempt to commodify female bodies have extended to several sectors in the commercial and non-commercial realms to levels that border (latent) gender-based violence. For example, many commercial adverts tend to display an erotically looking female body (and, to some extent, male bodies) on billboards or other adverts to attract customers. A visit to many restaurants and bars in Kampala, for instance, reveals a host of female attendants their employers reportedly compel to dress in very short skirts and appear romantic, purportedly to look attractive and thus attract more (male) customers. Moreover, this is not limited to informal business enterprises; some corporate entities, such as banks, do the same to female staff, especially those in the sales and marketing departments (Woon-Hyn, 2001: 16-17).

Ironically, while one group is 'exploiting' female bodies to maximise sales profits for their business enterprises, another group, especially in rural communities and those that are still dear

¹² *Kwemolamola* is Luganda word meaning the practice of looking at someone seductively with rolling eyes – facial expression

to traditional norms and practices, is preaching to girls to preserve and keep all their body parts intact and serene. The proponents of this preservationist ideology loathe the fact that females can work in energy-related civil activities or other tasks that involve climbing for fear of losing their virginity (Farahani, 2007: 212-230). Participants in the several interviews attested to this:

You see, doing a job that compromises my virginity is not good. Once you lose your virginity, you will never get the respect of your husband if you become lucky enough to find one. The man will say that this one started having sex long ago, and therefore she is a whore. And any time you develop a minor misunderstanding, he will say that even though I am married to you, you are a slut. #00:39:34-1#" (Interview with females at MTB, Paragraph 62).

Such sentiments hold firmly in several communities in East Africa that I interacted with in the study. For instance, according to revelations by some (elderly) female participants, in the past, among several Ugandan communities, a paternal aunt would be dispatched to escort a bride whenever she was being 'delivered' to her prospective husband. One of the significant duties of the aunt was to verify whether the bride was still a virgin at the time of getting married, and whenever she was found to be a virgin, the aunt would be rewarded with a she-goat (*Embuzi*). On the contrary, whenever the bride did not have an intact hymen, implying prior loss of virginity, then the aunt would return home with no gift but would be given a coin with a hole in the middle (a sign of ruptured hymen thus no virginity), an act that was supposed to embarrass her for not having adequately groomed her niece. (Leave alone the fact that the virginity test, in this case, leaves more questions than answers as it involved visually checking whether the bedsheets used during the first sexual encounter had blood stains. Bleeding indicated the presence of virginity and vice-versa). Consequently, even the bride price paid for a virgin bride was higher than that paid for a bride who had allegedly lost her virginity before the marriage (FGD with women in BZ Mini-grid in central Uganda)¹³.

In other words, the preservation of virginity, to a large extent, is a function of and works to amplify the value of the marriage transaction (Schlegel, 1991: 719). Moreover, in these communities, these paternal aunts were and are still responsible for socialising their nieces into social norms and discourses, including manners, morals and sex education (Lewinger & Garnett, 2021: 3; Muyinda et al., 2010: 159).

¹³ An extract from the FGD with women in central Uganda. The respondents (Elderly women) gave the views in their attempt to justify the sacredness of the female body which disincentivises their performance of 'rough tasks' like electricity installation.

Nevertheless, though not entirely disregarded, it is evident that variables like virginity have been interrupted by pressures imposed on society by globalisation and neoliberal ideological forces (Bay-Cheng, 2015: 279; Cindoglu, 1997: 259-260). Other pressures on virginity preservation include adversities like extreme poverty, the Covid-19 pandemic and other incidences that expose communities to economic distress or disability in social systems (Molek & Bellizzi, 2022: 218-219; Musunguzi et al., 2022: 1-2), as evidenced by the increasing cases of teenage pregnancies and other deviations from the traditional social norms. However, based on the interactions with participants, it was also evident that discourses of virginity and other elements of sex-typed body politics still play a significant role in career choices and, to a large extent, deter females from joining professions such as electrical technician work.

4.4.4 Power Relations, Intrahousehold Negotiations and Religious Discourses

The gendered stereotypes, discourses, and the resultant power relations form continuous cords that determine household dynamics and decision-making patterns within the family. In patriarchal communities characterised by hegemonic masculinities, the power relations and negotiation formula are often tilted to favour men against women and children in the households (Seidu et al., 2021: 2; Winther et al., 2020: 1). When male spouses dominate almost all the power in the household, to the extent of becoming dictators, though sometimes benevolent dictators (Bergmann, 2010: 146), then females' operational space diminishes. Decision-making processes regarding electricity acceptance, equipment purchase and installation are a subset of gendered relations (Njoh et al., 2022; Winther et al., 2020: 1). In the mini-grid communities, spouses also make decisions as to whether a partner can work for a power company as an employee or serve on voluntary community-based structures that support mini-grid project activities. These decisions involve negotiations at the household level but are moderated by discourses on the suitability of women's engagement in such works. Where the negotiation space is limited then, females' decisions to work are vetoed by their partners.

Other negotiations that were common from the participants' narratives include decisions concerning the installation of electricity in the family business premises, power purchase and power tariff payment, the amount of electricity purchased and consumed in the household and on which appliances, which electric appliances and accessories to purchase, and whether either spouse can participate in productive use of energy enterprises to generate income. All these decisions involve negotiations moderated by power relations and gender discourses. However, as the studies by IRENA (2019: 70ff) and Skutsch (2005: 37-38) affirm, even when such income

is generated through productive energy use enterprises mainly operated by the female partner, decisions regarding the expenditure of such income become a contestable issue in most African households, especially where discourse has it that men are the heads of the female and have veto powers to control all income earned by household members.

Matters are not helped when most females accept male dominance as a norm. As observed in the previous discussions, this normalisation and acceptance of male dominance is a diachronic product of socialisation and conditioning in patriarchal settings (Cerbara et al., 2022: 1-2; Mishra et al., 2012: 45; Witt, 1997: 253-259) that pervade most East African communities (Silberschmidt, 2001: 657). For instance, in a focus group discussion held in one of the mini-grid villages in Northern Uganda, out of the six women in the discussion, five concurred that men should have veto powers over decisions in the household because men are reportedly the heads of the household and such an arrangement was divined by God. Thus, while discussing why some females were finding difficulties joining energy management committees, they responded that their husbands do not allow them to do so as they expect them to stay home and do household chores. As a result, they find it challenging to go beyond the dictates of their male partners since it would lead to severe repercussions. The sentiments are reflected in an extract from the conversation in the focus group discussion with women in Northern Uganda:

I: But why are the power relations with spouses tilted like that?

P:1 Because the man is the head of the family, and it has been the case since the beginning of the world. Yes, it has been like that.

I: How do you feel about such an arrangement?

P:2: We have no problem with it because that is how God made it.

P:3: I believe it is like that and that it is how it is supposed to be. A woman is subordinate to a man, and we cannot be equal. It is impossible because you, as a woman, should know that the man is above you in a home. So, as a woman, you understand your position and respect your husband. The neck cannot be taller than or equal to the head” (FGD with females in AG village, Paragraph 20).

When characters invoke discourses about God and the Bible into the gender power negotiation equation, especially in communities like Uganda where over 96% of the population profess to be believers in 'modern' religions (either in Christianity -82% or Islam-14%) (United States Department of State, 2019: 1ff) it becomes difficult to negotiate against women marginalisation. Moreover, with the existence of numerous religious leaders constantly reminding women (and,

to a small extent, men) to observe divine obligations (Boyer et al., 2022) then, it becomes an uphill task to negotiate women's agency and power within households since religion influences decisions and preferences (Namatovu et al., 2018; Tamale & Mulliro, 2007). Indeed, reading the Bible reveals several verses that tighten women's space in the decision-making and power negotiation realm in the household and the public space. I outline below a few Bible verses from the teachings of St. Paul:

1 Corinthians 11:3: NIV: But I want you to realise that the head of every man is Christ, the head of the woman is man, and the head of Christ is God.

Ephesians 5: 22-24: Wives, submit yourselves to your own husbands as you do to the Lord. For the husband is the head of the wife as Christ is the head of the church, his body, of which he is the Savior. Now as the church submits to Christ, so also wives should submit to their husbands in everything.

1 Corinthians 14:34-35: Women should remain silent in the churches. They are not allowed to speak but must be in submission, as the law says. If they want to inquire about something, they should ask their own husbands at home; for it is disgraceful for a woman to speak in the church.

1 Timothy 2: 11-15: A woman should learn in quietness and full submission. I do not permit a woman to teach or to assume authority over a man; she must be quiet, for Adam was formed first, then Eve. And Adam was not the one deceived; it was the woman who was deceived and became a sinner. But women will be saved through childbearing if they continue in faith, love and holiness with propriety.

Similarly, the Islamic discourse has mounds of teachings and practices that deprive women of mutual negotiating powers with men, for example, in the Quran:

Chapter 4.34. states that Men are the protectors and maintainers of women in as much as God has endowed some of the people with greater capacity than others.....

And then:

Chapter 4.11. God commands you in (the matter of the division of the inheritance among) your children: for the male is the equivalent of the portion of two females. If there are more than two females (with no males), for them is two-thirds of the inheritance; if there is only one, then the half....

According to Davids (2015: 1-3), Mohammad (1999: 221) and Sirri (2020: 1ff), the power of these biblical/quranic teachings and associated practices should never be sidestepped while analysing power relations and their consequences, particularly in rural communities (like East Africa), where most of the population are or claim to be religious.

Engagement with men in focus group discussions similarly revealed tilted opinions about the power negotiations of females in the household dynamics of energy consumption and other related decisions. Statements like “I have to vet my wife’s decisions to see whether they make sense or not”, “my wife cannot buy an electric appliance and bring it into my house without my approval even if she is using her own money”, and “negotiating with a wife can be counterproductive” were not uncommon during discussions with men.

However, all participants agreed that females’ access to income opportunities changes the power dynamics. The consensus was that once a female partner starts earning some reasonable income, it becomes prudent to negotiate with her mutually if the husband is to partake in it or discuss how to spend it. Furthermore, discussions with participants in several group discussions and individual interviews revealed that some men get uncomfortable when their wives start earning as it threatens part of their masculine (coercive) power. The same observation is evident in Some’s (2013: 251ff) study on gender and the dynamics of negotiation and control over income in West African households.

In summary, most impediments to women's participation in mini-grid projects are primarily associated with the numerous stereotypes, discourses and discursive practices that have pervaded society over time. These discourses and beliefs place women’s physical capacity, body, and intellectual potential (discourses concerning intellectual potential are discussed in Chapter 5) at a lower rank while glorifying hegemonic masculinities. Moreover, in some cases, these gendered structures create gendered problems either before or after electrification, as the next section observes.

4.5 Discourses on Gender-Based Conflicts in the Mini-Grid Processes

In the previous section, we observed that discourses emanating from socialisation and gender stereotypes breed imbalances in decision-making power over several issues regarding purchasing or utilising energy resources. However, such power relations are not an end; instead, they go further in creating gendered conflicts in households or communities. However, as observed in chapter two, even before electricity is connected to a household, the nature of gendered roles and other discursive practices in the household reportedly exposes women to problems associated with energy deficiencies compared to their male counterparts (Pan et al., 2021: 8). Even when power gets connected, conflicts over power usage in the household, tariff payments, control of gadgets and appliances, and other changes in time use and labour dynamics

because of the emerging business opportunities. However, the households' electricity availability can (reportedly) curb some previous gender-based conflicts. In this section, I discuss the gendered discourses on conflicts associated with lack of access to electricity, the conflicts that emerge in utilising energy resources, and how electricity is reportedly used as a tool to resolve some gender-based disputes with the primary focus on the household level.

4.5.1 Discourses on Gender Conflicts Emanating from Energy Deficiencies

As the problems of climate change and pressure on biomass intensify in the absence of meaningful investments in electricity supply in many developing countries, discourses have painted household energy, especially for cooking and lighting, as an issue of concern. Moreover, because women do almost all the cooking or stay home for more hours than men (Darke, 2002: 19-35), the pressure from energy shortage exposes females to more stress than males (Gayoso et al., 2022: 290). In remote communities, poor people still rely on wood and other wood-related products for a more significant part of their household energy needs, and the tedious and time-consuming burden of mobilising and managing traditional energy fuels is discursively a feminine domain. In energy-constrained communities, this becomes a factor in females' disproportionate limited access to education, income and increased poverty. Poverty is a form of structural violence; thus, energy access to programs in rural areas reduces these forms of violence (Kaygusuz, 2011: 937).

In most communities where this data was collected, particularly in central Uganda and central Tanzania, it was evident that even observing the surrounding physical environment, a significant part of available land has been used for agriculture or grounds turned bare due to excessive human activity. As such, even the wood energy, unclean as it might be, has become hard to come by, exposing women to more pressure since, as local discourses dictate, they shoulder the duty of preparing food for their families. However, some respondents in Uganda reported that even the little firewood or charcoal that comes to the market for sale is prohibitively expensive as sometimes it has to be imported from neighbouring states like the Democratic Republic of Congo (DRC) or South Sudan. It was also reported that charcoal was only affordable for relatively wealthy households, while in the rest of the households, women and girls have to roam around the roadsides and fields looking for abandoned little pieces of wood and shrubs to use for cooking. Firewood currently constitutes a more significant part of

the household's daily budget/money (*Kameza*)¹⁴ , and husbands must (according to local discourse) leave home to sustain the family through the day. Previously, such money was only meant to cater to food items, but once it is used to purchase firewood, it becomes insufficient, leading to protracted quarrels over finances among partners.

It has to be noted that in all microgrid villages visited that had electricity, no single household reported using electricity for cooking because of cost implications associated with purchasing electric cookers and power tariffs. Even in other communities like big urban centres that use electricity from the national grid, an insignificant proportion of the clients utilise electricity or natural gas for cooking because of the prohibitive power tariffs (Blimpo et al., 2018: 2). As such, many households whose premises are connected to electricity use it for lighting and other light work and resort to firewood for cooking. It was also observed that due to land issues and the pressure for wood energy, affluent residents have leased and fenced off big chunks of forested land that was thitherto communally accessed for firewood, making it a crime to access/trespass into these fields. Nevertheless, women and girls reported that they somehow stealthily trespass into those forests to collect firewood, with dire consequences when caught. Some women reported suffering beatings, rape and other harmful actions that exposed them to insecurity. Such situations may not only be limited to these communities but are also prevalent in other parts of the developing world, as other research studies reveal (e.g. Cecelski, 2002: 29; Skutsch & Clancy, 2006: 61-89; UNDP, 2015: 17).

Using “unclean” energy like wood charcoal and other biomass-related fuels also exposes health complications due to excess smoke that causes respiratory and eye problems. Although it was not possible with accurate certainty to scientifically link the ailments to the dirty energy during the data collection, several female respondents reported that they suffered from sight problems, respiratory problems and dizziness, which they (in line with local discourse) thought was a result of extended periods of oral blowing of the charcoal stoves.

In addition, cases of accidental torching of residential premises due to open fire, either from firewood or candles, were reported, especially by those who cook in narrow spaces or at night

¹⁴ *Kameza* money is a local slang in Uganda used to refer to the daily funds that husbands must leave home before going to work. This money is largely for food products. Quite often when it is not enough as is always the case wives accuse their husbands of being irresponsible. Arguments over this *kameza* money has led to many cases of violence in households while other spouses use it as a measure of love from their partners.

when mothers have to light candles to attend to their babies. Unfortunately, for most places visited for this study, the building structures and materials used, like timber and grass, have a high affinity for catching fires. For instance, in the island communities in central Uganda, over 95% of the premises are simple improvised shelters made of timber walling, while in Northern Uganda, the housing structures are predominantly short grass-thatched mud and wattle circular huts. In both situations and regions, the probability of the premises catching fire is so high, a fact several participants affirmed. Surprisingly, even when the child causes a fire incident, the mothers are blamed or severely punished purportedly for not training their children well, even when the fire incident might have occurred when the mother is out of home on other errands or attending to other family chores. The issue of mothers' culpability is due to the widely held discourse that the mother is responsible for nurturing and overseeing the children's affairs and conduct in the household.

4.5.2 Gendered Conflicts Linked to a Clash between Energy /Electricity Access and Local Gender Roles/Discourses

When information on an upcoming energy project reaches the community members, their first response is excitement, hope, and thoughts about the possible business opportunities likely to accrue from the nascent electrification. However, along with the opportunities, unintended consequences come (Simberg-Koulumies, 2021: i, 5), a fact that most scholarship and discourse on gender and energy tend to miss. From the accounts shared by the participants in Uganda, some frictions emerge no sooner than the first electric pole is erected in the community. For instance, immediately after the power project is conceived, the right of access or land acquisition issues of where to construct the power distribution lines or the power plant emerge, and these raise tensions if not harmoniously managed. It was also reported that power companies acquired pieces of land from the households for pole erection purposes. Those families were compensated with some money. Due to the general norm/discourse that land and other household property belong to the men and that the women have limited right to land ownership in the family, all the compensation money would be paid to the husband. Husbands or men are discursively accepted as the heads of the family (Nalugoda et al., 2004: 107; Orach et al., 2015: 4).

However, most husbands who received payment reportedly utilised or misused this money on ventures not agreed upon with their spouses, and this would generate domestic conflicts where the wives attempted to demand the accountability of such compensation monies. As highlighted

in chapter two and corroborated by empirical data, some men reportedly used such funds to acquire new spouses or finance extramarital relations, an act that infuriated their partners, as “the worst thing women would expect in a relationship is for their husbands to marry an additional wife (Interview with mini-grid administrator PG Mini-grid). It has to be noted that although the wives did not have any legal ownership of the land, at least they had access to it when it was still under the ownership of the family. However, with the companies taking over the land that benefited the entire family and the money being utilised only by the husbands, the implication is that the wives and children lose the livelihoods that were hitherto derived from the impugned piece of land. Moreover, with limited opportunity to have a say in managing the proceeds from the sale of that land, they reportedly suffer a double tragedy. In the communities covered for this study, there were no cases of entire households being displaced apart from the parcelling out of smaller proportions of land just because the mini-grid projects were relatively small. However, with bigger power projects, whole households are displaced with the possibility of women and children losing entire livelihoods, for instance, as was the case with Kenya's Lake Turkana wind project (Cormack & Kurewa, 2018: 89; Nonfodji, 2017: 279-280). Matters are worsened when the husbands disappear from their families and shift to other locations with the money from land compensation (Twinamasiko et al., 2018: 11).

After the electrification of the community, opportunities and demands emerge, and the village dynamics change. For example, new business opportunities arise, the existing business enterprises may need expansion (Osunmuyiwa & Ahlborg, 2022: 1-2), migrations into the community change, and local committees to assist in managing power projects are (sometimes) formed. However, the connection of electricity to residential premises brings opportunities to watch TV and improved lighting, creating new expenditure lines like tariff payment and purchase of appliances in the household. These introduce changes to household dynamics, often as reported, create friction between spouses, as outlined in this section.

Accounts from the field reveal that when the local grid management structures are formed, women volunteer to serve as committee members or mobilisers. In addition, due to the availability of light at the business premises, business working hours increased, including working at night and returning home late, something that did not happen before the power was connected to the community. It has to be noted that women run most of the retail enterprises that were observed in the communities. Therefore, it was reported by several respondents that when wives return home late or spend most of their time away, husbands get apprehensive since

it affects other household chores like cooking. Cooking is one of the cardinal and non-delegable duties of wives' according to the local discourse on the gender division of labour in most East African communities (Njenga et al., 2021: 5). It was also reported that women staying long away from home, doing other voluntary work like power agents/champions¹⁵ or running business enterprises makes men nervous as they claim wives going home late, especially at night, provides fertile ground for promiscuity, and few men can tolerate that pressure (FGD with men in SD Mini-grid paragraph 36).

A related discourse concerns situations where wives individually finance the cost of installing power in the residential premises, a financial expense that is relatively high based on local standards, yet according to local norms, residential premises belong to husbands. Thus, according to participants' accounts and experiences, when couples decide to terminate the marriage because of misunderstandings, such wives demand to remove the electric gadgets, including cables and other appliances or solar panels, in case of households that use standalone solar modules. The attempt to carry away the power equipment raises fierce conflicts as the husbands resist these moves. The argument, and as per the practice, is that man is the head of the house, and all property in the house belongs to the husband, whether purchased by the wife or not. The scenarios above reportedly discourage women from financing electricity installation or purchasing appliances for residential premises even when they have the means to do so for fear of making losses in future just in case the marriage ends. (Interview with customer care officer-KS Mini-grid paragraph 77)

Power consumption, appliance utilisation, and sharing in the household also become issues that potentially create fractious relationships. There are concerns over one partner or member of the household dominating usage of electric appliances at the expense of housemates, raising concerns about tariff payments. For instance, on TV usage, men reported that women tend to dominate TV time, while women also reported that some husbands use their masculine hegemony and dominance to deny them adequate time on television. Using extracts from two focus group discussions in the SD mini-grid community on Lake Victoria island, one for men and one for women, the colliding interests and discourses are observed:

¹⁵ Power Agents are volunteers selected by energy companies to mobilise customers and explain any issues pertaining the power project.

Oh, you have talked about TV; sometimes television is a source of problems. Our husbands may decide to dominate the TV and watch boring shows that do not make sense, especially football, boxing and politics. Nevertheless, of course, when my interests in TV collide with those of my husband, I give up on him. If I do not surrender the remote, it may result in physical fights because I have seen it happen before—#00:06:19-7#” (FGD with women BZ, Paragraph 17).

Then, contrast the above with an account from a participant from a focus group discussion with men in the same village:

In my home, my wife literally blocked me from accessing the TV. She watches whatever she wants and does not allow anyone to access the TV. I even gave up on watching the 9 o'clock news since they collided with her favourite TV video series (soap Opera). Even the children have joined her in watching soaps. Soaps have become soaps in my house. When one ends, the other starts immediately, and they want to watch continuously uninterrupted. Whenever I insist, they ask me but Daddy, where do you want us to go? However, that does not stop me from paying for power #00:08:54-5#” (FGD with men in BZ Mini-grid, Paragraph 19).

Discourses over which gender consumes power more than others also lead to arguments over power purchase. For instance, when some men feel that electricity is being disproportionately used in the household, they react by not purchasing or delaying purchasing power (most of the grids in Uganda use pre-paid power payment systems). In such circumstances, wives may revert to their private savings to purchase power, but those who do not have the money may also rebel using what one participant called a silent rebellion;

If you refuse to pay for electricity, the wife will cause a silent rebellion using the many tools at their disposal. For example, if the wife has been serving you breakfast at 8 am, she will start serving it at 10 am or even not serving it at all (...). She can also deny you sex” #00:35:00-6#(FGD with men -BZ Minigrid, Paragraph 71 - 72).

One might be tempted to consider these arguments trivial and frivolous, but when partners reach the extent of withholding conjugal rights from each other due to disagreements over power payment and related hitches, which, according to some informants (male and females), degenerate into other more significant conflicts that end up injuring the relationship more.

In addition, as observed earlier, introducing electricity in the community attracts business opportunities through productive energy use. Like men, women start commercial enterprises and earn relatively higher incomes than those they have earned before. However, increased earning opportunities for women alter the power dynamics, which may provoke conflict in some households (McCloskey, 1996: 449). The popular discourses that men are heads of the family with all the associated power to control family finances and dominate decision-making within

the household have been observed. Resource control is one of the tools men use to reinforce their dominance and hegemonic masculinities (Angelucci, 2020: 610; McCloskey, 1996: 449). Though several studies claim that women's economic independence reduces violence against their intimate partners (e.g. Daga, 2021: 86-103; Dildar, 2021: 1695; Nyanzi et al., 2005: 13-26; Peled & Krigel, 2016: 127; Gage, 2005: 343), less attention is given to the reality that when wives start earning; some male partners feel that their power base is being eroded and may react aggressively for fear that wives will use the earning opportunities to control their affairs. Therefore, such men whose masculinities are threatened tend to act aggressively to keep the financially empowered women 'in their right place' (Li et al., 2023: 949). Indeed, during the focus group discussions, it was evident that men expressed discomfort about their wives' earnings and even greater apprehension at the possibility of the wife earning more than the husband. Such fears were profoundly evident in groups of male participants among the communities of central Uganda:

But to add to that, there are some tribes that I fear so much—women from Buganda. When a Muganda woman gets money, she becomes uncontrollable. Women from other parts of Uganda, like Mbarara, and Busoga, might still be manageable even when earning well. Perhaps while growing up, they are groomed to understand what man means and the power and respect a man has to be accorded in a home. However, Baganda women are very different. They love money more than marriage. When the wife earns money and the husband does not have it, the power of the man at home evaporates. He cannot speak, and the wife listens; she becomes very difficult. You, as the man, will no longer have a say in the affairs of your home. Even a simple act like punishing the child becomes hard for you as a father, #00:26:32-0#" (FGD with men -BZ, Paragraph 55).

Apart from the discourses above revealing the male discomfort associated with financial independence for their wives, the discursive use of adjectives like 'manageable' and 'controllable' reveals a discursively rooted conviction by such men to exercise power over their spouses. To such men, women are equated to objects, property, subjects or projects that have to be 'managed' and 'controlled', terminologies that are indeed common in project management discourse. Moreover, earnings transform the economic power of women, and the acquired economic independence renders them incapable of being effectively managed and controlled, an idea that may make some men feel threatened. However, despite the above claims by men, women complained that when the men discover that the wives are earning some money, they tend to abandon 'their' responsibilities (assigned to them by local discourses) of providing for the family:

P:7: Unfortunately for some men, when they see that a wife has started to earn, they turn a deaf ear and leave all the expenses to the woman. They stop funding what they have been funding

before. In such cases, we also buy a few things so our children can eat and hide the rest of the money away if there is a surplus #00:29:25-7#” (FGD with women in SD mini-grid, Paragraph 50).

Ironically, men in the interviews also complained that even when women earn, they do not contribute to household bills, claiming that that is the responsibility of men. Consequently, this prompts some men to steal from their wives or coerce them to surrender part of the money (FGD with men in BM mini-grid village paragraph 53). With accusations and counter-accusations from both partners and the fact that several women are gainfully running enterprises, more conflicts are expected. Planners of mini-grids, especially for rural communities, ought to understand those dynamics and empower communities to deal with them so that electricity does not breed more disharmony than what existed before.

4.5.3 Gendered Conflicts Lessened by Electrification of Communities

Despite the challenges observed in the preceding section, the participants agreed that “the installation of electricity in the house brings immeasurable pleasure to the household and mitigates some other existing conflicts”. (Interview with a female respondent in AG mini-grid paragraph 4). Providing lights in the streets of urban centres and security lights at home helps curb insecurity and other cases of mistreatment usually subjected to women, like sexual assault, when they move in darkness (Clancy & Dutta, 2005: 1ff; Skutsch & Clancy, 2006: 61-89). Rape cases and other forms of criminality were reported to be prevalent, especially in landing site communities. Lakeside fishing communities in far-flung islands harbour many criminals (according to local discourse) who sometimes migrate to islands to escape from law enforcement on the mainland. Others come from as far as Rwanda and the Democratic Republic of Congo after committing crimes (Interview with the local leader of SD village, paragraph 7). Cases of gender-based violence, such as attempted rape and assault of women and girls in the evenings as they travel back home, were reported to have been rampant in the trading centres (small towns) but started reducing after the introduction of street lighting.

In addition, the introduction of electric bulbs reduces or ends the use of candles and other rudimentary methods of lighting that rely on open fires, moreover in shelters that are highly vulnerable to fire, like the wooden houses in the landing sites and the short grass thatched huts prevalent in Northern Uganda communities. Such dwellings occasionally accidentally catch fire as women use candles to look for items in the house or make the light at night to attend to young ones. Moreover, some husbands accuse wives of stupidity and negligence when such cases

happen instead of sympathising with them. Luckily, such incidents of fires on residential premises have drastically dwindled with the introduction of electric lighting in households (Interview with the power agent in LM mini-grid).

Though no household reported using electricity for actual cooking, the availability of electricity eased the boiling of water for tea, which reportedly enabled women to serve tea to their husbands in time, unlike the laborious use of charcoal or firewood, which are hard to get. Consequently, serving breakfast on time enables the husbands to depart for work on time, while the quarrels resulting from delayed meals are effectively reduced (FGD with women in BZ mini-grid, paragraph 15).

We have already observed that men loathe the practice of their spouses staying away from home for so long and that women and children are television enthusiasts (at least according to male informants). So, some men reported that they use TV as bait to keep their wives and children at home, especially those who do not have formal jobs outside the homestead:

For example, we use television to control our wives and children, enabling them to stay home without roaming the villages. So, we use it as a trap. Because of that, we endeavour to make electricity available at home at all times. During holidays, children watch cartoons the whole day without moving aimlessly in the village. Even when I am away, and the power units get depleted, they call me, and I send the money for electricity very fast. #00:33:41-9#” (FGD with men -BZ mini-grid, Paragraph 68)

Despite the reported harmony created when the wife and children remain home, the language in the quotation communicates much about the extent to which the men use electricity and other resources to gratify their feelings of hegemonic masculinity. In addition, feelings of the desire to treat women like controllable objects reveal the discomfort that men suffer when women expand their agency. Nevertheless, the possibility of children not roaming around the villages and towns during holidays aids in shielding them from dangers associated with wandering around, mainly in countries like Uganda, where cases of child abduction and child sacrifice by criminal intended perpetrators are on the increase (Byansi et al., 2014: 78; McCormack & Hiring, 2022: 289; Silver et al., 2021: 533).

4.6 Breaking the Glass ceiling? Discourses on Solar Mamas and the Barefoot College

Researchers risk presenting a one-sided argument if they analyse the participation of women in the technical aspects of energy without recognising successful examples where the typical

stereotypes and barriers have been transcended to allow females to penetrate energy and other technology sectors and perform with commendable success. Despite the availability of many such cases of excellence, I use a case of solar mamas or solar engineers, a group of illiterate women aged between 35 and 55 who are trained to offer solar energy technical solutions to communities while at the same time boosting their entrepreneurship and income generation opportunities (Mininni, 2022: 112-123; Vaidyanathan, 2023: 8-10).

Several feminist researchers who have investigated the subject of gender and sustainable development have concurred that access to and participation by all in energy processes is essential in the search for sustainable development processes for social inclusion and gender equity (Batliwala, 2007: 561; Dutta et al., 2017: 1; Matinga et al., 2011: 11-14). However, due to societal discourses in developing countries, highly characterised by patriarchal structures that prescribe gender roles and responsibilities while placing many limitations on women, females find it difficult to proactively engage in energy services value chains (Clancy et al., 2012: 5; Mininni, 2020: ii-iii; Dutta et al., 2017: 1; ENERGIA, 2019: 29). This is true for the many communities in East Africa based on the several discursive practices and obstacles to female participation discussed in the preceding sections of this chapter.

However, the experience of ‘Solar mamas’ under the auspices of Barefoot College indicates that with carefully and consultatively planned interventions, it is possible to break the discursive barriers that hinder female participation in energy transitions and processes. Indeed, the dominant discourses on gender roles can and are being challenged using innovative ways that transform adult illiterate rural women into expert “solar engineers” (Mininni, 2020: 1).

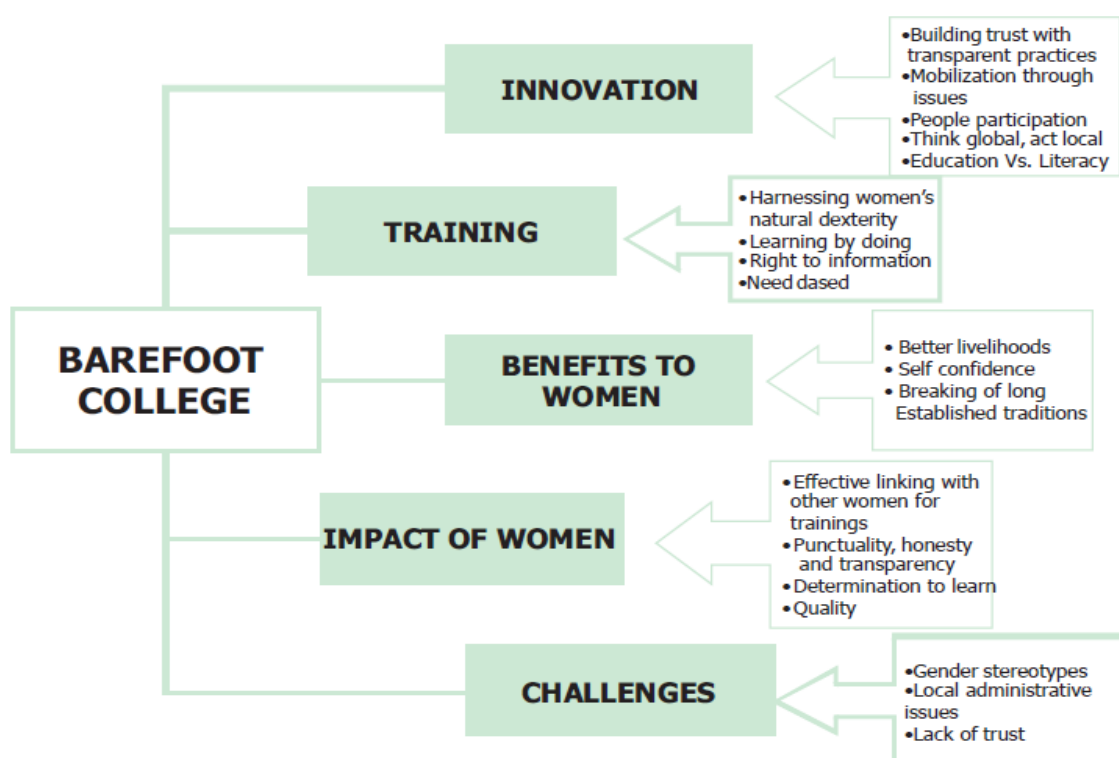
Under the auspice of Barefoot College International, an international NGO with origins in Asia but with a footprint in many developing countries, including Tanzania in East Africa, women are identified and taken for five months of training in solar energy technologies and other entrepreneurial skills that later engender their labour participation and income generation opportunities after the comprehensive training. This form of (positive) deviance approach contests the gendered division of labour and discourses and translates into reduced gender gaps (Slettli & Singhal, 2021: 49ff). The selection of these women is participatory and highly consultative as it includes villages and their committees to ensure the best candidates are selected. Taking an example of the Tanzania cluster, the prospective candidates must be 35-55 years old with a commitment to the local development of the village, illiterate or semi-illiterate, and born in the same village. In addition, a prospective trainee has to demonstrate ties to the

village, like having a house, a husband unless she is a widow, property and a commitment to stay in that village (according to a project officer, Barefoot College, Zanzibar, Tanzania).

At graduation, each candidate is expected to have mastered assembling and installing home solar modules, should install about 50 solar home systems for her respective village, and have knowledge about repairing the same system. Indeed, when clients want assistance fixing their solar systems, the solar mamas are supposed to come in and repair the system at a fee that they use to boost their income. This initiative is worth replicating as it provides frugal yet sustainable ways of caring for energy (Slettli & Singhal, 2021: 49-64; Wågström & Michael, 2023: 1-2).

In addition to the training in solar energy technology, these trainees also receive training in other empowerment packages to improve their confidence, agency, and self-reliance. These packages include self-awareness, rights and responsibilities, entrepreneurship, and digital literacy.

Figure 9: Analytical framework for Barefoot College training approach and outcomes for women



Source: IDRC (2011: 5)

It is worth re-emphasising that the case of solar mamas presents an exciting model and approach worth studying by scholars investigating ways of breaking gendered barriers to women's

participation in energy projects. First, the training focuses on elderly illiterate women breaking the myth that energy and electrical work is an exclusive domain of educated people and males. Secondly, these solar mamas have been able to break the “abominations” we saw in the preceding sections of this chapter that have structurally blocked other women from actively participating in energy projects either as technicians or in productive use of energy. For instance, whereas many men become suspicious when their wives spend just a few days away from home, the solar mamas can spend five months away from their homes and families attending residential training, which, according to several interviews, many other rural men cannot stand.¹⁶ In addition, these women are able (or allowed?) to climb up the buildings in addition to wearing trousers while executing their duties. The practices of climbing and wearing trousers have been cited as restrictive discourses that act as stumbling blocks for women attempting to venture into electrical engineering. However, even with solar mamas, few restrictive requirements in the selection still exist and are rooted in gendered discourse; for instance, the requirement for a prospective trainee to have a husband, unless widowed or having property in the village, borders around discursive practices that may subject some would-be candidates to exclusion.

4.7 Chapter Summary

In this chapter, I have examined the level of women’s participation and the bottlenecks to their participation in renewable energy mini-grid projects. It is observed that despite challenges, women participate right from initial project surveys done by the developers, though their views are sometimes registered in the names of males, especially where a female lives with a male partner in the household. Women also participate in various ways, like working in local committees or as power agents, while few other groups actively work as technicians. Common discourses suggest that women are more honest and committed, thus assigned customer care jobs or administrators in power companies purposely to handle customer payments and mobilisation. After electrification, women engage in several productive use of energy enterprises that improve their income, livelihoods, negotiation power, and agency.

Despite their enthusiasm, however, a swarm of gendered discourses impedes their full participation. Most of these discourses revolve around the gendered division of labour,

¹⁶ E.g. see views from participants in group discussion with men in SD minigrid in central Uganda (paragraph 36)

hegemonic masculinities that subdue women in technical work and forms of socialisation that give rise to regressive gender stereotypes. These stereotypes essentially undermine the role of women in technical-related work while portraying energy professions as an exclusively male domain. These stereotypes are exacerbated by the politics and discourses that objectify and commodify a female body but at the same time frame it as tender and soft and not suitable for ostensibly complex physical jobs like climbing poles and buildings. Matters are not helped when female bodies are considered objects that must be preserved to maintain 'purity' and fetch more (bride) price at marriage.

This chapter also examines the gendered conflicts associated with renewable energy or electrification in the community. It realises that before the electrification of a community, women and girls suffer health problems related to the use of firewood and open fire to cook. However, after electrification, these progressively reduce depending on the ability of the household to afford associated energy expenses. However, electrification tends to increase women's working hours at the business premises, occasionally leading to conflicts with their partners, especially when household reproductive chores are affected. The empowerment gained from improved income levels also, at times, acts as a threat to some male partners who respond with physical violence in a desperate attempt to reclaim the lost power.

However, when communities purposively organise, these gendered discourses and other bottlenecks can be challenged, and indeed, women can be successful actors and agents in the renewable energy sector, not only as technicians but also as entrepreneurs in the renewable energy sector. The case of solar mamas was discussed to demonstrate such possibilities.

The other significant barricade to women's participation is associated with gendered discourses in the education sector, which are comprehensively analysed in the next chapter (5).

5 Discursive Analyses on Gender and Education for Sustainable Renewable Energy Development

As observed in chapter 4, the gendered social systems and related discourses pervade the social structure and associated institutions. However, examining the gendered participation in the renewable sector would be incomplete without exploring the discourses in education since education builds a foundation for the supply of technicians, professionals, and other skills required in the energy sector.

Therefore, education provides one of the powerful tools and skills to stimulate females' and males' participation in the energy sector, but to a considerable extent, education is also gendered, limiting female participation, especially in STEM subjects. Moreover, the convoluted structure, the discourses within the curriculum, gender stereotypes, and prejudice among the learners, teachers, and guardians constitute problems that may make adopting energy-related subjects (STEM) by females an uphill task.

Thus, this chapter analyses the above discourses and gender, focusing on the gendered barriers and enablers and how they interact in diverse ways to enable or discourage women's participation in sustainable renewable energy development in East Africa. However, before delving deeper into the discourses and practices, I first outline Uganda's education structure to shed some light on the education context, particularly for those not well conversant with Ugandan systems. Uganda and Tanzania follow relatively similar models, but I chose to show Uganda's case because most of the school-based data was collected from Uganda because of its better accessibility and convenience.

5.1 The Structure of Uganda's Education Sector

Uganda's education system was designed following the British model introduced long before the 1960s when the British colonialists aimed to train 'manpower' (note the masculinised noun) to help in the local administration (Mamdani, 2016: 124) and perhaps to take over administration after independence (Ojijo, 2014: 5; Windel, 2009: 4). Before the British colonialists introduced (what they termed) 'formal' education in Africa, the education and learning process had started centuries before when children would be guided to learn the trades and skills practised by their parents in the family and community settings. This type of education was highly gendered, as boys focused on learning the trades of their fathers and girls

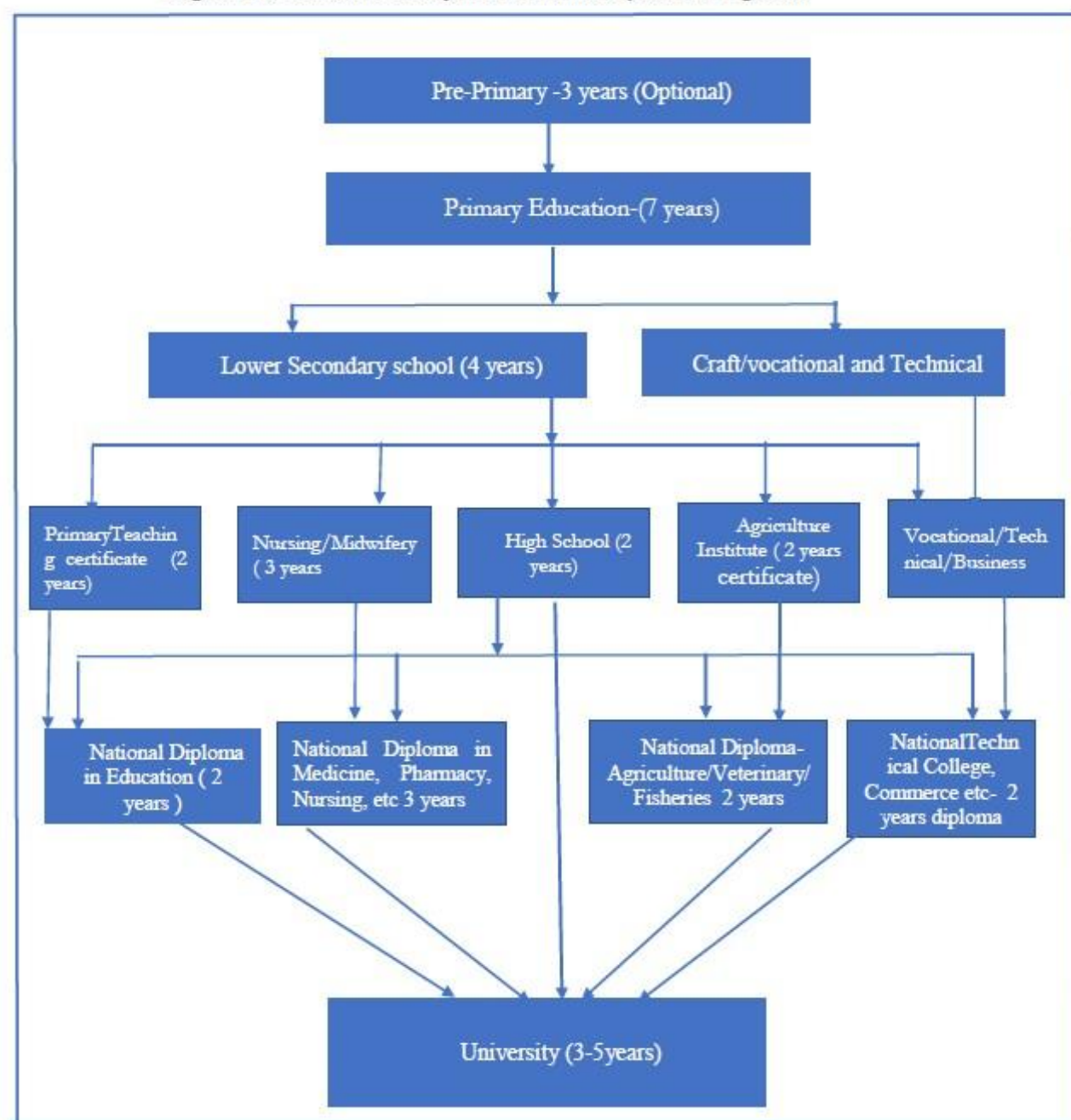
with their mothers (Tuğrul, 2011: 190-193). In this traditional education, specialisation was based on family lineage, and unemployment cases hardly existed since everybody studied a skill that was easily exchangeable in the neighbourhood where such skills were demanded (Adeyemi & Adeyika, 2002: 231). However, with the introduction of the Western education system structured on Western models, the curriculums, objectives, and learning set-up changed, leading to mixed results and outcomes for the native communities. These structures and outcomes have dictated the current education trajectories and processes in Africa in general and Uganda in particular.

Uganda's education system is comprised of 3 years of pre-primary education, locally referred to as Nursery/Kindergarten. Nursery education is followed by seven years of primary school, after which learners are advised (or forced) to pursue various alternatives for public and private education institutions based on their intelligence, motivations, financial resources and fate. It should be noted that though pre-primary education has started gaining popularity, it is still not compulsory, although the government has made a policy regulating its operations, especially for institutions interested in offering it (Ejuu, 2012: 248-255). Most urban-based schools only admit primary school children who have completed three years of kindergarten education. The situation is different in rural schools, where children start schooling straight away from primary one without undergoing pre-primary education (Ezati et al., 2018: 52). Therefore, primary education is generally considered the first level of formal education in which learners are introduced to a standard basic syllabus for seven years. This is followed by a secondary school that lasts six years, subdivided into two. The first four years constitute lower secondary, also known as ordinary level (O-level), and then two years are higher secondary or Advanced level (A-level). At lower secondary school, students complete terminal exams, which, when passed, lead to the Uganda Certificate of Education (UCE) while successful high school completion leads to an Advanced Certificate of Education (UACE). After high school, students proceed to higher education, where they spend three to five years of schooling, depending on the duration of the programme of study. Successful completion of this level leads to the award of a diploma or bachelor's degree. In short, Uganda's education can be described as a 7-4-2-4 system (Ochwa-Echel, 2016: 8).

It has to be noted that upon completing a single level in the education structure, students have varied options for pursuing their career paths ahead (including dropping out). For example, after completing primary school and passing the primary leaving exams (PLE), the learners can join

secondary education or pursue a three-year crafts course in vocational and technical schools. Those completing lower secondary (Uganda Certificate of Education) have four options through which they can further their education. They can either proceed to high school (Advanced Certificate in Education), join a two-year crafts course in vocational and technical institutes, join a two-year grade III teaching certificate (this is being phased out), or join any of the government's departmental programmes or private like Health, Agriculture, Cooperatives, Insurance, and several others. After completion of the advanced certificate of education or high school, students can either proceed to university, pursue an ordinary two-year diploma in business studies, technical education, and teacher education or join specialist courses offered by government departments still leading to the award of a diploma (Ojijo, 2014: 11-12).

Figure 11: The structure of the Education System in Uganda



Source: Authors depiction based on primary and secondary data

Despite the role played by technical education in society, there is a long-held belief and discourses with roots from the colonial period that academically weak students are the ones who are supposed to branch to technical training since they purportedly cannot ‘manage’ the rigorous academic requirements in high school and university (Alavi et al., 2013: 68; Guo & Wang, 2020a: 1; Kashiramka, Sagar, & Dubey, 2021: 1605-1621). The same discourse applies to those who opt for grade III (primary school) teaching certificates (Ejeh, 2005: 36-37;

Labaree, 2008: 297). Due to these discourses, many students are sceptical about technical/vocational education for fear of being branded academic failures and are therefore forced to proceed to university without deeply reflecting on their real career interests and opportunities. This issue is analysed further while dealing with the gendered discourses associated with participation in technical careers later in this chapter.

It is also imperative to observe that the education system in many African countries, including Uganda, is stratified along class systems and inequalities that exist in the communities (Kakuba, 2015: 11). The first cluster involves privately owned and privately managed schools charging exorbitant fees and thus attended by affluent members, then another cluster of private schools charging relatively low tuition to fairly middle-class parents and some private schools for poor parents, especially in places with no government schools. There are also schools jointly run by the government and the church. Missionaries initially set up these schools before the government came in to aid them, but these schools are still relatively expensive and can only be afforded by wealthy, middle-class parents (Masola, 2016: 161). Then, several public schools are poorly funded, relatively weak in academic performance, and attended by the majority poor (Deininger, 2003: 294-295; Kakuba et al., 2021: 2). These train the majority of the learners in primary and secondary. At the university level, there are still public and private universities, though class and gender stratification are also evident in universities; higher education is predominantly for the economically privileged class (Odaga, 2020: 1-11).

Uganda's Ministry of Education and Sports is responsible for regulations, standardization, curriculum development, and national examinations. Curriculum development and management of exams are the functions of semi-autonomous bodies. For example, the primary and secondary school exams are managed by the Uganda National Examinations Board (UNEB), and the curriculum is designed and regulated by the National Curriculum Development Centre. Examinations and curricula for technical/vocational and business schools are managed by the Uganda Business and Technical Examinations Board (UBTEB). Though universities are semi-autonomous and, therefore, manage their examination processes, the National Council for Higher Education (NCHE) manages their curriculum regulation, licensing and supervision (Ochwa-Echel, 2016: 9).

It also has to be observed that, recently, debates have emerged in the education discourse about the relevance of humanities and sciences to national development, with some policymakers

describing Arts courses and subjects as ‘useless’ subjects while praising sciences and related STEM courses and careers (Uganda Radio Network, 2020: 1). Because of this discourse, some people regard a humanities course is considered a luxury rather than a valuable field that requires serious investment. To the proponents of such discourse, a humanities course is viewed as a luxury for students who want to spend their time at school “finding themselves” rather than pursuing more relevant goals like the study of STEM courses like engineering and medicine (Monitor, 2021: 6). This puts those studying humanities and arts in disadvantaged positions whose qualifications do not attract the same value (especially in discourse) as those of engineering, electronics, and other related technical courses.

Matters get compounded as the majority of the students specialising in these so-called weak courses are females who end up in this field again due to dominant discourses, socialisation, and beliefs that women are not suitable for STEM and other technical subjects because the subjects are either complex or masculine (according to discourse) and therefore not for females (Bernstein, 2015: 1). This bias is essentially a result of the complex local (and sometimes international) linguistic and socio-cultural characteristics of continuous incidents of interactions and actions, which in turn create a social and behavioural influence on the members of the community leading to perceptions and beliefs that pervade the community with associated discursive practices. These discursive practices have created a divide between males and females in pursuing science and other technological-related careers. The subsequent discussions detail those discourses and their influence on career choices.

5.2 Discourses and Stereotypes in Education and their Implications for Energy-Related Career Choices

In-depth interactions with most participants both in school and outside school revealed that stereotypes and other learned perceptions heavily determine the career paths students take, especially in their decisions to pursue or not to pursue science and other STEM subjects and, later, engineering or technical-related courses at higher levels. These discourses, to a large extent, limit girls’ participation in the science field, although, to a small extent, they may positively influence females’ decisions to pursue the same. The discourses and their implications are analysed in detail in the preceding discussions.

One of the observations was that females in the science field and careers are perceived as intruders who found their way to STEM because of favour or unique character. These

sentiments result from the long-held belief that technical and STEM careers are predetermined masculine-oriented and, thus, women should have less business in such careers. Women who, for example, complete degrees or diplomas in sciences and join the workforce in the technical professions are considered to have crossed professional boundaries and, therefore, are intruders or have unique characteristics that rotate around being subnormal or super normal. This branding of such women as being different from ‘normal’ creates a problem since, ordinarily, most human beings would not want to deviate so much from the social norms (McDonald & Crandall, 2015: 147). In addition, when women get jobs to work in such careers perceived as masculine fields, their male and female subordinates hesitate to offer them due respect since they assume that such women did not get those jobs based on ability and competence but rather favoured because of their gender. The above notions are further evidenced by one of the female instructors in a technical institute who had this experience to share:

P.1 Then I had many students or other people ask me what I am doing in men’s courses, asking questions like why did you choose this course? But my answer would be, why do you ask me? Why don’t you ask the boys? For example, I felt I was supposed to pursue that course. It later became normal in class, but the outsiders kept heckling me. Some boys later came to understand that it was normal for me to do the course, but they still had the feeling that I was an intruder in the course. Likewise, if you see a boy joining Tailoring or Catering, colleagues ask why he is doing those feminine courses. But they later come to appreciate it with time. You find many male tailors and chefs or waiters as you go around. Those beliefs remain in our societies, but people will understand them later. #00:12:20-0#” (FGD with females at MTB, Paragraph 22).

Coupled with the above sentiment is the predominant discourse held by most societies that women are weak and less academically gifted, and men are strong, more academically intelligent, and therefore exclusively suited for science subjects and careers. Related to this belief is that sciences and STEM subjects are complicated and thus meant for men, who are also discursively perceived to be comparatively more intelligent and suitable for the presumably hard sciences (Halpern & Lamay, 2000: 229ff; Hill et al., 2010: 19-20). Indeed, an education management consultant in Uganda who was interviewed for this study argued that, from the onset, communities hold a view that sciences are complicated, and since many girls are trained to perceive themselves as weaker, it is difficult for them to opt for science subjects after being subjected to such prejudice. As observed in chapter four, people learn these biases from the social environment where girls and boys grow. Likewise, boys usually branded as strong (masculine) grow up with the conviction that they are indeed strong or ought to work hard to show strength in all fields. Maxims like ‘you are a man and must face everything with brevity’ are not uncommon. This branding, in turn, fuels the males’ energy to attempt sciences because

they perceive sciences as sophisticated and, therefore, must attempt complex subjects to prove they are masculine enough (Makarova et al., 2019: 1-11). In most African discourse, being masculine or ‘real man’ implies that one has to display the (essentialised) qualities of a brave and strong person, a notion that reinforces masculinities (Potgieter, 2012: 16-17). In a bid to prove that they are courageous, the boys may end up excelling in sciences, and even though the girls had the necessary potential to excel too, more often, their inherited biases limit them from even making first attempts as it would be perceived as though they are wasting their time in a subject that they discursively can hardly pass (Brickhouse et al., 2000: 441-444; Thompson & Windschitl, 2005: 1, 9).

Coupled with the above is a general discourse that women are not meant to study science and engineering, not because of the claim that women are weak, as seen in the previous discussion, but just because of a constructed belief that sciences and technical courses are just masculine in themselves and thus meant for men only. Such perceptions go with the assumption that women are suitable for arts, humanities, communication, and other ‘cool’ subjects that deal with real issues. According to one male participant (teacher) in one of the primary schools in Uganda, these biases play a crucial role in determining the level of learning and the choice of subjects on which they choose to concentrate. He had this to say:

“But bias also plays a big role in the learner’s level of learning and choice of subjects. Personally, I have taught mathematics and science throughout my teaching career. I have always had contempt for SST (Social Studies) since my school days because I knew those subjects were for women. Those subjects like History used to bore me. They were too wordy, and we used to associate rumours-like wordy subjects with women #00:11:16-7#” (Interview with teachers at a primary school in Western Uganda, Paragraph 19).

When children join school and land into those entrenched biases, they get conditioned to buy into the arts-science dichotomy, and it becomes difficult to change even when they grow up. Thus, girls who opt for sciences may be frowned upon and labelled ‘male’ girls. In extreme cases, depending on the context of the community, such girls are ridiculed and given nicknames like *Kinyanyabishiki*, *Kinyanyababasheija*, and *muhungu mukobwa* (Western Uganda dialect, meaning girls who display attributes that are locally ascribed to boys - the tomboys). The same applies to similar girls who engage in other activities like football and other ‘male’ sports. Such girls find it hard to be accepted in female school groups and are pushed to associate with boys. This stigmatisation generates discomfort, especially when they have confidential information

that they think would be best shared with girls, not boys (FGD with primary school teachers, paragraphs 27-28).

As noted by Solbes-Canales et al. (2020: 1), such discourses and stereotypes or biases are nurtured as learners progress in their academic careers and become more complex as they grow up. According to several teachers interviewed in this study, there is evidence to confirm this. They contended that in lower primary school, where children spend time before being exposed to complex academic discourses, learners do not demonstrate significant gender differences in subject performance. In lower primary school, performance is uniform, and some girls lead their cohorts in mathematics and science, but by around Primary 6 and 7 (upper primary in Ugandan education structure), the differences and biases have already emerged and are getting entrenched. The teachers contended that serious biases emerge from around Primary five, generally when girls start puberty. Biases that mathematics is for boys also start emerging, affecting their concentration and, consequently, performance in the same subjects starts to decline (FGD with primary school teachers paragraph 20). Such discourses are reinforced by some parents and teachers who, too, hold an essentialist view and gendered expectations about the capacity of males and females in science and arts subjects or other fields (Muntoni & Retelsdorf, 2018: 212ff). As a result, some schools, especially at the secondary level, deliberately try to balance the number of boys and girls in science and arts classes. Nevertheless, even when this is done, many girls later abandon the science classes and go to arts, claiming that this is where they reportedly fit well and feel more comfortable (HB-FGD with teachers paragraph 32).

Like any other social construct, gender biases and discourses differ and impact students differently depending on location and setting (Haslanger, 2016: 16-23). Specifically, it was found that the gender imbalances in subjects differ from rural to urban communities and schools. There is some relative gender balance in urban schools, and the career gaps are less, unlike in rural areas where children arguably have to be cajoled into studying, coupled with complex gender discourses and biases rooted in deep-held traditional beliefs (Bargawi et al., 2022: 1917, 1928). In addition to entrenched local beliefs, girls in rural areas get involved in household chores at a young age, which consumes much of their time. They reportedly spend more time cooking, sweeping, fetching water, nursing siblings and other reproductive chores at the expense of studying, which limits their performance at the end of the school term (FGD with teacher, paragraphs 5-6). Boys rarely engage in reproductive work since community

discourses hold that such household chores are meant for females (Levison & Moe, 1998: 339). Therefore, it is not surprising that the performance in science, in general, is remarkably lower in rural areas. Likewise, school dropout rates are higher in rural areas than urban communities.

Similarly, in boarding schools, students and relatedly females perform better in sciences than in day schools. It is from those boarding students that the few girls who pursue sciences at university emerge. Though not acknowledged by respondents, it can be deduced that the marked difference in performance between the girls and students in boarding schools can be attributed to resources and the nature of schools (Babirye, 2022: x). Therefore, this difference can be described as a class issue. Most of the boarding schools in Uganda are indeed for the financially able and thus afforded by children from relatively affluent households who can finance education beyond the basics.

On the other hand, day schools are dominated by students from financially constrained households since they charge lesser tuition, which results in inadequate facilities and resources like laboratory equipment that may not adequately expose students to rigorous learning. However, a study by Gyeltshen & Rai (2023: 837) in Bhutan showed the contrary; day students posted better performance in STEM subjects than their colleagues in the boarding school section. The same day-schooling students posted better scores in self-efficacy than the boarding students. A closer examination of this study shows that boarding and day schooling contexts are relatively similar to those of Uganda; for example, Brown (2015: 1-15) argues that day students in Bhutan (like in Uganda) walk long distances, don't have internet access at home but experience low peer pressure at home, unlike boarding schools. The reasons given for improved performance in STEM by day students in Bhutan were that they concentrate privately at home and get guidance from parents, enhancing their self-efficacy (Gyeltshen & Rai 2023: 838). One would say such conditions are similar to the context in Uganda, but it is still hard to explain why, in Uganda's case, the performance in STEM (and non-STEM) by day schools doesn't follow a similar trajectory to that of Bhutan. This gap raises intriguing questions that perhaps call for more research.

5.2.1 Discourses on Allure, Decency, Marriage and Subject/Course Choice

One of the arguments presented as the motivation for girls' better performance in arts subjects as opposed to STEM was that subjects like English make girls good communicators and more 'presentable', an attribute which, according to them, increases their opportunities not only in

the job market but also more opportunities to attract love and marriage partners. For this reason, some schools reportedly coerce girls to study literature in english and communication skills (FGD with university students, paragraphs 20-25). One would wonder whether boys, too, do not need communication and presentation skills, but the argument in discussion with students (participants) was that boys do not necessarily need to look attractive to get partners; they need to work hard and earn money since money is what matters much if they are to attract female partners. Participants also revealed that some teachers insist girls should have good spoken english to appear appealing. Girls thus strive hard to pursue humanities and other communicative arts to be charming, get competitive in the job market, and improve their marriage chances. Consequently, as argued by some student respondents, girls spend considerable time perfecting their english accent to appear fashionable and ‘modern’ to increase their value in the ‘relationships market’ (ibid).

In an inquiry about the degree of importance they attached to marriage and the effect that it can have on one’s academic goals, the responses varied according to the participant's education level. For example, most females in secondary school responded in the affirmative that they highly regarded marriage and would not pursue an academic career, which could limit their opportunities to get marriage partners. When the same question was posed to the girls at university, the majority concurred that they too valued marriage as necessary in their lives but would not necessarily determine their choice of careers, although years ago, when they were still in primary and secondary, they thought it was crucial. They thus added that, in retrospection, marriage opportunities would have influenced their choice of which courses to concentrate on and which to drop or give less concentration.

Since many students start subject selections in their lower secondary school level, this age is, in most cases, associated with puberty as far as growth and development are concerned; it is easier to understand why marriage and attractiveness become key in secondary school and less important at higher levels of schooling like university. Indeed, the study by Parsons et al. (2015: 12-17) suggests that pressure for marriage among girls progressively reduces as they progress higher in their careers. Yet, career paths have already been determined by the time one joins college or university, with fewer opportunities to switch from sciences to arts or vice versa. A study by Hui-Ching & Memon (2021: 4-8) indicates that switching from arts to STEM is particularly hard for women, even when offered special conversion programs.

The parents and the social environment in African cultures train and orient young girls to prepare to be ‘good’ marriage partners right from infancy, which also buttresses the matters. The words of Nalweyiso (assigned name), one of the university students, can shed some light on this indoctrination;

“But among us, the Baganda girls, we are constantly told that as a girl, you have to behave like this, do this, etc. We are groomed from childhood to appear attractive and respectful as girls. By the time we grow up, we are already brainwashed. And this form of counselling or brainwashing also takes place at schools. Senior women¹⁷ do it. These senior women would also train us in things like pulling our clitoris (*while laughing profusely*) so that we become sexually appealing to our husbands in future when we get married. Whatever these women do not tell girls, aha. If these women or teachers find you doing something, they will tell you that what you are doing is not expected of a Muganda girl. They are supposed to groom girls into promising future wives. Even female teachers will advise you to talk calmly if you are flamboyant; they will tell you that a girl should not talk much. #00:34:20-6#” (FGD with female students at a University, Paragraph 25 - 28).

Such indoctrination among boys and girls does not stop with general conduct but also crosses almost all other spheres of behaviour, like how they eat, walk, and dress. Taking gender and dressing as an example, girls are encouraged to wear dresses while men wear pants, and it is taken as a disgrace for a girl to dress in pants. Samalie (assigned name), who was in the same focus group discussion with Nalweyiso, attested to this:

In my former school, no female would be allowed to cross the school gate and enter the compound if she was wearing pants, even when such a female was a parent. It was an offence. Even riding bicycles among girls is forbidden in our community, although I always do it defiantly. But as you know, when it comes to practical activities like electrical engineers climbing poles, you cannot climb a pole while dressed in a *gomesi* (*Gomesi* is a traditional long dress common among women in central Uganda). #00:36:25-3#. FGD with female students at University, Paragraph 25 - 28).

The main argument given by the elders for restraining girls from exercising agency in as far as behaviours like dressing and riding bicycles are concerned is that such girls are crossing gender boundaries, leading to shame and embarrassment for the family. Such acts (according to discourse) depict failure on the part of the parents (in most cases, mothers) to guide the children properly (Collett, 2005: 327-328). Therefore, the community, including uncles, aunts, and village elders, struggle to tame the supposedly misbehaving girl and bring her to the ‘correct

¹⁷ A senior woman is a title given to a member of staff, always female, in charge of guiding girls on matters concerning sexuality or related subjects.

line'. In the process, such members blame the mother for failing her duties. Usually, society places the duty of grooming children squarely on the mother (Hossain, 2022: 159; Pickett, 2017: 361), though, in many patriarchal communities, the father claims credit when the children display acceptable behaviour or good performance in school (Liu, 2019: 82-85). There is a maxim in the local Ugandan dialect, "*omwana omusiru ovumisa mama we*" translated into English, that a lousy child brings shame and ridicule to the mother while a bright child brings honour and glory to the father (#00:06:18-6# Interview Musawo, paragraph 19). Understanding the role of such maxims is essential in discourse analysis (Brinton 2001: 139).

It has to be noted that such discourses and gender markers are specific to age and class (Obbo, 1995). For instance, whereas wearing trousers by girls is detested by the older generations, where most of the interviewed students' parents belong, the students find no problem with dressing in the fashion they prefer. However, such choices eventually put them into conflict with their parents and the members of the older generation. Likewise, whereas women riding bicycles may be conceived as unacceptable among the Baganda society in central Uganda, the northern and eastern parts of Uganda highly encourage women to ride bikes and engage in other allegedly 'masculine' activities and conduct (Chantelois-Kashal et al., 2020: 80-95). The same applies to the rural and urban divides, where communities in urban areas have transcended some traditions, such as dressing restrictions. Moreover, with more pressure exerted on traditional societies by the modernisation drive, such beliefs will continue to be contested (Kolarova, 2006: 1241).

5.2.2 The Politics and Discourses of Beauty and Options for and Against STEM

Closely linked with the discourses in the preceding section was how beauty or the desire to be perceived as beautiful influences some (female) students' choice of subject selection in school. Some (student) respondents argued that sciences and their respective careers, like engineering, are meant for girls who are not beautiful or do not mind their beauty, as such courses are reportedly associated mainly with masculinity. Therefore, according to those students, such STEM courses are meant for boys since beauty is arguably unnecessary for males. It has to be recalled that in most African cultures, during training ('feminising/masculinising'), young girls are greatly encouraged to be neat, tender, calm, well-behaved, and beautiful to be attractive in society (Black & Sharma, 2001: 19-25). Surprisingly or not surprisingly, beauty is not one of the vital attributes when boys are being groomed. Instead, they are trained to be strong and work hard to attract beautiful girls and be responsible future heads of the family.

Furthermore, it is not uncommon to find a 'beautiful' boy being addressed/teased as a girl while a not-so-beautiful girl (based on the commentator) is being addressed as a boy. These cross-identifications are taken as a humiliating insult, sometimes leading to physical fights. In many African communities, addressing a man as a 'madam' or any feminine reference is considered a great insult (Interview with a local leader, SL Minigrid paragraph 5).

Therefore, because sciences are branded masculine (Line & Mellstrom, 2011: 314), and since masculinity is associated with less beauty (Black & Sharma, 2001: 100), some girls opt for arts for fear of being associated with less beauty. The words of Tabo (assigned name), one of the participants in the focus group discussion with female students at Makerere University, give a pointer to these discourses:

While we were studying at NY Secondary School, the teachers would boldly tell us that it was in the arts class where pretty girls go, and scientists were called boys in general, even when some girls were part of the science class. So even the girls in the Science class were called boys. There was a time when a teacher came to our class and, to greet us, he said, "Apart from Josephine, the rest, good morning, boys.! *Banange* from that day, they called the entire science class boys. Then, for those in art class, the greeting was like, 'Hi, beautiful girls. So, in the arts class, we addressed ourselves as girls, but for the others in the two streams of sciences, we addressed them as boys. They would even greet themselves as hello 'bro' (bro being slang for brother) irrespective of sex. So even girls started addressing themselves as 'bro', or boys addressing girls as bro, and it would appear normal. So even teachers in the science class would be like, good morning, my brothers, without adding anything like 'and sisters.'#00:20:56-1#" (FGD with female students at University, Paragraph 16).

These incidents are not isolated to one school but are prevalent in many schools nationwide, as revealed by other students in the focus group discussions. It was also revealed that such characterisation would subject girls to feelings of humiliation for reasons already discussed in the preceding paragraphs. According to Marriam (assigned name), one participant in the group discussion, these feelings add another twist to the situation. The perceived feelings of less beauty limit the girls' stand in deciding which love partner to date; they perceive it as a favour when boys approach them for a love relationship. A simple request for love from the boys would (allegedly) make science girls accept without resistance as their defence is weakened by the already negative perceptions of the self-image. Moreover, local discourse holds that a girl is expected first to resist advances from boys even when she is interested in the relationship because acceptance without resistance makes the girl appear cheap (Marriam- FGD with University students paragraph 15).

The act of being approached by males for a relationship, yet she belongs to the allegedly ‘not-so-beautiful group’ in the school, in turn, creates excitement, consequently reducing concentration in academics, leading to a decline in performance. To participants in this discussion, such excitement among girls in science class offers males an advantage to perform better than the girls in the same class, as the boys are reportedly less affected by distractions about beauty or lack thereof. A note has to be taken that such dynamics occur at the secondary school level, where most of the students are teenagers and where the concern for romantic relationships holds and exerts more pressure among students (Kansky et al., 2019: 1) than at any level, like primary school or university education. Leaving the purported excitement and grades aside, addressing girls as boys occasions psychological torture and demotivation in class in class if we are to further go with the words of Tabo:

(...) consequently, girls from the science class who were addressed as brothers would feel psychologically tortured. They would go and complain to the senior woman, they even went to the Headmaster, complaining that they are being called boys (.....) are we, not girls, don't we have breasts, why are they calling us boys? So the Headmaster arranged a meeting with all the senior 6 class and warned us to stop calling girls from the science stream as '*bro*s' (brothers), but the meeting also turned into a comedy event as everyone was laughing at them, which humiliated the girls further. But even after the meeting, it was the order of the day as nothing changed afterwards. #00:23:16-3#" (FGD with university students, Paragraph 18).

From the above complaint, one can contend that such distractions have much potential to deter some girls from taking STEM courses and, subsequently, STEM or renewable energy-related careers even when their initial preferred choice or academic talent initially placed them in sciences. Moreover, overcoming such challenges requires a solid mental character and confidence level that not every student might be lucky to have.

In addition, interaction with the male group reveals male power politics in the sciences versus arts discourse. In most Ugandan academic discourse, science courses are assumed to be associated with students with more substantial academic potential and are more valuable than those in arts (Monitor, 2021: 6; Uganda Radio Network, 2020: 1). For this reason, some boys feel uncomfortable seeing a girl who is purportedly brighter than them. They consciously or unconsciously express this discomfort by continuously interrupting girls in science class with disruptions, including love requests, teasing, nicknames and other forms. Moreover, the patriarchal discourses that glorify male dominance and the associated hegemonic masculinities make boys believe they are and should be more academically potent than girls (Steinmayr & Spinath, 2009: 736). Therefore, such masculinised boys feel humiliated seeing a girl/female in

their midst who is presumably more intelligent and, by extension, more powerful than them (Pomerantz & Raby, 2011: 49). Therefore, it can be deduced that the nick-naming and the branding of girls as brothers is part of this game orchestrated by male students from the arts to prevent their female counterparts from pursuing the supposedly more intellectually demanding courses that the very boys might have failed to pursue.

5.2.3 STEM Subjects (discursively) Deemed to be Complex, Abstract and Boring for Females

One of the teachers interviewed observed that a common belief among students, particularly in rural areas, was that if one is lucky enough to get into school, they should avoid complex subjects by all means. These beliefs are, however, not gender specific. They also claimed that going to school is an opportunity not readily available to many poor citizens in East Africa. The goal of many learners from poor backgrounds, thus, becomes to try by all means to avoid those (allegedly) complicated subjects so that they do not fail to pass and get embarrassed. Getting poor grades at that level would force parents to pull them out of school. So, to avoid being withdrawn from school due to bad grades, students are inclined to opt for subjects that peers deem passable easily (FGD with teachers, paragraphs 21, 30-34). Hence, the discourse about what is hard and what is simple is a crucial factor, and the mindset that sciences are hard makes even those offering them register dismal performance. According to the teachers interviewed, some of these biases and decisions form even before some learners start schooling:

So, as a young student, you hear people say those STEM subjects are so complex, and you say ok, I won't even attempt, so sometimes students make decisions even before the first attempt. Secondly, the reason why students, especially from low-income families, dread sciences is for the reason that they are expensive. So, a parent wanting their daughter to study sciences only ends up settling for Nursing because it is shorter, cheaper and feminine" (FGD with primary school teachers, Paragraph 35).

One would argue that if science courses are complex and expensive, the experience should be the same for boys and girls in the same cohort and, therefore, not a notable gender concern, but this is not the case. According to some respondents (teachers), there are local beliefs that girls have to study faster and hurry out of the school system before they get caught by an 'old' age when they are still in school. According to the same respondents, the argument was that girls grow up very fast and gain body weight that is sometimes not commensurate with their actual age, hence appearing older. They reportedly appear like mature women even when they are still so young. Therefore, when a girl psychologically realizes this, and without proper counselling

and guidance, she starts rushing to get out of academics. Options like repeating a class become an unlikely decision. The goal thus becomes to focus on arts that are deemed simple, pass and get out of the school system before ‘ageing’ (HB, FGD with teachers, paragraph 34).

The number of females enrolled in East African schools is relatively equal to that of males, particularly at lower levels of education. The numbers admitted at universities and other tertiary institutions, too, do not show significant gender differences in terms of numbers (Kuno et al., 2021: 4-6; Onsongo, 2009: 72). However, the ratio of males to females in the technology courses is grossly tilted in favour of males. Several girls reportedly dread technical courses like Electrical Engineering because of the assumption that requisite subjects like physics, mathematics, and chemistry are challenging and require a lot of mathematical calculations that girls may perceive to be meant for a masculine orientation (Brandell & Staberg, 2008: 495-509; Kaahwa, 2012: 1-12). According to one lecturer interviewed for this study, even when the government of Uganda moved ahead to make science subjects like physics, chemistry and biology compulsory in lower secondary schools, many females considered studying them a waste of time since many believed they would fail them. Consequently, they prefer to allocate that time to arts with the perception that they will score better in arts. It is usual to find a student telling a teacher that ‘I cannot waste my valuable time attending a physics class; I passed mathematics a long time ago, implying that even if they attempted, they would, after all, fail it (KJ -FGD with female students at MTB Institute paragraph 48).

A related explanation advanced by the students interviewed was that learning arts and humanities is fun and exciting, while sciences get abstract and boring. Subjects taught in the form of stories touching things that one can easily connect with, like history and geography, are easy to memorise, even when doing other chores outside the class. Even teachers find it easy to explain them to young learners while teaching (Tina, FGD with university students, paragraph 20). It is (reportedly) the opposite in science and mathematical subjects where most of the concepts and terms used are, in most cases, alien to students and challenging to connect with real-life experiences (Inoue, 2008: 36), yet the ability for students to connect subject content with everyday life is critical in education (Stohlmann et al., 2012: 2). The dilemma associated with studying subjects and concepts that students find to be abstract was elaborated well by this female participant:

What made me hate mathematics and physics during my school days were concepts like Algebra, Tangents, cita, cosines, Ohms law, Logarithms and other abstract things I can’t

remember now. But what are logarithms, and how will I ever apply them in life? It is not easy to connect these things to real-world problems. So why don't they look for better words to use? Can you imagine calculating one mathematical calculation covering two book pages? Moreover, even after spending all that energy, you even fail it? #00:18:02-5#" (FGD with teachers in a primary school, Paragraph 24 - 25).

Although it is not the goal of this study to judge which course between arts and sciences contains more abstract material than the other, there is a likelihood that students will perceive as boring and abstract subjects that they are hardly able to apply or identify with at any time in life (Inoue 2008: 36, Kaahwa, 2012: 1-12). This would be resolved if content developers and teachers in the STEM field, especially in lower classes, looked for innovative ways of packaging and delivering teaching material in ways that do not cause frustration among learners (Inoue, 2008: 61-62).

Because of socialisation and the diachronic nature of discourses from elders who have been in the school system earlier, claiming that sciences are complex and more challenging for girls, it becomes difficult to diffuse those perceptions among younger learners in the long run. By the time they reach higher classes in school, where career decisions are made, they already have STEM phobia. These biases, therefore, start forming during pre-school, from home, then progress to primary school, secondary school, university, and finally, the work environment. However, these perceptions can be easily averted if the young learners get equally encouraging counsel or stories from females who have successfully managed STEM and act as "fire extinguishers" or role models. Role models (female) who have succeeded in STEM courses and careers help to defuse the phobia against STEM among young female learners.¹⁸ The contribution of role models to motivating young female students to join STEM fields is further supported by the study by Blickenstaf (2005: 376-377). However, to the contrary, Krämer et al. (2016: 1, 8-9) argue that for females to flourish in the STEM sector, they need friendly male instructors and agents other than just female role models. This argument implies that as long the male instructors are friendly, they can as well inspire female students more than female role models.

¹⁸ Comment extracted from the speech by one the female electrical engineers, acting as deputy Executive Officer of the rural electrification Agency in Uganda.

5.2.4 Teachers' Character and Teaching Methods that Reinforce the Gendered Discourses

Biases about the male-female dichotomy in course choice are sometimes propagated by the teachers in and outside the classroom. The teachers consciously or inadvertently propagate gender discourses from the language they use, how they teach, talk and treat students, the examples given, the learning methods deployed and, to some extent, the textbooks they use to teach. One respondent (teacher) contended that, for example, when a teacher is teaching and asks questions to check whether the students are following, the students who respond to the questions are assumed to be the only ones who are bright, and the teacher's attention tends to focus on these fewer students at the expense of the majority who seldomly respond (FGD with primary school teachers, paragraph 2). Nonetheless, due to the prevalent social-cultural dynamics that discourage girls (relative to boys) from speaking much in public spaces (Baxter, 1999: 81), most students who ask or respond to questions are highly likely to be boys. As reported by HB, one of the respondents in the discussions, when there is a general assumption that male students in the class are brighter, teachers give minimal attention to female students. Secondly, some mathematics teachers, due to their inherent prejudice about girls' capacity in STEM subjects, tend to humiliate them in class, and such kind of humiliation limits the capacity of students to explore and enjoy the lesson freely. To complicate the already bad situation, mathematics teaching is often associated with caning students who fail to pass the mathematical calculations. It was revealed that for some teachers, the number of calculations one fails to get right would equal the number of canes a student receives. In addition to the physical effects, such harsh punishments have the potential to make a student detest a subject altogether, as revealed by one of the respondents;

Most of the time, when you hate a teacher, you cannot actually understand what *he* is teaching. Personally, I hated the Physics teacher from form two until the end of my secondary school time. I hated him with all my zeal. He caned me, and I was sick for a whole week. Comparatively, I was good at english literature, as our literature teacher was nice to me. I always felt secure in literature class. #00:00:58-7#” (Nawaguna in the FGD with Makerere University students, Paragraph 3 - 4).

Circumstances like the ones alluded to above subject students, especially females, to intense anxiety or fear, and they resort to dodging Mathematics and similar lessons and drop out of school altogether if they do not get adequate mentoring. Comparatively, the boys in the same class may not feel similar apprehension as they can openly confront a teacher who mistreats them, and even when they get corporal punishment in front of their colleagues in class, they

reportedly do not suffer such a level of psychological embarrassment. According to some teachers (respondents), male students find it relatively normal to resist mistreatment or to be involved in altercations, which is not the case with their female counterparts. Some other teachers also tend to practice discriminative teaching methods without overtly disclosing it, hence compounding the tragedy of some groups in class, as revealed by one of the teachers:

Some teachers are misogynists, and there is a way they tactfully eliminate girls. He eliminates them without necessarily disclosing it to them. When it comes to grading the books, he may grade work for two or three boys who are known to be bright; when he finds that they have passed, he will tell the rest of the class to mark themselves. Moreover, this is very common in Mathematics lessons. After the self-marking by the students, which is also an awkward practice, bright students, especially boys, will have the confidence to ask the teacher for clarification, especially if they failed to solve a specific number, while a less bright student can never ask questions to teachers. They will instead be waiting for the moment the teacher gets out of class so that they can regain some freedom. #00:05:43-5#” (FGD with Primary School teachers, Paragraph 14).

The same participant goes on to add that;

Yes, professionally, we are supposed to look at those children and understand their weaknesses. We should try to befriend them so that they drop that fear. But some teachers do not care. They say they do not have time for ‘dull’ students. They say they will move with students who are willing and able to learn and have no time for ‘failures’. That after all, they have a vast number of students to handle and waiting for the weak students to catch up is not practically possible #00:06:37-6#” (FGD with Birungi and Hellen, Paragraph 15 - 16).

From the above, it can be observed that such teaching methods can be detrimental to the morale and progress of learners (Tang & Hu, 2022: 1-2), more so in settings like Ugandan schools where the teacher-to-student ratio is exceptionally high (Ankwasiize, 2018: 167). To achieve learning outcomes from such settings, teachers should instead be considerate and tactfully integrate the students with efforts to mix talented ones with less talented ones and instil a positive attitude towards the so-called complicated subjects. In such cases, even the less gifted students would excel in sciences through peer-to-peer learning. However, the learning outcomes can be disastrous if the teachers stratify the students according to capacity without deliberately integrating the weak and strong (Interview with school teachers paragraph 49).

Coupled with the above are the entrenched gender-stereotypical or gender-blind teachers that continue proliferating the discourses that technology is meant for males with a limited role for females. Moreover, such teachers reproduce these biases in their everyday dealings with the students. Let us take this real case that one participant shared: In one of the schools in central Uganda, a non-profit organisation was working with children to promote agricultural

mechanisation, and in one of the activities, they were assembling a small machine to promote small-scale irrigation. When the officials requested ten students to be trained in assembling that machine, teachers brought a team of ten boys without any girls in the group to the chagrin of the field facilitator. When the field officer (facilitator) inquired why they did not bring any females, the teacher responsible responded that he thought “those technology things” were not meant for girls but boys. The field officer protested, and girls were brought to participate together with the boys. By the end of the exercise, the girls had performed well and were full of enthusiasm (Interview with AR paragraphs, 9,20).

Observably, such beliefs and narratives by teachers place the females at the margin regarding participation in science and technology since they may also be made to believe that those STEM-related aspects are meant for males only and may exercise fewer initiatives to venture into such. The same also affects their esteem and career goals, and they may not attempt to pursue science and technology further. Thus, how teachers think and act and, retrospectively, how they were taught may significantly influence the nature of guidance and career advice they offer their students (Peng & Xiong, 2021: 131-132). Such influence may include the reproduction of gender discourses and prejudices in class. Unless retooled, their teaching becomes a reproduction of how and what they were taught and can only deliver what they know; as one participant remarked, “You cannot give what you do not have”. (Interview with Kinywagi, paragraph 31). Indeed, scholars in educational psychology (e.g. Cole & Engeström, 1993: 4-9; Holland & Lave, 2001: 3-5; Peng & Xiong, 2021: 131-132) tend to agree that the past has the power to influence an individual’s present. Such teachers consequently continue to unconsciously marginalise women and girls, which puts the latter at a significant disadvantage as they may even lose interest in STEM early in school.

The above notion further connects well with another puzzle in the equation in that most of the science teachers in Ugandan schools are male to the extent that some students may study from primary to secondary without ever seeing a teacher of chemistry, mathematics or physics who is female. Such conditions instil or reinforce the biases in learners that some subjects are not meant for girls. Perhaps had the girls and boys grown up witnessing several female teachers teaching those science subjects, it would be an effective motivator to girls and consequently to replicate the example of their teachers, hence diminishing the gendered biases in subject choice.

5.2.5 Teachers' Prejudice, Biased Guidance and Biased Examples in Teaching

It was established that when students are transiting from one level to the other, say from primary to secondary or from lower secondary to high school, and a choice of course or subject combination is to be made, teachers and school directors play a pivotal role in guiding students and parents on the appropriate subject combinations or career choices. Therefore, as Tabo, one of the respondents in the focus group discussion with students, stated it is not uncommon to find when teachers have an already preconceived list of male and female courses or subject combinations. Similarly, in lower technical courses like vocational institutions, such teachers tend to advise females to apply for courses like secretarial studies, catering, tailoring, hotel management, and hospitality. In contrast, males are advised to apply for 'masculine' courses like motor vehicle mechanics, electrical engineering, building and concrete practice or civil engineering, claiming that such courses are "naturally designed for males", and the former group of courses are naturally meant for girls (FGD with females at MTB Institute). The practice of naturalising what is essentially a social construct is an issue that has raised much debate among regular members of the public and gender scholars (Baer & Kaufman, 2008: 75-76; Benyishay et al., 2016: 1ff; Gerlach & Gainotti, 2016: 46-53; Ruskai, 1991: 11-14). Perhaps further studies may be needed in this direction to determine what is natural and social in academics, as claimed by some of these teachers.

Whereas some of those school staff members innocently communicate their gendered subjective biases because that is what they believe, some, as per revelations from some female respondents, are strongly prejudiced against females, are intensely misogynistic and will brush off any female who attempts to pursue sciences. They do a lot to plant perceptions among females that they are not fit for science academics unless such girls prove themselves to be of extraordinary potential, a standard that the same teachers do not subject to male students (FGD with university students, paragraph 4-12). Ironically, some female teachers also hold such prejudices. In their mentoring sessions, such female teachers (locally referred to as senior women or Directors of studies) tend to counsel girls to choose Arts combinations if they are ostensibly to succeed in academics and side-step STEM combinations since they are suitable only for males (ibid). In some situations where a student resists and rejects the imposed subject combination, parents are summoned to the school and informed that their money would go to waste since the daughter is attempting to pursue complicated subject combinations that she cannot pass. Ultimately, they propose that history, religious education, English literature,

languages, home economics, and sometimes geography are the ideal subject choices for female students¹⁹.

5.3 Discourse-engendered Experiences and Challenges for Females in STEM

Like the gender discourses, women and men who join courses perceived as belonging to the opposite gender face problems and sometimes opportunities that make their stay in the said courses either thorny or exciting. Staying in a course heavily dominated by the opposite gender and being looked at as an intruder, stranger, or just a humble visitor needing compassion and special attention is a significant challenge female students in STEM encounter. Such experiences, as delineated by the participants, are discussed hereinbelow.

5.3.1 Disruptive Effect of Marginal Numbers of Females Amidst ‘Crowds’ of Males

Other factors aside, the over-tilted numbers favouring one gender may make some students uncomfortable. For example, Jolly, one of the female participants and a lecturer in a technical training college, studied as a lone female student in a class of 40 students undertaking civil engineering. Likewise, in a class of electrical engineering visited for this study at one technical Institute, the females were 7 out of 38 students. Although this presents a significant improvement, according to the school principal, the number of females pursuing similar courses has stagnated at less than 5 % of the class. As a result, these female students reported experiencing some discomfort, especially in the initial phases of the courses, as they perceived themselves as somehow being in the wrong place. Nevertheless, since most of them join such courses after serious consideration and thorough soul-searching, they tend to develop a ‘thick skin’ to push on amidst numerous gender-based distractions.

Like in the previous sections, most distractions recorded are purely social and based on gender discourses and myths. The only non-social distraction reported amongst all female respondents were situations of menstrual periods or periods of pregnancy where they get physical body weaknesses that render them to miss classes or fail to participate in some practical lessons that require physical energy like lifting heavy equipment in the laboratory or field work electrical installations.

¹⁹ Statements paraphrased from the focus group discussions with University students in Uganda, and also with a Principal of MTB Institute in Uganda.

Nonetheless, in classes where girls are extremely too few compared to boys, they tend to experience unwanted advances from boys seeking love and relationships, with different boys offering love and marriage proposals. In addition, because there are comparatively too many boys competing for very few girls, sometimes the competition gets disgustingly too high to manage²⁰. Although such experiences are not uncommon in youth-dominated groups, they may reach levels where the female students feel distracted and uncomfortable.

5.3.2 Friction with Parents as Girls are Branded Defiant Rebels

Perhaps the most unnerving experience revealed by the female students, especially in the vocational schools, was parents' opposition to course choice. In other words, some parents and guardians are absolutely opposed to funding a girl to pursue courses they refer to as 'men' courses. Thus, it was found that several females who pursue technical courses decide on their own and do so contrary to the advice of their guardians. In such a case, the girl who opts to be an electric technician goes directly to a technical college after secondary school and pursues electrical engineering or plumbing courses. In contrast, girls who obey their parents' choices end up taking courses like tailoring, catering, hospitality, and related 'female' courses. This defiance creates friction between the students and their parents' choices. The girls who assert themselves opt for the technical courses because of the conviction to pursue their goals end up being branded unruly by their parents, which at times leads to denial of school fees and other forms of parental support.

Like any traditions and beliefs discussed before, some parents tend to believe that their daughters will not manage the technical courses and, therefore, sponsoring them would be a waste of resources and put the family to shame, especially when they are seen conducting themselves like men. Consequently, such students face school fees hitches since they are doing courses their parents never approved. For example, if a girl is studying electrical engineering when her parents want her to study either accounting or catering, there will be some hesitance in tuition payment by the parents. Furthermore, according to the school principal of one technical school (respondent), such girls often tend to be dismissed from school due to tuition fees defaulting. In some cases, they study for three semesters, and in the fourth, the parents start

²⁰ Paraphrased statements extracted from the interview with BJ- principal of a technical Institute in Uganda paragraph 18).

demanding a change of course. Such students who manage to continue despite the disagreement with their parents must prove themselves beyond a reasonable doubt before getting tuition from their parents. This friction is a discomforting challenge their male counterparts do not necessarily encounter (Interview with BJ- school principal, paragraph 18).

Another seemingly trivial yet daunting experience girls face in male-dominated STEM courses is the accusation that overstaying in the company of males makes them adopt some unwanted male character traits that are unfeminine. One such character trait is using vulgar language, especially by on-site electrical technicians. An extract of the interview with one of the respondents adds more light to this indictment:

“P: Another challenge is that when these girls stay with boys for long, they adopt boys' bad manners. So, after a short time, you find there is no difference between a boy and a girl, and all become the same. #00:14:21-0#

I: Like which characters? #00:14:18-9#

P: For example, being talkative and vulgar. You find that these girls are using the exact vocabulary boys use. For instance, they also start using obscene words the electricity technicians use. They don't fear speaking anything. A woman can mention a vulgar word, and you feel like you are almost collapsing, not words that are expected of a real woman. For instance, on field sites where electricity network extension lines are being constructed, you find those young men referring to a pit as a vagina and an electric pole as a penis. So when they are placing the electric pole in the pit, they keep shouting push it! Push it harder! while shouting lots of other obscene words. Pushing harder is not an innocent statement, as it appears. After a few days of fieldwork with boys, you find girls shouting such obscenities without any fear. Whereas it might be ok for boys to use such language, society can not accept women who use such words. #00:14:56-3#” (Interview with an electrical technician instructor at Technical Training Institute in Uganda, Paragraph 20 - 22).

Such blame reveals so much about the dominant discourses of masculinities and femininities and how society can be so harsh that it has even restricted the acceptable vocabulary and language of women or men. According to these communities, whereas it is permissible for males to use ‘indecent’ words and escape unsanctioned, true femininity or womanhood does not tolerate the use of some vocabulary (Karyn, 2003: 22-33; Lucchetti, 2021: 57). Therefore, females who continue using such unfeminine vocabulary are branded defiant or antisocial.

5.3.3 Access Restrictions During Internship

Though not in bad faith, this time as ‘an act of kindness’, but still rooted in the discourse that girls are tender and should thus be preserved from complex and heavy tasks, several female students in the technology sector find themselves being stopped from participating in fieldwork

activities that require expending hard physical energy. For instance, it was reported that when it comes to mechanical engineering, where students are expended to lift or fix heavy machinery, field-based supervisors, especially those who have hardly dealt with female technicians before, tend to hesitate to allow female students to lift, fix or operate some equipment. Similar experiences were also reported by female students in electrical engineering whose supervisors stopped them from climbing electric poles or other high-rise structures for fear that they may fall and get injured. When they are allowed to climb, they reach a certain level in the middle and are forced to descend. The excuse is always that women have soft legs and may fall easily (Interview with BJ school principal MTB). However, it was also found that in a situation where a woman adamantly climbs up successfully or successfully operates heavy machinery, then it creates a lot of excitement and everyone on-site, including passers-by, is invited to come and see a woman doing ‘strange things’ turning the whole exercise into some drama show or tourist attraction as opposed to the intended learning and training exercise. “Then you hear people commenting that this is marvellous, how can a girl climb up like that, how can a woman operate such tractor?” (Interview with Jolly, female instructor, an Instructor at a Technical Institute paragraph 37).

5.3.4 Discourses that Technical/Vocational Courses are for Academic Failures

There is a long-held discourse in society and some academic circles that technical and vocational courses are for students with weaker academic potential. Accordingly, to prove that they are academically intelligent, students must study ‘academic’ courses and progress through the traditional channels of primary, secondary, and high school and join a university for a degree programme. Traditionally, particularly in Africa and some Asian countries, as some scholars argue (e.g. Bosch & Charest, 2008: 439-440; Guo & Wang, 2020b: 1, 8), the common practice has always been that students who branch after primary or secondary education to pursue technical/vocational courses are those who have scored poor grades at secondary or high school. This tendency makes many students abhor technical education to the extent that even when institutions offer bursaries and scholarships to attract applicants, they fail to get numbers or still get those who scored minimally in their primary or secondary school exit exams as one principal of a technical school reveals:

The problem here in Uganda and surrounding countries that has persisted for a long time is the belief that technical and vocational education is for academic failures and high school is for clever students. So even if you offer a parent a bursary, his daughter or son cannot come. Ugandans believe that someone who has not passed through high school does not understand

much, cannot reason well, and therefore cannot perform well if they progress from technical college to university. It would be our wish to boost female students' numbers in technical courses, but even if you say that for every girl that scored first or second grade at secondary, we are going to support this student with a tuition waiver, parents will still not allow them to come and enrol. The higher percentage for technical education is only those who scored third and fourth-division secondary school exams. Only this year, we have admitted students in the first division, but still not many. Most of the students we have been admitting are only those in the third and fourth divisions. Even with the third and fourth divisions, you still have students with those grades who insist on going to the high school level. Others who do not attend high school opt for courses in tailoring and catering. They say *gwe genda ossibe enviiri* (go and study hairdressing) #00:27:17-6#" (Interview with Principal MTB, Paragraph 31)

One of the practical tools used to boost student numbers in schools is through offering subsidies to students by the school management, especially to those who perform well. Moreover, providing such incentives to target females would indeed increase female students' numbers in technical subjects. However, such incentives may not improve enrollment when technical graduates are scorned as academically weak and less analytical (Kashiramka, Sagar, Dubey, et al., 2021: 1614).

However, it has to be noted that such attitudes are only subjected to those who pursue courses in technical schools. It is different for those who offer technological courses like engineering at university since it is assumed that a university education and a degree are the apex of success for all academically intelligent students. According to Mamdani (2007: 1ff, this belief has created a rush by every household to get an academic degree, while universities have turned themselves into marketplaces churning out degrees irrespective of quality and labour demand. Crowley (1999: 22) calls this rush for degrees 'academic megalomania'. Since technical and vocational courses are the ones which may be financially affordable by the majority of the less wealthy and train most of the field-based technicians, then such perceptions that demean the competence of vocational graduates may, directly and indirectly, limit the supply of female technicians in the renewable energy sector.

5.3.5 Even Males in 'Feminine' Courses Suffer Backlash

Like females in the courses that are branded masculine, males who participate in courses dominated by girls also suffer some repercussions emanating from gendered beliefs. Although some girls who study in male-dominated courses may enjoy sympathy and respect from male colleagues (Blickenstaff, 2005: 384), the experience is different for males, at least going by the confessions of a male student, the only male student in a class of 46 students of the so-called

feminine course, secretarial studies. In addition to being disrespected and scorned, they are the last to get attention when the training facilities are limited.

For example, when the training facilities are limited, and there is a need for some sort of competition, it becomes difficult to compete with the girls. They tell me to improvise like a 'real man.' A real man is expected to find solutions to complex situations. Furthermore, sometimes ladies will gang up and start scorning you with comments like I cannot get married to the male secretary. Some girls think we who study the so-called female courses are not men enough.” #00:29:40-8# (Interview with Kahwa, a male student of secretarial studies).

According to the principal of one technical Institute, when boys discover that such contempt is too much, they change the course or abandon school and go to do other things. Similar situations befall male students in courses like nursing, catering and hotel management, hairdressing and tailoring, fashion and design. For instance, taking a study of the experiences of male nurses and male nursing students, Wang et al. (2011: 36) argue that such males suffer negative perceptions emanating from the method of student recruitment for the courses, gender biases in teaching and the social views that portray such males as not masculine enough. This ostracisation causes significant discomfort and psychological pressure. For example, in chapter 4 of this thesis, we already observed how, in 2021, the Ministry of Health in Uganda issued a decree that ordered all male midwives out of labour wards for no other reason but just because they were males (Bagala, 2021: 14). The experiences are not any different in other so-called feminine or sex-typed careers where males find it hard to gain acceptability and value which in turn may affect their self-efficacy in those fields (Broadbridge, 2008: 11-13; Jay & Lance, 2008: 279-280; Matsui et al., 1989: 1-4).

5.4 Not all is Gloom for Female Participants in Technical Courses.

The preceding discussions communicate a grey picture of the participation of women in the technical and STEM fields. However, the glass ceiling is gradually being broken, and in addition to the increasing numbers of women joining the sector, numerous opportunities and positive experiences abound for female participation in the industry. As observed from the field discussions highlighted, I reconstructed a few below.

5.4.1 An Increasing Number and Excellence of Females in STEM Courses and Careers

Despite the many years of history dominated by discourses that make it odd for women to penetrate technological education, the trajectory has immense potential to change and continues to change reasonably fast (Grosch et al., 2022: 1-30). Indeed, the numbers are increasing both

at the technical college level and universities and looking at the situation in the past few years, it is just a question of time before gender parity gaps in the STEM field progressively shrink, though the discursive barriers are still solid. The numbers are increasing not only in STEM courses but also in other courses and careers that were hitherto perceived as male domains. From as low as 0% in the past years, statistics show that the number is increasing steadily (Blickenstaff, 2005b: 370). For example, based on the enrolment list for Busitema University in Uganda for 2018, the number of females had risen to 31 % (402) of the total 1267 students admitted for STEM courses at degree and diploma levels (Watera, 2018: 50). Likewise, of the 82 students graduating with a Bachelor of Electrical Engineering in 2021 at Makerere University, 20 were female, representing 24% of the total (Makerere University, 2021: 106-107).

It was also revealed that once females join STEM subjects and related technical careers, they tend to be more active, and many perform better than males in the same cohort. According to one participant interviewed for this study who coordinated internships and examinations for faculty at a university, females, most of the time, academically score better than males, and secondly, become more active in practice in the field. This argument was corroborated by other staff members in different institutions. The reasons given were that whereas male students tend to take things for granted, females get more attentive, knowing they are being scrutinised and sometimes undermined by males in the group and even the wider society. This sentiment thus apparently makes them deploy all their energies to the tasks. The same applies to situations when they go for industrial training or internships. They adapt to the situation so fast and exhibit high commitment.

Moreover, to cultivate trust and to be given meaningful assignments in these technical male-dominated fields, they must work hard and prove impeccable capacity before being appreciated. For example, whenever females report for internships, the first impression from prospective supervisors is, “But what can this woman manage to do here?”. Because of such an attitude, they are only assigned simple tasks that do not require physical energy and skill, akin to being taken as auxiliary assistants. However, after a few days in the field, the determined females keep proving themselves and displaying their passion for learning and performing and, in the process, get more skilled. Once the employers or supervisors discover that the said females are capable and more competent, they treat them more seriously, appreciate them, and even allocate them more deserving assignments, which reportedly enable them to ascend the career ladder

faster than their male counterparts in the same cohort (Interview with principal MTB paragraph 16). In addition, a category of teachers exists who, unlike the prejudiced group discussed in the previous sections of this chapter, instead encourage females to pursue and stay in the science sector:

They tell female students that the modern world needs more sciences than humanities and that the sciences are profitable and well-paying in the job market. Therefore, girls who want to free themselves from financial reliance on their spouses need to do science (Natuhwera, female electrical technician in Uganda).

The discourses on whether modern society needs more natural sciences than humanities have raised vigorous academic and policy debates. Nevertheless, the government of Uganda, mainly through the current president, Yoweri Museveni, has also augmented this discourse by constantly praising the study of STEM courses while castigating arts and humanities as less relevant to development (Monitor, 2021: 6). To this effect, he issued a pronouncement in 2022, increasing salaries for science teachers by 400% and a 0% increase for arts teachers. The arts teachers laid down their tools in protest (Karugaba, 2022: 2; Sekanjako, 2023: 8). The effects of such discriminative treatment of teachers on the education students' educational outcomes need to be investigated further in other studies.

5.4.2 Special Consideration for Internship and Job Opportunities

Despite the hitherto-mentioned challenges faced by female students at the internship placement, it was revealed that getting accepted at the internship placement is relatively easier for females than males, mainly when the opportunities are limited. It was also revealed that though they are first overlooked during their initial days at the internship, but after the initial orientation and waning of fears, they are later appreciated and offered more practical guidance than their male counterparts. Moreover, it was reported that females tend to be quickly helped whenever there is a technical challenge. For example, while fixing a machine or setting up any other electrical equipment, a girl tends to have a higher chance of getting assistance in lifting or fixing because of the prevailing perception that females are physically weaker (Interview with principal MTB paragraph 24). However, in the end, those perceptions deliver some dividends in the workplace.

Similarly, other 'feminine dividends' ensue from higher employability probabilities of female graduates of engineering-related careers. This advantage is so, especially in institutions that promote gender balance and affirmative action in their employment practices and ring-fence a specific quota of jobs for men and women:

Then another advantage they get is access to jobs quickly. For instance, now I have got an order from Industrial Area, where they have told me to provide seven technicians for hire, and the requirement is that the number should be gender balanced. They need four welders, and they also want three electricians. So, all three girls in the second year of electrical engineering will automatically be taken. The boys will take the welding slots. So most of the time, since the girls are few, they always get absorbed easily since we usually get orders for technicians almost every end of the academic year. So, in terms of employment, girls get more chances. Then, even in class, the girls tend to be praised and treasured by colleagues because they are too few amidst a crowd of boys. So, they are treated like any scarce commodity in the market. #00:17:52-1#” (Interview with the principal of MTB Institute in Uganda, Paragraph 26).

Thus, since the number of women in such technical professions is always low compared to males, filling up the job quotas reserved for females becomes less competitive, unlike men who have to jostle for the fewer available slots in recruiting organisations and companies. It was reported that some female technicians and engineers get job offers or bookings before graduation due to their scarcity. Furthermore, because of the importance attached to these female employees, companies allow them to continue and upgrade their qualifications as they work. With these incentives in the job market, females get incentivised to join the technical and engineering fields.

Finally, seemingly trivial but locally significant is the comparatively higher opportunities available to the girls in the STEM sector to quickly get love relationships and marriage suitors compared to their colleagues in the humanities and other professions (FGD with females at MTB). Being in groups where their numbers are proportionally meagre and since, according to the principle of propinquity as evident in Sternberg’s Triangular theory of love (Anderson, 2016: 1-3), there is a high chance one is likely to get a marital suitor or get more attached to people in their immediate circles (Madey & Rodgers, 2009: 76-77). Therefore, the comparatively small numbers of females amidst larger male-dominated groups naturally make the competition for female mates higher (Clutton-Brock, 2007: 1882-1885).

Generally, the issue of marriage and relationships would appear less significant in this discussion. However, considering the local context in East Africa, where relationships and marriage are highly revered in discourse and practice and preferably at a younger age (Walker, 2012: 231-233), it follows that any field or space that gives men and women higher marriage opportunities and mates is likely to be considered a treasure.

5.5 Gendered Discourses in Textbooks and Curriculum and (probable) Implications

Analysing the gendered education outcomes in the renewable energy and technology sector can be better comprehended after examining the learning content the learners are subjected to for the more significant part of their formative years in school. The impact is well appreciated through systematically critically examining the textbook contents and, consequently, the curriculum. A systematic analysis of the teaching and learning materials reveals that they are packed with deeply gendered discourses, with the likelihood of inducing learners to form cognitive models that create dichotomies between masculine and feminine professions. Moreover, these perceptions are reinforced by the examples, names, terminologies, illustrations, drawings, quizzes and assignments contained within the textbooks and other instructional materials or literature.

For instance, an analysis of many primary school textbooks reveals that the names of great scientists, doctors and other technicians are majorly male; even if it is a story in an English lesson, it will most likely paint the characters for such science positions like a doctor or an engineer are all in the names of males. It is rare to find a female identity attached to such characters. So, young girls and boys consuming material from such books grow up knowing that these professions are the preserve of men, and this influences their career ambitions. Even those girls whose subject preferences were science-based subjects might be diverted to humanities and arts after interacting with such gendered academic material continuously for an extended period.

Illustrations are also often gendered; in most books, though at present they are changing, relatively most of the older books give illustrations that communicate gender stereotypes in professions. For example, if they are to provide an example of somebody constructing a house or doing any electrical installations, they put a picture of a male. When primary school children observe such illustrations dominating the book and construction being a science, they see construction with a masculine lens. Therefore, since gender is socially learned through a series of reoccurring discourses and practices that children experience as they undergo growth and development (Bem, 1981: 354; Lorber, 1995: 13-14; Scott, 1986: 1062), it follows that continuous exposure by learners to such material influences them to grow up forming perceptions that fields like construction and the related sciences are masculine, and other household chores, for instance, are exclusively feminine. So, the primary conditioning factors,

in this case, are the illustrations and names (feminine or masculine) assigned to characters in the textbooks, particularly if the teachers adopt the same biases in their classroom teaching.

However, some attempts, though still scarce and clumsy, are being undertaken to align the textbooks with gender-sensitive content. New books are reportedly aligned with modern trends to address gender justice in pedagogy since gender is a category that many institutions are encouraged to mainstream. According to Chapin & Warne (2020: 1), many institutions, though, try to demonstrate gender mainstreaming more in their literature than in actual practice, usually to appear to be fulfilling the conditions set by funding agencies and development partners. (Chapin & Warne, 2020: 8).

To guard against gender bias, the textbook teaching and learning media content should deliberately demonstrate that females and males can perform similar tasks and refrain from propagating the feminine-masculine dichotomy in academic media (Brugeilles & Cromer, 2009: 41-47). As per the Ministerial Policy Statement for the financial year 2022/23 for the Ministry of Education of the Republic of Uganda, the same objective is promoted by the National Curriculum Development Centre, which emphasises that materials published for curriculum purposes be approved by the curriculum development centre, and in the process of approval, gender sensitivity checks are carried out or are supposed to be conducted (Uganda Budget Information 2022: 111). However, not all reading literature that finds its way into the schools goes through the National Curriculum Development Centre, as a study by Hite and Carr (2006) established some of the school books bought from vendors on the streets or donated by other partners, both local and international supposedly to help education institutions in Africa (Hite & Carr, 2006: 1ff).

Thus, to comprehensively establish the gendered nature of the textbooks, this study sampled a set of textbooks for a deeper analysis. The textbooks were picked from the primary school curriculum, focusing on all four core subjects covered in Uganda's primary school curriculum, including mathematics, science, social studies, and literacy studies. At least a book for each class or grade was analysed, though not all four subjects were covered. The purpose was to have an insight into the gendered discourses (or lack thereof) that line the textbooks and other teaching materials and assess their capacity to influence the perceptions and, consequently, the subject choices and biases of the learners, especially at their formative level, which in most cases is primary school level (Cerbara et al., 2022: 1-4).

Initial revelations by teachers triggered this assessment that most of the textbooks used influenced the way learners thought about the gender division of careers. The findings from the textbook analysis were indeed affirmative, and the proceeding table shows a summarised sample of gendered observations (illustrations, pictures, language, assignments) as they are in selected textbooks with a column on implications for discourse formation. The matrix presents observations from only four of the analysed textbooks. Then after the table, a further detailed assessment of the nature of the discourses created or reinforced by the contents of the textbooks is discussed further.

5.5.1 Mapping Discourses: Textbook Analysis Matrix

Textbook 1: Social Studies: Pupils Book 4 - Good Luck Publishers Limited, First Edition 2018			
Page No.	Subject	Observations (Gendered Statements/texts/Illustrations in the book)	Implications for discourse /stereotype formation and reinforcement
4	Finding directions in the area with the help of others. (Illustrations /pictures of the city map	-All the characters taking children to school are females. -Characters entering public transport are males and females	Feminising childcare work
24-25	Pictures showing activities on the River Nile	Pictures: All the characters engaged in fishing are men (figure 2.8)	Reinforcements of beliefs that fishing is a masculine trade. Indeed, in the field interviews on Lake Victoria, participants expressed that it is taboo for women to sit in fishing boats.
		-Six out of the eight characters in the tourism on Lake Bunyonyi are males (fig.2.9) -7 out of 9 rafters are males. The captain is also male. The driver of the tour van is a male.	-Masculinising the rafting sport and similar sporting activities. -Driving is masculine and less feminine. (similar discourses were observed in field interviews as observed in chapter 4)
30-31	Picture of women engaged in Terrace farming (environmental conservation)	-All the characters in the picture are women. -One woman is nursing a child as she digs (fig 2.16).	-Farm and gardening work is for women -Childcare work is feminine
		-On the next page, a truck collecting waste for disposal is full of males alone.	-‘Dirty’ physical jobs are masculine.
39	Pictures illustrating economic activities in the rural community	-Coffee harvesting where all characters are men -Tea harvesting by a mixture of men and women -Sugar cane harvesting being done by males -Banana harvesting by males	-Whereas women do most of the digging and care for crops, harvesting and appropriating the proceeds is for men. -Market vending of foodstuffs is (discursively) a feminine activity

		-Irish potatoes market showing three male 14 female vendors	
40	Two pictures juxtaposed against each other	-Furniture making in the carpentry workshop- all participants are males, against another picture of three women carrying firewood in the adjacent area.	-The carpentry profession is exclusive to men. -Firewood collection, cooking and related reproductive work are feminine.
42,45	Picture of grassland use	-The character grazing animals is a male. On page 45, another male is also grazing cows (on the subject of overgrazing)	-Animal grazing is masculine work.
48	Two pictures of caring for vegetation juxtaposed against each other	-All the characters involved in irrigation (with appropriate technology) are male. -A woman is making a manual application of manure.	-Technology-related work is masculine. -Women have less to do with advancements in technology.
56	The story about the origins of the Bagisu people	-When the Masai stole the cows of Masaba, Mwambu and the brothers followed them up heroically and rescued the cows in addition to other gifts.	-Boys as grazers, cattle keepers, brave, heroes and other masculine markers
56	The Story of Gipiir and Labongo (Luo Migration)	-The story mentions Olum, the father, and the son, but there is no mention of the mother or daughters' names. -The boys were powerful and brave Gipiir used the brother's spear to spear at the elephant. -When Gipiir went to the forest to look for the spear, he met Lubanga (female), the spirit that used to guard the elephants in the forest. She was sympathetic and gave him back the spear and some beads (so sympathetic indeed). -Labongo's daughter was playing with the bead and accidentally swallowed it. On Gippiir's insistence, the girl had to be killed and split open, and the bead recovered.	-Males as powerful, brave and controlling, therefore hegemonic masculinities -Females are portrayed as sympathetic, compassionate and generous, but males have less sympathy -Girls as dispensable (had to be split to recover the bead) -Girls as lovers of jewellery -Girls as less careful
66	Picture	-Woman selling tomatoes on the stall	-Market vending of foodstuffs as a feminine activity
67	Employment	-Two men are connecting some cables in the industry. One looks to be having a supervisory role.	-Electricity work and profession as a masculine job
68-71	Types of work people do	-Women carrying silverfish	-Petty trade in foodstuffs is a feminine job. Indeed, the silverfish business was reserved for women at the landing site communities we visited.
		-One woman attending to a cabbage garden	-Crop farming is feminine
		-Man doing bricklaying work.	-Construction-related work is for males.
		-A young lady working as a secretary in an office, sitting in front of a computer, typing and answering a telephone call with a broad smile.	-Feminising front desk office and secretarial jobs, while the telephone and broad smile reinforce discourses that women are good at customer care and sales

76-77	Social activities in the community	-Picture of a traditional marriage ceremony with women dressed in a <i>gomesi</i> kneeling in front of two men (possibly greeting them) The men are dressed in <i>Kanzu</i> Wedding function where women are sitting on one side, men on the other side (neutral)	-Reinforcing discourses that women are supposed to kneel and 'to sit properly' but men should not bother -Discourses on 'appropriate dressing' between females and males
		<i>Imbalu</i> (male circumcision rites) in Mbale district, done to initiate boys into adulthood	-Circumcision rite done to young boys purportedly to usher them into manhood and to make them real men. This ritual reinforces hegemonic masculinities.
90-92	Workers in the district	-Picture of Nurses attending to a patient (8 females and one male nurse)	-Reinforcing discourses that Nursing and midwifery are feminine professions
		-The male Chief Magistrate (p.91) -Police arresting a suspect; all the seven police officers are male, and the suspect being arrested is also male (p. 92)	-Law enforcement is a masculine job -Males exhibit more criminal behaviour than females
		-All the over 100 worshippers praying in a mosque are males (p. 95)	-The continued marginalisation of the role of women in some religions
100	Leadership	-All the six pictures of leaders (kings) displayed on the page are males, and they go ahead to indicate that this leadership is inherited from the fathers.	-Leadership, hereditary or elected, as a masculine role.
104		-Picture of leaders in a meeting discussing problems affecting society: A man addressing the participants on a microphone while the two women in the meeting are looking on.	-Decision-making and community leadership are a preserve of males. -Women as not suitable for public speaking
106	Human rights (Right to rest and leisure)	-People (boys) playing football	-Creation or reinforcement of gender differences in sports preferences
111	Helping and caring for the needy	-In the text, women are listed among children, refugees, orphans, sick, poor, older adults, and prisoners as people who are in need and thus deserve help and special care in the community.	-Painting the female gender as a vulnerable category
116	Education services	-All six members of the academic procession during the graduation ceremony are males.	-Men as better academic achievers and academic managers than women.
118	Security services	-Picture of 6 police officers (all males) apprehending a suspected criminal (who is also male) Soldiers/army guarding the country and all males.	-Security work, law enforcement, and military work as masculine -The constant display of male suspects reinforces the discourse that 'criminality has a male face.' (Edlund et al., 2008: 1ff).
122	Water transport	-Picture of a boat on Lake Victoria with occupants, but whereas the occupants are of mixed gender, the captain is a male.	-Technology-related work, like operating a boat, is a masculine job.
125	Electricity services	-The picture of a child (male) switching on the power	Electricity-related jobs are masculine

128-129	Communication services	-Whereas the picture for people using mobile phones shows a man and woman, the one for a radio presenter is a female	-Females are better at communication services.
132-134	Teachers and doctors (pictures)	-A female teacher in class -The doctor treating a patient is male -Nurse whose role is indicated as a helper is female	-Gender division of roles and professions following the common stereotypes
		-Veterinary doctors treating an animal. Two females and one male	-A fair example of gender-sensitive teaching content
134	Police officers	-Three traffic officers, all male -Two (male) police officers working with police dogs	-Security work and law enforcement are masculine professions
136	Carpenters	-Picture of a male operating a carpentry workshop	-Carpentry and technology-related work is masculine
188	Army officers	-Two pictures of army officers, one on parade and the other for soldiers doing community work. All males with no single female	-Masculinising military and security service work
144	Attitudes towards work	-A picture of youth demonstrators carrying a banner with the caption “National Association of the Unemployed”, with one female out of the nine visible members	-Linking violence to masculinity -Men need jobs and money more than females
145	Creating employment opportunities for youths	-Picture of two males engaged in brick-making -Shoe repairing work by male	-Masculinising particular trades and professions
148	Provision of medical services	-Pictures of Nurses training at Mulago Hospital with only one male out of 13 trainees	-Feminising the nursing profession
156	Provision of security	-The boss addresses four security guards. All the guards are male, and the boss is also male.	Masculinising security/guarding work

Text Book 2: Fountain Primary Mathematics: Pupils Book 6 by R. Kavuma and E.A Karuhije 2017 Edition

43	Operation on whole numbers	-The principal of a National Teachers’ College bought 1450 kg of flour in Term 1, 2007 kg, and 1549kg of flour in Term 3 of the same year. How much did he (male) buy during that period?	-Institutional headship is a preserve of males.
46	The Lattice method of multiplication	-A trader has two dozen boxes of bar soap. In each box, there are 24 bars of soap. He sells each bar at Shs 2,400. How much money will he (male) get from the two boxes of soap?	-Large-scale trade, unlike petty market vending, is for males.
105	Sharing ratios	-When a man died, he left 2 sons, Waiswa and Tenywa, as well as 210ha of land. If the sons shared the land in the ratio of 3:4, respectively, how many hectares did each son get?	- Reference to a man and sons only may imply that property inheritance and land ownership are for males. -Females have diminished rights to inheritance and land ownership.
112-113	Problems involving profit and loss	-If Joseph Nganda buys a pair of trousers at shs 25,000 and sells it at 35,000, what profit has he made?	-Reference to “he” creates the impression that trousers are meant for males.

		-Katende sold 5 sets of chairs to Namasagali University for 85,000 each. Katende had made them in his workshop at 65,000 each. How much profit did he make?	-Carpentry and workshop-related business enterprises are for males.
		-Mbogo sold his piece of land in Kololo.....	-Insistence on “he” reinforces the discourse that land ownership is a preserve for males.
117	Problems involving simple interest	-Mr Male bought a motorcycle at shs 2,400,000. He sold it to Daudi at a profit of 20%. Daudi also sold it to Jimmy at a loss of 10%. How much money did Jimmy pay for the motorcycle?	-Motorcycle riding and ownership is for males. -Trade and wealth creation are masculine roles.
131	Mean, Median, Mode, and Range	-Aguti (female) scored 80 marks in English and 28 in Maths. To calculate the average mark.	-The act of Aguti (a female) scoring 80 marks in English but a paltry 28 may feed into the local discourse that girls are generally poor in Mathematics and good in English. (Why is there such poor performance in mathematics?)
146	Exchange rates	-Dr Carlington, who was in Washington (USA), sent US\$ 90 to Doreen Arac of Kitgum. On the same day, she received 40 pounds from her sister in London. How much Uganda shillings did Doreen get from a Foreign Exchange Bureau in Uganda if she exchanged all the two currencies?	-The use of the male name (Carlington) reinforces the discourses that medical doctors are males. -Reinforces an everyday discourse in East Africa that women are supposed to receive money from men and not vice-versa.
147	Exchange rates	-A businessman took US\$ 200 to the Bank of Uganda. He wanted to change these dollars to Ush (1\$=Ush 1760). How much money did he get?	-Vocabulary like “businessman” reinforces the stereotype that business is for men and women are for reproductive chores.
178	Capacity in millilitres	-Kizito gave Athieno 60ml of medicine. Athieno is supposed to take 15 ml of medicine per day. For how many days will Athieno take her medicine?	Kizito (male) prescribing medicine reinforces stereotypes that doctors are males.
197	Pythagoras’ theorem and its use	-Mukasa wanted to climb a wall that was being constructed. He used a ladder 10m long. He used the ladder, touching precisely the top of the wall 6m away from the wall at ground level. What was the height of the wall?	Mukasa (a male) climbing is an example that reinforces discourses that climbing is a preserve of males.
General observation in the textbook: Despite the use of a few female characters, most of the characters used in the textbook for examples, questions, and illustrations are males.			
Text Book 3: A New MK Primary Mathematics 2000, Book four: By Kigundu Mukasa Daniel et al. 2002: Second Edition			
40-41	Operation on numbers	-A boy counted 268 cars on Monday and 454 cars the next day. How many cars did he count in the two days?	-Things to do with cars and machines are for males. -The consistent association of counting with males may imply mathematics is masculine.

		<p>-Matovu had 875 ewes, 400 rams, and 175 lambs. How many sheep does he have altogether?</p> <p>-A farmer had 1475 cows and 425 bulls. She later bought 867 cows. How many heads of cattle does she have altogether?</p>	-The two numbers provide a gender-balanced approach to teaching Mathematics and farming.
55-56		<p>-A man used sh.96 to buy dresses for his 4 children. What was the cost of each dress?</p> <p>-A father shared 4500 shillings among his 5 children. How much did each get?</p>	-Men as providers and breadwinners for the family
62	Number patterns and sequence	-Nkangi and Agaba were given these two numbers, 91758 and 24687, from which to choose an Even Number. Help them to find the even number.	-Both <i>Nkangi</i> and <i>Agaba</i> are male names in Uganda. Therefore, the question reinforces the discourse that mathematics or calculus only suits males.
78	Test	-Mukawe got 136 votes from one village and 90 votes from another. How many votes did he get all together?	-That leadership and politics are a preserve of males.
104	Fractions	-Benna sold 0.3 of her land last year and sold another 0.4 of the same land at the beginning of this year. What is the total piece of land sold?	-Such a question helps to challenge the dominant discourse that women do not own land.
105	Fractions	<p>-Nabitosi bought 2.5 metres of ribbon. Agiyo bought 1.5 metres. What length of ribbon do they have altogether?</p> <p>-A boda-boda motorcyclist bought 2.5 litres of petrol and put it in a fuel tank. After riding for some distance, he bought another 1.5 litres. How much petrol did he buy altogether?</p>	<p>-Both Nabitosi and Agiyo are female. Therefore, the question reinforces the discourse that fashion and design are feminine fields.</p> <p>-Bodaboda (motorcycle taxi) is a job for males. Indeed, few women who attempt to join the boda boda business are marvelled at or treated with cynicism (Irakunda, 2024: 1).</p>
111	Fractions	-Mbabazi had 3.5 metres of cloth. She cut off 1.8 metres. What length of the cloth was left?	-Femininising fashion and design professions
		-A boy cycles 6.2km from his home to school. If he cycles 4.7km and rests. How many km remain?	-Masculinising bicycle riding, something that is common in communities where this research was conducted
114	Test	-A boy played football for $2\frac{1}{4}$ hours and went to sleep for $1\frac{3}{4}$ hours. How much time did he use altogether?	-Soccer as a preserve of males
121	Graphs and Interpretation of Data	-A schoolboy recorded the number of motorcycles that passed by his home in one week. The table and questions follow.....	<p>-Counting and Mathematics as a masculine task</p> <p>-Boys should have more interest in motorcycles and machines than girls</p>
154	Measures (Money)	-A milkman supplies 7 schools with 847 litres. How much milk does each school receive? (An attached picture with a man on a bicycle delivering milk to a woman)	-Words like ‘milkman’ and the picture of a man on a bicycle delivering milk reinforce the myth that milking is a preserve of males

157	Measures (Money)	-Dr Ludigido bought a tin of Panadol at shs. 12,000 and sold it at sh.9500. What was his loss?	-Consistent association of doctors with males masculinises the medical profession.
167	Measures (Time):	-A cyclist rode for 5 hours 30 minutes from Ibanda to Isingiro and 2 hours 35 minutes from Isingiro to Mbarara. How long did he ride?	-Association of cycling with males
		-Angella cooked beans for 3 hours 15 minutes and meat for 1 hour 45 minutes. How much time did she spend cooking? There is a corresponding picture of a young girl cooking on a firestone while kneeling (Keen interest in the significance of kneeling)	-Association of cooking and other kitchen work with femininity. -Kneeling is perceived as a sign of appropriate femininity. Indeed, in central Uganda, women are expected to kneel while preparing and serving food. Preparing the food while sitting or squatting is tantamount to poor grooming and lack of manners (Karungi, 2016: 1).
170		-A housekeeper took 7 hours and 32 minutes to do her housework. If she spent 5 hours and 40 minutes washing, how long did she take to do the rest of the work?	-Housekeeping and reproductive work as a preserve of females
		-Mr Kamuli spent 4 weeks 3 days fixing the roof of his house and 1 week, 5 days painting it. How long did all this take?	-Construction and related technical work as a preserve of males
192	Measures (Length)	Picture of two pupils measuring distance at school with a tape measure. Both are males	-Reflecting technical work is suitable for males only
222	Measures (Capacity)	-Two boys climbing a water tank to pour water there. A girl is waiting down.	-Males are allowed to climb, and females are not.
237	Measures (Temperature)	-Picture of a man/ boy checking the car's engine temperature.	-Mechanical work is a field for males.
241	Body temperature	-Dr Muzito recorded the temperature of a patient every after 2 hours. He later made the graph below.... -A picture of a doctor (male) attending to a patient	-That medical doctors are supposed to be males
259	Algebra	-8 herdsmen took the same number of cows to graze. Altogether, they took 80 cows. How many cows did each graze?	-Vocabulary like 'herdsmen' already places cattle herding under men with no role for women
260		-The headmaster bought some books. He distributed them equally to 7 classes, and each class got 6 books. How many books did he buy?	-Terms like 'Headmaster' reinforce discourses that school headship is supposed to be for males.
		-The textbook at the bottom of every page has a picture of a young boy with the caption "Think". This is followed by some numbers to memorize or reflect.	-Males should be intelligent, and more so in Mathematics.
Textbook 4: Fountain Integrated Primary Science, Pupils Book 5: By Sam Mugisha, Rose Nalunga, Richard Kavuma, Harriet Nantamu, Harriet Mudondo, David Nkulabwire, 2003- Fountain Publishers.			
47	Biological, Physical, and Chemical changes in the environment	-A picture of two women washing and drying clothes on the drying line. A few metres away, a man is seated and resting under a tree	-Categorisation of washing and other household work as feminine. -Men are not supposed to do household work.

60	Keeping goats, sheep, and pigs	-Picture of man shearing sheep	-Animal rearing as a preserve for males
96	Heat Energy	-Picture of a woman ironing clothes using charcoal pressing ironing box	-Association of household work with femininity.
125	Community Health	-Three pictures, a girl washing clothes in a basin, a young boy bathing, and a woman-mother cooking food	-Categorisation of reproductive chores as feminine
155	Immunization	Two pictures, one with a male doctor vaccinating a baby against Diptheria and another with a female doctor vaccinating a baby against Tuberculosis	-An excellent example of gender sensitivity in teaching health science
203	Bacteria and Fungi	A picture of a man using a microscope to observe bacteria and other organisms.	-Advancements in modern technology are associated with males.
209	Prominent scientists in the Bacteria and Fungi/ vaccines field	-Alexander Fleming discovered Penicillin to stop the growth of the fungus penicillium -Edward Jenner, an English doctor, discovered the vaccine against smallpox. -Louis Pasteur, a French scientist, discovered a method of preserving milk. He also discovered the vaccine against Anthrax and rabies. -Howard Florey improved on the performance of Penicillin.	-Listing several prominent scientists without mentioning a single female reinforces the discourse that females are unsuitable for science or other technological breakthroughs.
222	Health and Social problems	-Picture of sick people with the caption "sick people need love and care". A woman attending to a sick man -Two other pictures of a woman caring bathing, and then feeding a baby	-The feminisation of care work

From the summary of the observations in the table, some themes reinvigorating the existing gender discourses in schools and the community can be observed. As argued before, repetitive consumption of these messages by the learners may cement the discourses in the learners' 'knowledges' and practices (Fournier-Tombs, 2023: 131-136). Selected few are discussed further below.

5.5.2 The Feminisation of Characters, Roles, Trades and Professions

The different texts and illustrations in the different books, as observed in the summarised matrix, consistently portray activities and examples based on the dominant discourse about the roles meant for women and men in society. I will use examples based on the different topics and pages in the books and as highlighted in the matrix. For instance, in a picture in textbook one on page 90, there is a topic about *workers in the district*; a nurse is attending to a patient. In another picture showing a group of nurses, 8 are females, and one is male. On page 132, under the topic of *teachers and doctors*, there is another picture of a nurse helping a patient; the nurse is still female, while the patient is male. The doctor in the same picture is male. In the

same book, under the topic of *types of work people do*, there is a picture of women carrying silver fish, a young lady selling merchandise in a craft shop, and a young woman working as a copy typist/secretary in an office while sitting in a front office typing work on a computer while answering a telephone call with a broad smile- wide smile emphasised. Comparatively, on the next page, under the subtitle *Communication services*, there is another picture of a man and woman using mobile phones; the picture on the opposite side shows a female radio presenter. In the same textbook, under the subtitle; '*Provision of medical services*,' a picture of nurses undergoing training is displayed, and as expected of the typical stereotypes, of the 13 trainees in the picture, only one is male while the rest are all females. The point here is that the books play into and reverberate well with the common discourses associated with the gender division of roles and professions, for instance, the stereotype that the nursing profession is a preserve of women with minimal reference to the role of male nurses (Kaur et al., 2023: 157).

The same stereotypes of feminising some roles and professions transcend and go to subjects like mathematics. For example, two sample questions are analysed: one mathematics textbook for primary six under the subheading, *working with decimals* (Textbook two, page 105) and *fractions* (page 111). One goes as follows: "Nabitosi (female name in Uganda) bought 2.5 metres of ribbon. Agiyo bought 1.5 metres. What length of ribbon do they have altogether"? Then, another question on fractions goes, "Mbabazi (female name in western Uganda) had 3.5 metres of cloth. She cut off 1.5 metres. What length of cloth does she remain with?" Throughout other textbooks, most tailors are given feminine names, and such presentation may reinforce the belief that tailoring work is meant for females. Though taught in mathematics, such questions conform to the discourses that females better manage fashion design as a profession or hobby (Stokes, 2015: 219-224).

The above description may appear innocent, regular, and value-free to a non-critical observer, but it is likely motivated by the authors' stereotypical beliefs. Indeed, most of the content reviewed conforms to the popular discourses about the roles and professions socially allocated to women and men in society. Moreover, as Young (2010: 1ff) concurs, when children keep reading these materials, they tend to get indoctrinated into developing perceptions that create such gendered dichotomies within particular tasks and professions. For instance, as seen in the previous paragraphs, all nurses are portrayed as women, selling crafts and small merchandise like silverfish, tailoring secretarial work, and other front desk work, all believed to be 'feminine tasks'. Displaying a wide smile for a lady answering a phone call also plays into the common

gendered discourse that women are supposed to be joyful, which makes them more feminine and thus appropriate for front desk jobs, while it is tolerable for males not to show warmth while attending to clients (Seo, 2022: 1).

5.5.3 Gendering Roles- Masculinisation of Tasks and Professions

Parallel to the above, the textbooks reproduce discourses on feminine and masculine roles as popularly held by society. As I highlighted in the previous section, where all nurses were female, all pictures depicting a doctor show male characters. Leaving pictures aside, even the narratives in the mathematics textbook conform to the same stereotype that the medical profession is exclusive to males. I will pick three mathematical questions from the exact textbook (textbook three) for further assessment;

Lesson on exchange rates

“Dr Carlington (*male*), who was in Washington (USA), sent US\$ 90 to Doreen Arac of Kitgum. On the same day, she received 40 pounds from her sister in London. How much Uganda shillings did Doreen get from a Foreign Exchange Bureau in Uganda if she exchanged all the two currencies? (Textbook analysis, Paragraph 149 - 151).

Lesson on measurements (Capacity in millilitres)

Dr. Kizito (*male*) gave Athieno 60ml of medicine. Athieno is supposed to take 15 ml of medicine per day. For how many days will Athieno take her medicine? (Textbook analysis, Paragraph 155 - 157)

Lesson on Measures (Money)

Dr Ludigido (*male*) bought a tin of Panadol at shs. 12,000 and sold it at sh.9500. What was his loss?” (Textbook analysis, Paragraph 200 – 20)

From the above three numbers, it can be observed that all the three doctors mentioned are males and are conducting business with female clients. Nowhere within the textbook reviewed did I see females being addressed as medical doctors. In the medical field, according to the textbooks in question, females are relegated to either being nurses or clients. The implication is that such narratives help compound the learners’ and societal beliefs that medicine and science are masculine fields (Nye, 1997: 60).

Similarly, the social studies textbook (Textbook one) shows a picture of a magistrate (*male*) on page 91. There is also a picture of police personnel arresting a suspect, and, unsurprisingly, all seven police officers in the picture are male, and the suspect being arrested is also male (p. 92). Additional images show the army providing guard services, other police officers directing

police dogs, and the traffic police officers apprehending a driver (male) who seems to have defaulted road use regulations. All those pictures reinforce the widespread belief that law-enforcement and other professions requiring stern action are for males (DeLisi, 2005).

In addition, as per the pictures and texts in the textbooks, most of the technology-related work and professions are attributed to males, compounding the discourse that technology adoption is quicker in males than females (Venkatesh et al., 2000: 1,40,50). For instance, all the characters involved in irrigation, a technical-related activity, are males. In the same picture, there is a woman manually applying fertilisers, depicting her and women as not conversant with modern technological labour, while in another illustration (on page 67), men are fixing electric cables in the industry. Other technical-related pictures observed in books include men doing bricklaying work and a picture of a man operating a motor boat on Lake Victoria (the passengers are a mixture of males and females, but the captain is a male). Likewise, all pictures representing carpentry work include males only with no females. These illustrations reinforce discourses concerning local beliefs on masculine roles and professions.

Of all the textbooks examined, mathematics tended to hold more gender-biased narratives, and its use of long sentences also carries messages with a high potential to influence learners' perceptions about the masculinisation of technical or related work. Different topics were considered in the textbooks, but each topic in the textbooks had several narratives that promoted gender subjectivities. I illustrate this with examples of narratives from assignment questions for a few selected topics in mathematics.

Topic: *Problems involving simple interest*

Question: Mr Male (*male*) bought a motorcycle at shs 2,400,000. He sold it to Daudi at a profit of 20%. Daudi also sold it to Jimmy at a loss of 10%. How much money did Jimmy pay for the motorcycle?" (Textbook analysis, Paragraph 143 - 144)

Topic: *Pythagoras theorem and its use*

Mr Mukasa (*male*) wanted to climb a wall that was being constructed. He used a ladder 10m long. He used the ladder, touching precisely the top of the wall 6m away from the wall at ground level. What was the height of the wall?" (Text Book analysis, Paragraph 158 - 159)

Topic: *Operation on numbers*

Question 1: A boy counted 268 cars on Monday and 454 cars the next day. How many cars did he count in the two days?" (Textbook analysis, Paragraph 163 - 164)

Question 2: “A boda-boda motorcyclist bought 2.5 litres of petrol and put it in a fuel tank. After riding for some distance, he bought another 1.5 litres. How much petrol did he buy altogether?” (Text Book Analysis, Paragraph 184)

Question 3: “A boy cycles 6.2km from his home to school. If he cycles 4.7km and rests. How many km remain?” (Textbook analysis, Paragraph 189)

Topic: “*Graphs and Interpretation of data*”

Question: A schoolboy recorded the number of motorcycles that passed by his home in one week. The table and questions follow...” (Textbook analysis, Paragraph 194 - 195)

Topic “*Measures (Time)*”:

Question: A cyclist (*male*) rode for 5 hours 30 minutes from Ibanda to Isingiro and 2 hours 35 minutes from Isingiro to Mbarara. How long did he ride?” (Textbook analysis, Paragraph 203 - 204)

“Mr Kamuli (*male*) spent 4 weeks, 3 days fixing the roof of his house and 1 week, 5 days painting it. How long did all this take?

Topic: *Measures- Length*

Illustration: Picture of two pupils (*males*) measuring distance at school with a tape measure” (Textbook analysis, Paragraph 208 - 211)

All the above narratives and pictures would not be a problem if we had a few similar questions with female characters. However, it was impossible to find similar questions with female characters. Such narratives reinforce the discourse that technology activities like buying and riding a motorcycle/bodaboda, climbing walls, cycling and driving cars are only for boys and men. These narratives keep alienating female learners from appreciating the fact that they can also participate in technology. For example, instead of using two boys in the picture to do tape measurements, if female pupils had done it or a male and a female, then neutrality would have been promoted, but this was never the case. Alternatively, examples involving riding and climbing could have had a mixture of males and females. Even simple activities like counting cars on the road are attributed to boys. These are not value-free narratives. It has to be recalled that one of the factors that hinder women’s participation in electrical engineering professions, as observed in previous sections, is that it involves climbing, a practice that females in central Uganda consider an abomination. Textbooks would have worked to change these stereotypes if, for example, the authors had shown a few pictures or examples of women climbing or buying boda bodas; possibly, the impact on stereotype formation would have been different.

Finally, in the science textbook (Textbook 4) for primary six on the topic of *Bacteria and Fungi* (page 203), there is a list of what they refer to as ‘Prominent scientists in the Bacteria and Fungi/vaccines field;’ all of them are males, without mention of any females. They include Alexander Fleming, presented as a doctor “who discovered Penicillin to stop the growth of the fungus penicillium”; Edward Jenner, as an English doctor who discovered the vaccine against smallpox then; Louis Pasteur, a French scientist who reportedly discovered a method of preserving milk-pasteurisation and at the same time discovered the vaccine against Anthrax and rabies, and Howard Florey who reportedly improved on the performance of Penicillin²¹.

These scientists made the above discoveries and deserve credit, but maintaining such material in the textbooks year after year without including similar scientific discoveries made by females in science hides females’ technological innovations and perhaps demoralises females from believing that they can also make great strides in science and technology, as every example promotes the role of men. Furthermore, since this material is taught in primary school, it may teach young boys and girls that science and technology are no-go zones for females.

Another field in the textbooks where males are stereotyped concerns narratives communicating managerial and leadership positions. In the books reviewed, six pictures discussing the subject of leadership were seen. Moreover, all six pictures exclusively include men without the involvement of women. For example, in one of the pictures (Textbook 1, page 116), a man was shown with a microphone addressing a large group of women who looked subdued listening. Another picture (Textbook 1 page 104) shows members of a university’s academic procession heading for a graduation ceremony, all of the entourage members being male with no single female²². Apart from pictures, even narratives, especially in mathematics, contain statements that may bias the learners to develop perceptions that leadership is a preserve of males. I show two assignment questions from a mathematics textbook among the many statements.

“The principal of a National Teachers’ College bought 1450Kg of flour in Term 1, 2007 kg and 1549kg of flour in Term 3 of the same year. How much did he buy during that period?”
(Textbook Analysis, Paragraph 129 - 130)

²¹ Fountain Integrated Primary Science- Pupils Book 5: By Sam Mugisha, Rose Nalunga, Richard Kavuma, Harriet Nantaumu, David Nkulabwile, 2003- Kampala, Fountain Publishers.

²² Social Studies Pupils Book 4. Good luck publishers limited, First edition, 2018, p. 116

and then;

“The headmaster bought some books. He distributed them equally to 7 classes, and each class got 6 books. How many books did he buy?” (Text Book Analysis, Paragraph 226).

From the above two statements, if the author had decided to be gender neutral by mixing “he” and “she” for different statements or avoiding the use of pronouns altogether, it would have aided in avoiding the entrenchment of the gendered discourses in the academic environment. However, the constant use of the pronoun “*he*” for the school principal and headmaster may teach pupils that leadership roles at school and the community are meant or better done by men.

5.5.4 Characterisation of Men and Women with Traits that Imitate Popular Discourse

Within the textbooks, men and women are assigned character traits and markers that conform to the popular discourses within society. This artificial characterisation helps to ensconce the existing beliefs and stereotypes. For instance, whereas men are assigned character markers like brevity, intelligence, toughness, and other attributes that compound hegemonic masculinities, women are assigned characteristics that border with inferiority and extension of feminine stereotypes like being sympathetic, caring, forgetful, and vulnerable. Like the preceding discussions, most of this characterisation is propagated through the books' narratives, statements, and stories.

In one of the social studies textbooks (Textbook 1) under the topic “*Luo migration*” (the ethnic group that currently occupies the larger part of Northern Uganda and parts of Kenya), a folk story is narrated where two brothers, Gipiir and Labong, sons of Olum had a severe disagreement. (Their mother is neither mentioned nor does the story mention sisters). In the narration, Gipiir used his brother’s spear to go hunting in the forest and used it to spear the elephant (a sign of brevity), but unfortunately, the elephant disappeared with the spear. When Gipiir returned home without the spear, his brother Labong was bitter and strictly demanded his spear back. Out of anguish, Gipiir decided to go back to the forest to search for the missing spear, and on his way, he met Lubanga, a (female) spirit that used to guard the elephants in the forest. She was sympathetic, gave the spear back to Gipiir, and added some beads to him (discourses of female sympathy?)

Consequently, Gipiir returned the spear to the owner, Labong, and the matter of the missing spear was resolved. However, after a few days, Labong’s daughter played with the beads that Gipiir had brought and accidentally swallowed one bead. Gipiir vehemently demanded his bead

back out of vengeance since Labong had also done the same when the spear was lost. Finally, with no other options, the girl's stomach was split, and the bead was recovered from her stomach. Because of this bitter conflict, the two brothers parted ways; one group moved to the East of the River Nile, and the other group headed to the West of the Nile, where they (according to folk tales) still inhabit today.

Examining the above story as taught to students annually reveals profound discourses and characterisations of men and women with different stereotypes. For example, men are presented as brave and aggressive, possessing power, but are also merciless (markers of hypermasculinity). On the other hand, Lubanga giving back the spear and donating her beads to Gipiir, a stranger, portrays someone sympathetic, merciful, and a peacemaker willing to forgive those who had transgressed against her territory; attributes that are discursively presented to denote true feminine character. It is not uncommon to find local and international discourse referring to women as peacemakers (Cohn et al., 2004: 130-131), though some scholars on conflict studies drawing from feminist theory question this belief by arguing that females, especially after attaining leadership are motivated to perform gender by invoking their toughness and capability through initiating conflicts as means of gaining and maintaining status in elite policy groups; hence the moniker "Iron Ladies" (Schramm & Stark, 2020: 515-516). Regrettably, the fact that the girl accidentally swallowed a bead may portray women as forgetful and perhaps less careful.

The fact that the curriculum is full of such folk tales taught to young learners annually does not leave them free; instead, they get indoctrinated and espouse such beliefs and stereotypes against gender identities and roles (Sovič & Hus, 2015: 495), especially where a teacher doesn't carefully come out to inform learners to deconstruct the stereotypes in those messages. In addition, males are characterised as intelligent and thoughtful, as displayed in one of the mathematics textbooks (Textbook 2). Every page footer of this textbook has a picture of a young boy facing upwards with the caption "think," followed by a series of numbers ostensibly to memorise or reflect on. Does this portend that girls do not or should not think or that mathematics concerns them less? The concern here is that irrespective of the author's intentions, such an illustration may send a solid communication to readers that disorients or orients the learners' perceptions about mathematics and masculinity. Women are also categorised as vulnerable victims. In one of the social studies textbooks (Textbook 1), under the topic, "*Helping and caring for the needy*," women are listed among children, refugees, orphans, sick,

poor, old age, and prisoners as categories of people who are needy and thus deserve “help and care in the community.” Whereas it is easy to understand why, for instance, children or the sick are needy and deserve specific help, it is unclear why women keep appearing among the categories of vulnerable people in literature.

Consequently, such narratives about women’s vulnerability have found much space in international discourse in humanitarian discourse (Zieliński, 2019: 1). For instance, it is not uncommon when, after an occurrence of a disaster, media reporters or humanitarian agencies report that the disaster has affected such and such number of women and children without mention of men. Women and children (as well as men) are indeed affected whenever disasters occur. However, the consistent selective reporting on women and children when reporting about victims, minus mentioning men, signals that men are indomitable and less susceptible to misfortunes or abuse (Coralie, 2016: 333), a presentation that leans towards hegemonic masculinities. This consistent branding of women as vulnerable victims could scare them away from venturing into the academic and career territories discursively regarded as complex, like energy and other technology or STEM-related careers.

Other discourses exhibited in the textbooks that created a gendered division of labour and gendered roles include assigning reproductive roles to women. For example, in the illustrations, all characters escorting children to school are female, with pictures of women cooking, washing, collecting firewood, sweeping, and cleaning the house, while mathematics questions use female names when referring to activities like cooking. Likewise, men feature more in productive activities like furniture making and collection of waste in cities. Others include the representation of men as income earners and property owners, including the right to inheritance, and the presentation of men as family providers, especially on items requiring financial expenditure.

Finally, in the textbooks, there are widespread depictions of gendered cultural rituals that reinforce gender and power differences between men and women. For example, in community functions, women are shown to kneel in front of men while appearing with signs of submissiveness, while in the social studies book,²³ there is a demonstration of a male circumcision ritual among the Bagisu community in Eastern Uganda. The purpose of the

²³ Textbook 1 as indicated the the matrix

circumcision (*Imbalu*) ritual is to purportedly transform boys into ‘real men’ before they can be allowed to date girls, who in the pictures are shown happily dancing for the circumcision candidates. Such rituals have created and heavily reinforced hegemonic masculinities (Khanakwa, 2016: 115; Makwa et al., 2012: 71).

5.6 Interventions to Mitigate Gender Differences in the Education Sector

From the preceding discussions, it is evident that the education value chain, from policymakers to parents, teachers’ learners and curriculum developers, has some underlying and deep-rooted perceptions and biases that make education delivery gendered with outcomes that depict gendered trajectories. The discursive practices within the education structure present an uphill task for females to compete favourably with males and orient learners to believe that females are suitable for arts and humanities courses (Ikkatai et al., 2020: 1-15). In contrast, science and technology-related courses are presented as an exclusive domain for men. Deliberate actions are therefore needed to address this trajectory and enable all players to realise the fact that women, like men, are equally able and competent enough to offer STEM courses that culminate into renewable energy-related trades and careers (Brugeilles & Cromer, 2009: 41-47). A few of the interventions derived from interviewed participants and literature are discussed below.

5.6.1 Continuous Professional Development for Teachers and Mobilisation of Parents for Mindset Change

According to Kinywagi, an education policy expert interviewed for this study, there is a considerable need for projects and interventions purposely focusing on changing teachers’ mindsets about gender sensitivity and balancing the application of discourse in teaching. Doing this retools teachers and learners with skills that can help address some of the gender imbalances manifested in the education system (Interview with Kinywagi, paragraphs 31-35).

The stakeholders need to be supported to understand the actual meaning of gender equity and practical gender mainstreaming processes. For many stakeholders, when the need for gender mainstreaming is invoked, they take it as a numerical involvement of females and males without necessarily interrogating the intrinsic dynamics that affect gender relations (UNDOC, 2021: 9-10). Educationists need to appreciate how speech and discourse influence gender and how characterization in teaching content influences gender biases in education attainments and career choices (O’Brien, 2021: 1). However, it takes a considerable amount of time for a gender-insensitive educator to understand that even the characters being used in mathematics may be

gender-biased. For instance, if a learner repeatedly hears names and titles like engineer Henry, Doctor Martin, and others, then, when dealing with concepts relating to nurses and secretaries, the common names change to Nurse Hellen, Teacher Alice, and similar feminine tags, such patterns create impressions in the cognitive spheres of young learners that nurses are supposed to be females while engineers are men. When such perceptions and traits get entrenched at a young age, changing them later becomes difficult (Heckman & Kautz, 2012: 451-454). Therefore, teachers need that mindset change to address underlying perceptions and biases that may have also been developed during their growth, education, and training. They possibly teach how they were taught (Tang & Hu, 2022: 1-2; Oleson & Hora, 2014: 29-45). However, it would make a difference if they paid attention to discourses and teaching methods that propagate equity (Brugeilles & Cromer, 2009: 31-46). Moreover, since some may require new training, the government should focus on continuous professional development to handle emerging issues like gender equity and other facets that promote sustainable education. However, to attain this change, they need to be facilitated to unlearn and then learn new methods, including unlearning their gendered pedagogy (LeMaster & Johnson, 2019: 196-197) through a series of packages exposing gender concepts and gender-sensitive teaching methods as one respondent suggested:

Otherwise, you find some teachers using the class notes they used to write when they were still students. Nothing much can be achieved without dealing with teachers' skilling because a teacher is central to a child's development. So, whatever the teacher says is what the child takes, and without engaging teachers, you are doing nothing. If these gender biases continue littering our education system, then there can never be sustainable development. #00:34:45-5#" (Interview with Kinywagi -an education and curriculum specialist, Paragraph 36)

In addition to teachers, advocacy is also needed among the children and the parents if the messages and interventions are to anchor sustainably. Parents are significant stakeholders in influencing children's cognitive growth and development, and these parents need to appreciate gender parity and gender relations if they are to transmit gender-balanced socialisation or deconstruct their inherent gender biases (Migdalek, 2021: 722-723). Whereas teachers might require detailed professional development training, parents may require other forms of advocacy using unconventional means like drama skits, fliers, and music (Interview with Kinywagi, paragraphs 39-40). In any training that focuses on creating an impact in children's lives, it is highly advisable to train the three categories; otherwise, training one group like teachers alone, children and parents may not implement the interventions, and if children and parents retooled without doing the same to teachers, then teachers may oppose or fail to

appreciate the needed transformational messages (ibid). In addition, this training is better done using a bottom-up approach with an initial gender assessment to identify the gender knowledge gaps and the training issues agreed upon between the trainers and the intended trainees. Afterwards, training of trainers (ToT) can be done for some teachers who would eventually move down and sensitise their peers, children, and parents. According to Wabyona (respondent for this study), the results might be counterproductive if external trainers are the ones deployed to deal with local people or trainees up to the grassroots. Instead:

You need to train a few teachers intensively; they will even help you sensitize the parents. Actually, when a teacher is trained well, he grasps everything and can even train better than the so-called national consultants because he is a professional trainer and has acquaintance with those people, and they easily believe in her. You do not need to carry a trainer from Kampala to sensitise local people in the village. They will fear the stranger trainer and will not even ask questions. But if you come from Kampala and train some teachers, now the teachers will sensitize the parents, and they will be very free with them and can even ask any question, oppose and even engage in dialogue with serious opinions, which they will not do with a trainer who is a stranger (Interview with Wabyona paragraph 3).

On learners as stakeholders, Herlihy & Watson (2012: 497) recommend that there should be a candid discussion with girls and boys still in lower levels of education and illustrating to them the costs and benefits associated with technical subjects and related careers in comparison with humanities so that they make informed subject decisions free from learned biases (ibid). They need to be encouraged to question some traditional beliefs and gender stereotypes while embracing modern cultures that challenge essentialist views that portray females and males as having intrinsically different characteristics and abilities that predispose them to study various subjects or trades (Mandakathingal, 2021: 317-376). Starting these discussions right from the primary school level is imperative because, based on the interactions with students, they begin making career choices as early as lower primary (ibid). In Uganda, for instance, after completing primary seven, students are free to join technical or secondary school education, so they need to get the information early in life.

5.6.2 Gender-sensitive Language Use in Teaching

We have already observed in this chapter that teachers play a pivotal role in producing or reproducing gender biases and, subsequently, subject and career choice directions among learners. Therefore, having done sensitization and capacity building among teachers, as seen in the previous paragraphs, the next step would be implementing gender-sensitive teaching approaches, especially on speech use. Consequently, realising gender-sensitive teaching

language, teaching material, teaching examples, and illustrations would contribute a lot in reversing the stereotypical discourses about female participation in the science or technology sector. For instance, the use of both ‘feminine and masculine names’ as a teacher provides examples in teaching content that addresses technical activities and professions; however inconsequential it might appear, it does much in communicating to females that they, too, are suitable for the technology sector as counselled by Natuhwera, an instructor in a technical training institute interviewed for this study:

Me, in my technical teaching, I deliberately do things differently, even when the textbook states otherwise. I try to be gender-balanced in my examples. For example, when I teach construction, I will say that if Jane can stand in corner A and Daniel goes to corner B, they stretch the string and start laying bricks. You can see I have put ‘Jane’ in one corner and ‘Daniel’ in another, and they are working together. I do not say Tom and Dan, for example, since both would be males with no females in the discussion. #00:30:53-5#” (FGD with females at MTB, Paragraph 53).

Likewise, teachers should avoid using discourses that discourage girls from attempting the so-called challenging subjects like Mathematics, Chemistry, and Physics and avoid phrases like “these things are not meant for you, and you will not manage them” while advising females to attempt to select STEM subject combinations. Moreover, where it is discovered that a student, whether male or female, is weak in a particular subject, deliberate efforts should be applied to help the student understand the subject, not just brush her/him off, as is the case with many teachers (according to several female participants in the interviewed). In addition, efforts should be made by policymakers and curriculum developers to address the discourses in the textbooks to reflect neutral and value-free messages, illustrations, and assignments. Such content aids some gender-biased teachers in delivering content in a reasonably gender-balanced tone.

5.6.3 Special Incentives and Affirmative Action

Like any other structurally disadvantaged group, special incentives would be an excellent remedy to close the gender gaps in the sector. Indeed, as (Odaga 2022: 1-2) indicates, the government of Uganda has attempted to close the gender disparities in the education sector by awarding additional credits to females intending to join university education. These extra credits (1.5) help females to become more competitive compared to males. These credits are added to any female student, irrespective of whether she is applying to pursue sciences or humanities. However, although this initiative helps to increase the number of female students joining University education (Odaga, 2022: 1-2), it may not necessarily increase females in the STEM sector since it only starts at university entry. This weakness is partly because many

learners make career decisions early in primary or secondary school. Thus, this incentive should start quite early or be publicised early in the educational careers of young learners if it has to have an impact in the later part of the education career. Starting it after high school or at the end of form six²⁴ renders many learners to hear about it when they are filling out University entry application forms, which might be too late. (Daphine, FGD with University students, paragraph 48). A better way would be to start supporting female students from lower secondary schools or before, and information about the different weighing systems used to admit students to universities or other training institutions should be made available to students earlier. In this case, learners in senior one at the age of 12 or 13 years would study while aware of what to expect as they progress higher up in their academic pursuits (Kwesiga, 2023: 1). Female students, especially in rural areas, suffer from various structural barriers like excessive reproductive chores in households, which eat into their studying time at home and school (Bargawi et al., 2022: 1917-1944). Therefore, special incentives are proposed not because the females lack intelligence, as some discourses (from interviews with students) have been shown, but because of structural injustices relating to the gender division of labour and roles that permeate many patriarchal communities in Africa (Adjoh-Davoh et al., 2021: 1ff).

Another approach would be instituting such affirmative action initiatives for females joining lower technical and vocational education, not necessarily targeting only those joining universities, as is the present case. Based on the field observations, technical and vocational schools supply most technicians with craft certificates or ordinary diplomas required to maintain mini-grids, while academic degree holders get employed in high-end planning and managerial positions. However, there are no initiatives like the 1.5 credits to support girls joining the technical and vocational fields. Instead, the Ministry of Education subjects all applicants to similar entry requirements of a minimum of five passes at secondary school and one principal pass obtained at high school, irrespective of gender. The absence of positive discrimination at this level limits the supply of female technicians who can work at the lower end of the electricity value chains. In short:

There is no deliberate policy by the government of Uganda to promote the participation of girls in technical or vocational courses. In fact, for you people doing research, kindly emphasize that one in your recommendations so that girls can have a slight advantage and enable them to boost the numbers. If the government is doing it at the university, why not at the technical college

²⁴ The last class in High school before students join University as per Uganda's structure of formal education

level? We cannot even offer bursaries here for girls in the form of reduced tuition because those bursaries are more effective in primary and secondary school” #00:22:42-6# (Interview with Principal of MTB Institute, Paragraph 30 - 31).

However, as noted by several respondents, it also has to be observed that any interventions that target increasing the number of girls in the technology sector should also include the participation of males to be successful. For instance, sensitising the boys about the importance of girls’ education would make them more supportive rather than adversaries. The previous discussions revealed that some boys view females in sciences as intruders who are not ‘feminine enough’ and end up teasing and bullying them. However, raising awareness among the boys would help simplify the environment in which the girls in the STEM sector operate since, in all classes and fields, all genders have to work and complement each other's efforts and abilities (e.g. Interview with Kinywagi paragraph 19). Studies have established that women empowerment programmes involving men have been more successful than those targeting women alone (Niyonkuru & Barrett, 2021: 6-8, 11).

Finally, the teacher recruiting agencies need to prioritise female teachers for STEM subjects at the primary and college levels. Children need to see female teachers (or role models) teaching the so-called male subjects so that they can appreciate that those subjects are not just an exclusive domain of men (Blickenstaff, 2005: 376-377). Otherwise, it becomes challenging to convince a girl to specialise in science when she has never seen a female science teacher in all her life (Tannia-FGD with female students, paragraph 4). But then, according to arguments from some female instructors, recruitment bodies and commissions in Uganda are heavily riddled with corruption and bribes, a practice that further strains female job applicants. Women are reportedly not good at paying bribes, but even if they want to, they can hardly access the required money to afford the bribes and effectively compete with men (McGee & Benk, 2023: 169-184; Ramdani & van Witteloostuijn, 2012: 495,499), whose access to resources and attitude towards bribery may be comparatively higher than for females. However, even when the females have the required bribe money, local discourses post that they do not understand the politics and shrewdness surrounding the exchange of bribes as men do (FGD with females at MTB paragraph 67). Moreover, this predicament gets more complicated by some members of the education service commissions or school directors who still harbour stereotypes that females cannot make good teachers or performers in the science and technology sector, consequently hesitating to recruit females for such jobs (Friedmann & Efrat-Treister, 2023: 32).

Some of these iniquities need to be addressed by responsible governments and other stakeholders if the participation of females in the technical education sector is to progress.

5.7 Chapter Summary

This chapter aimed to analyse the contribution of a gendered education system and its entrenched gender discourses to the gender inequities in access to and participation in the renewable energy sector. The argument here is that a gendered education, teaching language, learning environment, textbook content and students' attitudes and perceptions that reinforce the myth that females are less suitable for technical-related subjects deprive the energy sector of a critical mass of female technicians, managers, and volunteers to match the numbers of males in the sector. The discussions further show that even females who manage to penetrate such science courses face repercussions resulting from similar regressive myths, discourses, and cultural beliefs and practices. Nevertheless, despite this, it is evident that several females have indeed crossed those socially constructed academic boundaries and joined the science disciplines and professions, and their performance is outstanding. With continued mobilisation, capacity building and retooling of learners, parents, teachers, and policymakers on mainstreaming gender in education first and then mainstreaming gender in STEM education, the gender divide in the education sector and subsequently in the renewable energy sector will gradually dissolve.

6 Discussion, Conclusions and Recommendations

In this chapter, I recap the study aims by evaluating and reflecting on the central question of gendered discourses, the ‘knowledges’ and the power relations associated with the discourses and how they impact the participation and the sustainability of renewable energy projects. In the same chapter, I reflect on how the intersectional approach is deployed in this study, followed by recommendations for lessening the gender gaps in the energy industry based on the data and discussions in chapters four and five and then present the contribution of this research to the broader academic debate of renewable energy and sustainable development. Finally, from these insights, I present areas for further study and cap with final remarks on the entire thesis.

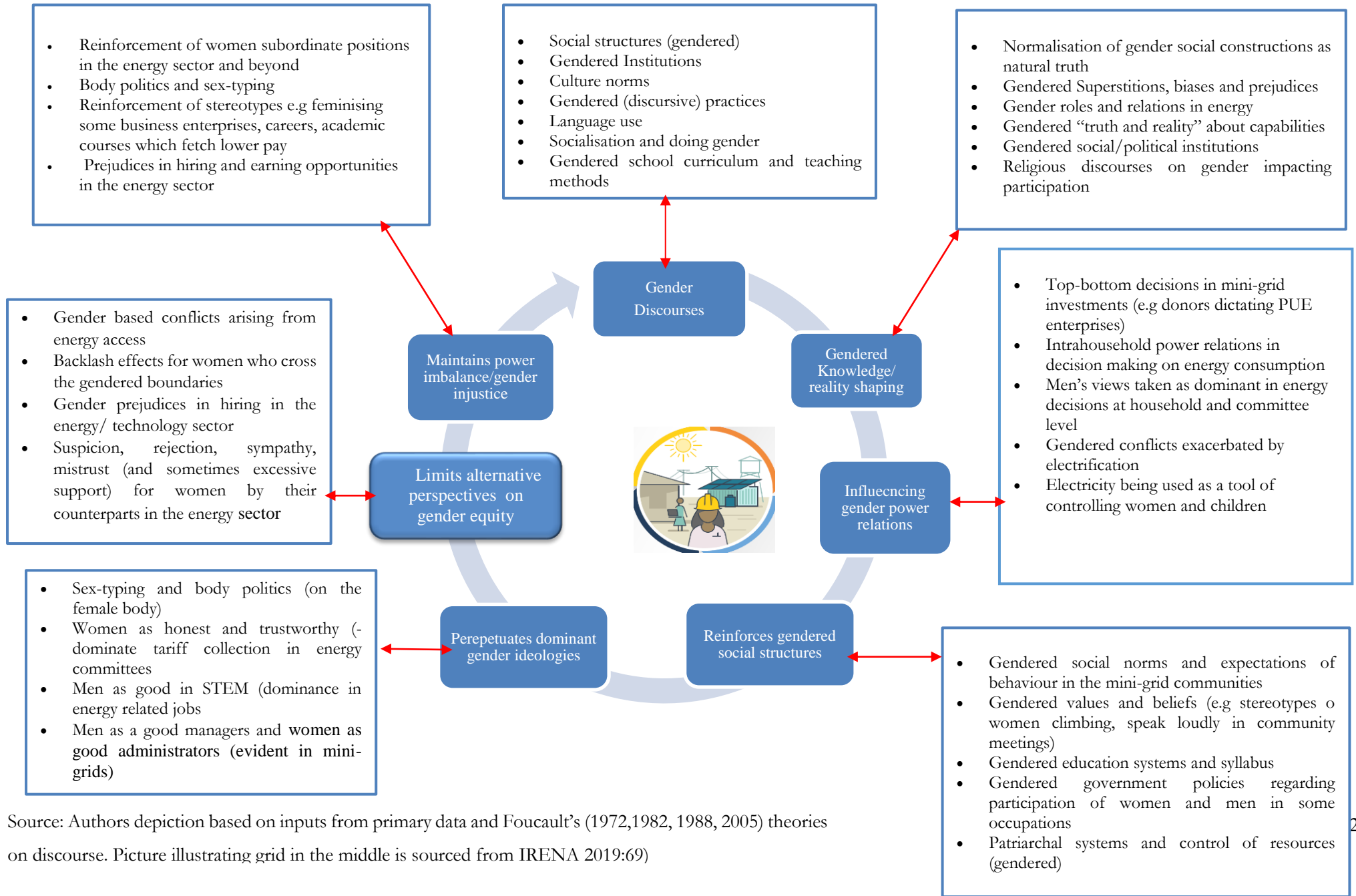
6.1 Recapping the Study Aims and Conclusions.

This study aimed to investigate and analyse the multivariate and intersectional nature of gender, the power of gender discourses (Bergvall, 2014: 173; Scott, 1986: 1067-1068), associated discursive practices in the social structure and how these influence the gendered participation in and the sustainability of renewable energy projects. Gender justice is presented in the general discourse in academics and practice as a panacea for enhancing sustainability not only for the renewable energy mini-grids but also as an antidote for achieving global sustainable development (see Clancy et al., 2003: 21; IRENA, 2019: 9; Mininni, 2020: 4,9; Skutsch, 2005: 51; UN Women & UNDP-UNEP, 2015: 1).

Based on the above premise, therefore, an emerging argument from this study was that the participation of women in the renewable energy and technology sector is low compared to their male counterparts, and yet if sustainability, as well as gender justice, are to be realised, part of the solution would be to plug the observed gender gaps. The specific questions of inquiry focused on the level and extent of participation of women and men in the renewable energy sector, the discourses that influence the gendered participation, the gendered conflicts consequential from renewable energy investments and the general introduction and consumption of electricity in the community. The additional questions of inquiry were to analyse the gendered discourses in the education system that influence males’ and females’ choices for renewable energy careers and how gender can be integrated within the renewable energy processes.

Based on the findings, the study concludes that discourses and other discursive practices that have existed for a long time in East Africa tend to produce realities, and power relations reinforce gender divides in the participation of men and women and other genders in the renewable energy sector. Accordingly, these discourses, associated practices, perceptions, beliefs, myths, stereotypes, and prejudices need to be addressed in the local communities, the education sector, the general social structure, and the mini-grid project cycles for sustainability to be realised. The actual impact of gender discourses on participation in the energy sector, as discussed in chapters four and five, is summarised in the analytical frame work presented in the following figure.

Analytical outcomes of discourse and gendered participation in sustainable renewable energy mini-grids in E.Africa



As observed in chapters three, four, five, and from the above figure, discourse analysis aided in examining the outcomes of discourse concerning actions, perceptions and policies within the community (Adjoh-Davoh et al., 2021; Tamale & Mulliro, 2007; Diaz-bone et al., 2007) and how they shape women's and men's participation in different activities of the mini-grid lifecycle. Analysing these discourses goes beyond statements and texts to looking at dominant practices and how they are rooted in people's lives and cultures, as Allen (1999) suggests. Furthermore, understanding discourses aided in interrogating their links with the regulatory and institutional frameworks and rules that directly or indirectly influence knowledge production, circulation, or communication, including people's perceptions, opinions and beliefs among the different stakeholders in the mini-grid communities.

It should be noted that although primary data was collected from Uganda and Tanzania, results indicate that the two countries had no significant differences regarding men's and women's participation or the other discourses surrounding feminine and masculine identities and roles. However, save for the solar mamas on the Zanzibar island of Tanzania, the views about male and female participation in energy and associated masculinities and feminine identities in Uganda and Tanzania were essentially not different. As noted before, these feminised and masculinised identities, roles and discourses are inculcated during growth and development and thrive as the individuals interact within the community in which they grow (Bem, 1981: 354; Scott, 1986: 1056; Solbes-Canales et al., 2020: 1). In the process, the perceptions about what is expected and or what is abnormal about gender roles are implanted and gradually get solidified (Scott: 1986: 1065-1058). Perceptions of women not being suitable for renewable energy occupations based on gender are cultivated, and myths linking masculinity with better intellect and, therefore, suitability for science subjects and technical occupations are adopted from the discourses prevailing in the broader social structure over time. Based on that premise, any attempts to reverse the trajectory and recruit more females into the renewable energy sector demands a deliberate confrontation of these beliefs and practices, albeit a task that may require more time and resources.

As David et al. (2010: 1154-1157) state, these discourses are diachron; they are entrenched within the societal language, knowledge, and practice, and they have evolved over time. This knowledge creates divisions and power relations, such as the gender differences observed in most of this study.

As studies by Foucault (1988: 212, 2005) and the works of Butler (1990: 1ff, 1993: 2-5) on gender discourses have demonstrated, discourses impact individuals as they are normatively mediated and constituted. They also influence a wider society as they influence socialized individuals and interactions in social situations (Diaz-bone et al., 2007: 1-18; Jäger, 2004; Keller, 2007: 1ff). Consequently, discourses shape reality (Shi-xu, 2005: 13). They control what we know as truth or not truth and what is expected of different stakeholders in the household or society. As they get entrenched into the broader society, they impact not only individuals but also public or social institutions and the decisions or policies made within. For instance, regarding renewable energy, discourses determine what is endorsed as the ideal way of investing in energy and the technologies touted as appropriate and sustainable by different local and international development agencies. Discourses further create knowledge that influences whom renewable energy mini-grid developers choose to be involved in their activities, the type of productive energy uses enterprises that they decide to introduce in the communities they serve and which stakeholders to give support to. For example, in the mini-grid villages visited for this study, most of the donors would bring already determined support items for women, like ground nut paste-making machines, juice blenders, and refrigerators, purportedly to ease their work even without any prior consultation on the (preconceived) perception that that is what they deemed fit for women. Such decisions are influenced by what the donors believe to be “feminine” businesses or appliances. Another evidence of how discourses influence national policies was, for instance, when, in 2021, the Ministry of Health in Uganda decided to order all male “midwives” out of the labour wards, claiming that such work is only a preserve of female midwives (as highlighted in chapter four). Examples of how discourses influence academic choices and careers for females and males and other ways in which education is delivered have been well elaborated in this thesis, particularly in chapter 5.

It can be noted that most of the discussions concentrated on discourses, stereotypes, and cultures in Africa because this study was conducted in East African settings. A non-critical view of this paper paints an impression that discourses and similar practices are unique to Africa or other societies of the global south that sometimes discourse paints as backward, conservative and heavily traditional (Lewis, 2013:1ff). However, it is also possible that even the “developed” countries of the global North have their share of discourses and, in many cases, are not very different from those observed in the South. For instance, a study by Freyta (2018: 29) posited that until recently, Germany experienced problematic forms of superstitions like beliefs in

witchcraft, some of which (might) still prevail to resent. The following quotation from Freytag's study demonstrates how deep the superstitions and beliefs were:

The Most Esteemed Royal Government may commonly find these beliefs in witches and ghosts, in the devil and his supposed manifestations everywhere among the educated and the uneducated, in the province of Prussia and in all others of this state and all states. Even in most recent times, witch-hunts have occurred in the Regierungsbezirk (administrative sub-unit within a Prussian province) of Coeslin, in the area of Bütow and, before that, near Peplin and in the Marks, as documented examples of the difficulties of exterminating a madness perpetuated and continued by tradition (Freytag 2018: 29).

Though seemingly situated in historical settings, the above quotation demonstrates that the beliefs in superstitions like witchcraft were prevalent in Germany and were considered problematic by the leaders. According to Pelizzo et al. (2023: 869), though some traditional beliefs and practices, e.g. seeking the services of traditional healers, are negatively and significantly related to several development indicators, the impact of socioeconomic development on social norms, discourses, and cultural change remains nonlinear and complex relationship (Inglehart & Baker, 2000) leading to persistence of superstitious discourses in the North. Nevertheless, the intensity of superstition has subsided with the advent of modernisation, and witchcraft may no longer be highly regarded as the likely cause of diseases among the educated. However, among the less educated, it may remain a regular suspect for several chronic diseases or other misfortunes (Heinz, 1993: 55).

Similar superstitions and beliefs are also prominent in other "Northern" countries like the US. As Togler (2007) notes, this can be evidenced by the high demand for newspapers and magazines that usually carry horoscopes and the level of attention attached to horoscope content by many readers (Torgler, 2007: 713-714). A study by Ankerberg & Weldon (1999: 1ff) on the influence of astrology revealed that beliefs in astrological discourses heightened in the last decades, and many organisations have employed astrologers as part of their staff and some universities and colleges had started offering courses in astrology. Similar studies (e.g., Gallup & Newport Jr., 1991: 137; Ross & Joshi, 1992: 357-361) revealed high belief, interest and participation in superstitious conduct. Superstitions are highly accepted in sports among players and managers (Beiley, 2023: 1; Bleak & Frederick, 1998: 1)

For example, Wade Boggs, a former baseball player and Hall of Famer,

believed that he could hit better after having eaten chicken, and he always went through a five-hour pre-game ritual, including actions such as ending his grounder drill by stepping on third, second, and first base, taking two steps in the first-base coaching box, and jogging to the dugout in exactly four strides (Vyse, 1997: 4).

Such a kind of beliefs, as seen above, do not differ much in practice and intention from those observed from East Africa, for instance, where girls are barred from climbing trees/poles or buildings or riding bicycles for fear that they will attract bad luck to themselves and society.

In addition, regarding gender discourses in education in the Global North, research conducted by Froehlich et al. (2022: 1) on gender stereotypes in STEM education in Germany and Japan found that (like in East Africa) though there is no significant difference in performance, women's abilities and interests in STEM are stereotyped as low compared to males. STEM is discursively linked with attributes that are more (discursively) valued in men than in women (Cheryan et al., 2015: 1). Like in other countries, such stereotypes include competence, assertiveness and ambition for males, while women are stereotyped as warm, and honest (Abele et al., 2016: 1-2). Such beliefs render women hesitant to join STEM for fear of encountering negative social consequences like being perceived as unlovable (Froehlich et al., 2022: 2; Obioma et al., 2022: 764). Thus, it can be assumed that, like in East Africa, such gender stereotypes are equally responsible for women's underrepresentation in STEM fields. Indeed, studies done separately in Germany and Japan (e.g. Adachi, 2014: 87; Ikkatai et al., 2020: 1-2; Steffens & Jelenec, 2011: 324) showed that women are negatively stereotyped in STEM in both countries. The findings might not differ in other similar countries (see Froehlich et al. 2022: 1-2). Due to their entrenched nature, dealing with these discourses and their effects requires learning (and relearning) dialogue, collaboration and coordination through crossing institutional and social boundaries and transgressing stubborn perceptions.

But, as the discussions in chapters four and five reveal, not everything about the gender dynamics and discourses or their impact is static. Many females have come up to negotiate their way into the technology and renewable energy sector and ably compete with men with good outcomes. However, it often comes at a social cost- being seen as less beautiful, less worthy for hire, and sometimes in a negative light for attempting to cross into the stereotypically masculine realm (Amanatullah et al., 2010: 256-257). Nevertheless, evidence from the field study shows that the number of women pursuing technical careers is increasing; more girls are pursuing courses like electrical engineering, while the number of female technicians in the renewable energy sector is expanding. Doubts like being rebuked for climbing poles or dressing in trousers are challenged mainly by the young generation. The solar mamas in Tanzania provide a good case in this direction. Women also dominate the productive use of energy (PUE) in the mini-

grids under consideration, while many of the teams that mobilise for new power connections are also dominated by women.

The education sector is also showing signs of transformation. For instance, in 2019, the Makerere University governing council passed a STEM affirmative action policy providing for a 40% female quota for all students enrolling in STEM courses to enhance gender equity in STEM education (Wamai, 2019: 1). At the same time, efforts, though still scarce, are in place to subject new curriculum books in Uganda to a gender parity test and approval by gender specialists before being rolled out to schools. The setback here is that not all academic institutions in East Africa systematically align their teaching to curriculum-approved standards (Atuhurra & Kaffenberger, 2022: 1-2). However, I didn't find any visible attempts to deal with the teachers' stereotypical teaching methods, and this study identifies this as a gap that necessitates targeted retooling.

6.2 An Intersectional Reflection

Notions of gender, masculinities, social class and the neoliberal impact of modernisation influence people's experiences, perceptions and social discourses about women's participation in technological fields. Each notion acts not in isolation, but all interact simultaneously to create multiple levels of perceptions, practices, experiences, outcomes, including masculinised or feminine identities.

While studying phenomena that are not universally fixed or uniform, such as gender in project participation, it is better to analyse the multiplicity of cases or inequalities than assume the homogeneity of all women or men, a mistake, which according to Mohanty (1984: 333-354), many scholars commit, especially in researching subjects that involve cultures and discourses from the south. An intersectional approach helps to avoid being simplistic or monolithic with the possibility of missing the opportunity to critique the existing and multiple-gendered 'knowledge' (Messerschmidt, 2012: 58). Lira et al. (2023: 668) take this argument further by recommending Deleuze & Guattari's (1987: 1ff) rhizomatic approach, which posits that such social phenomena (like gender relations and other discursive practices) are complex, non-linear, spread out and keep evolving and multiplying without a single point of origin or limits (Mambrol, 2017: 1). Like a rhizome has no centre, which makes it difficult to uproot, even gendered discourses and knowledge have no clear specific beginning point, making them complex to examine or uproot (Lira et al., 2023: 668-669). They are constantly in the process

of generation, degeneration and regeneration, and this regeneration may take different directions like the actual rhizome behaves (Linstead & Pullen, 2006: 12897, 1289; Siegel, 2000: 1).

With such complexities in mind, the selection of respondents and the subsequent analysis of these gender discourses in this study necessitated a consideration of the specific sets of experiences of class, age, ethnicity, social status, history and physical settings of the respondents while attending to the intersectional and rhizomatic processes and dynamics that influence or constitute them (Verloo, 2006: 11).

For instance, as far as the participation of women in technological and male-dominated careers is concerned and its gendered practices and perceptions, different aspects, as discussed in chapters 4 and 5, shape those experiences, especially in modern times. For example, regarding the construction of femininities and masculinities, it was observed from the study that gender roles and discourses are multifaceted and have a class angle whereby with increased modernisation, femininities and hegemonic masculinities have tended to reduce, especially among the urban middle class to a large extent but also among the rural lower class to some extent. These differences have sometimes created intergenerational and interclass collisions in perception, an aspect that became evident during focus group discussions. For instance, one female respondent whom I interviewed remarked that:

These days, things have changed, and women are no longer the women we used to be. For example, we never used to eat chicken, eggs, or grasshoppers, and we showed blind, unquestionable respect to our husbands. However, nowadays, women have become more financially independent, accomplish multiple tasks and contribute to paying several family expenses, an aspect that was rare before. Such women, especially the educated ones, are not dependent on their husbands and cannot be dominated just because of their gender. Therefore, we do not just conform to the popular feminine expectations we were used to in the past. #00:11:09-5# (FGD with women in BG Mini-grid paragraph 22).

The above sentiment demonstrates remarkably that educated and middle-class women and some from the lower classes are attempting to demand more agency in society under pressure from neoliberal capitalism, where almost every adult has to work and earn to survive. Aslan & Gambetti (2011: 135) suggest that these earnings opportunities can potentially enhance women's agency and negotiating power. This agency has necessitated crossing the socially prescribed boundaries, including venturing into technological careers like energy, which were hitherto taken as an exclusive field of men. According to Tamale (2009), this emancipatory agency has gone beyond work careers but also moved to other forms of agency, like negotiating

the terms of the relationships, including control over sex and other rights, which was a hard bargain in the past (Tamale, 2009: 89-90).

The above analysis reveals that when modernisation intersects with social class, especially the educated middle class, masculinities, femininities, gender roles and associated discursive practices tend to change. However, a longer period might still be needed to close the gender gaps meaningfully. For instance, the UN secretary-general, in his speech to commemorate the International Women's Day celebrations in 2023, lamented that it might require more than 300 years to close the gender gaps citing the rate at which women are losing some of the rights that they had started to enjoy, especially in some predominantly Islamic nations (Pannett, 2023: 1; Subramanian, 2023: 1). Though this may appear demoralising to feminists, one would still hope that every development that reduces the gender gaps empowers (some) women. While comparing masculinities and modernisation discourses, some scholars, e.g. Kaye (2005) and Schmidt (1991), observe that with modernisation, 'men seem to be losing identity and power, and the weakening gender gaps and roles have somehow led to gender antagonism between the emerging and the hitherto perceived gender roles (Kaye, 2005: 300-3003; Schmidt, 1991: 732-735).

In short, with more women attaining education and getting enlightened about the costs associated with gender inequality, coupled with the era of modernisation, gender discourses and the resultant practices tend to transform. However, the transformation occurs at different speeds depending on the setting and context. Human beings are not uniform entities and, therefore, experience gender constructs differently. Likewise, as evidence from the field data shows, the perception and appreciation of female and male participation in the energy sector are also moderated by age, level of education, physical residence, exposure, level of income, religious affiliations (to some extent) and ambition. Consequently, simultaneous identities may operate in individual human beings, resulting in differences in the experiences of feminine or masculine discourses, practices, and opportunities for participation in renewable energy mini-grids.

6.3 Walking Backwards into the Future? Enhancing Gender Justice in Renewable Energy

I use the idiom "walking backwards into the future" to infer that to address the several forms of gender injustice and discourses existing at present and to have a democratic future society with minimised gender inequities, we need first to recognise that they have their roots in the

past. Looking back into the far past and understanding how the past has influenced the present helps actors to make appropriate proposals for improving the future (O'Sullivan, 2019: 424; Rainford, 2017: 3). Indeed, the past has been characterised by a couple of multiple and complex discourses and cultural practices, some of which have lasted centuries and are hard to dismantle but characteristically shape the way society and gender relations are organised into the present. Understanding their past progression helps actors design effective strategies and policies to address them and to create a future that accords all people (males and females and other gender identities) fairer recognition and fair opportunities in managing mini-grids and other renewable energy investments or other resources.

Therefore, I suggest that by reflecting on the past and analysing the present, tailored interventions designed for and with the community members in a gender-sensitive participatory manner while allowing more negotiation space for women and other marginalised groups could result in greater transformative and sustainable outcomes. Promotion of advocacy on gender fairness at all institutional levels could enable members of the community to question intergenerational cultural practices and beliefs that perpetuate discrimination against females and other minorities. Renewable energy developers and other practitioners could attempt to understand local needs, contexts and dynamics through broader and more meaningful consultations before setting up mini-grid investments in the targeted communities. By analysing local context peculiarities in their past and present, it could be possible to set up interventions to promote gender and social justice rather than exacerbate the already existing injustices and other unintended outcomes, as has been the case with some of the visited mini-grid projects. Based on the above background, some recommendations to the relevant actors for promoting gender justice in the energy sector are presented in the following sections.

6.3.1 Gender Analysis and a Gender Mainstreamed/sensitive Approach to Renewable Energy Planning and Delivery

The data collected for this research uncovered multiple discourses and realities pointing to the fact that women, compared to men in East Africa, occupy a position of subordination and subjugation shaped mainly by conditions and relationships that have existed in communities for a long time. Entering communities with this in mind necessitates that energy grid developers and other practitioners first conduct a gender analysis and gender mainstreaming to purposively promote an inclusive approach that accords equal opportunities for the participation of women

and men while attempting to address other structural barriers that hinder balanced participation and equitable benefits (IRENA, 2019: 1ff).

Gender analysis and, subsequently, gender mainstreaming and gender justice discourses have been promoted as being vital in the mini-grid planning and implementation process because persistent inequalities in access to development resources and opportunities hamper technical, social and economic efficiency and sustainability (Duran & Sahinyazan, 2021: 8; Johnson et al., 2019: 169). Therefore, recognising these inequalities ensures adequate planning is done to deal with them in time. In most rural communities, the gendered systems and discourses subject women and men to different and asymmetric roles, rights, and responsibilities. For instance, in rural East Africa, females with intersectional identities often have unequal access to productive resources and opportunities such as education and training, credit, capital, land and decision-making authority (Anyanwu & Augustine, 2013: 400; Tamale, 2004: 50). Scholars e.g. Oparaocha and Dutta (2011: 265) suggest that such asymmetric relationships demand a mini-grid planning process that justly promotes the well-being and empowerment of both males and females. It is also recommended that like any other project requirements, gender analysis and mainstreaming ought to be done at the earliest possible time in the mini-grid project cycle as it can fundamentally affect the entire program and structure of the mini-grid and its outcomes (Oparaocha & Dutta, 2011: 265; Sibyl & Kuriakose, 2017: 3; Skutsch, 2005: 37). Yet, gender analysis and mainstreaming are not a one-time exercise done only in the initial planning phases but instead should be made an integral part of the entire mini-grid planning, implementation and operation phases that should continue through the whole lifetime of the mini-grid project (IRENA, 2019: 67; Skutsch, 2005: 37).

Using gender-sensitive indicators allows for the effective monitoring and evaluation of the mini-grid project activities at later phases, which feed into more effective future planning and delivery of more mini-grid benefits (Goetz, 2006: 71; Mahama, 2001: 1ff). This proposal implies that for mini-grid planners and implementors, mainstreaming gender into the project lifecycle would involve systematically identifying the consequences of the proposed intervention on the different categories of women, men, and other possible identities based on intersectional criteria and address any potential adverse outcomes as the project is developed and implemented. For example, as observed in chapter four, some mini-grids may lead to negative consequences or conflicts between partners in the household.

Johnson et al. (2020: 1ff) guides that to maintain gender sensitivity and responsiveness, mini-grid development throughout the project cycle requires a re-examination of the roles traditionally ascribed to women and men through different methods, including discourse analysis and redirection of efforts to ensure that the relevance of those roles and discursive practices in the target community is incorporated in the design of the mini-grid. Mini-grid developers, especially in patriarchal rural settings, should thus investigate the gender difference in access levels to legal and traditional rights, property access and control rights, differences in roles and decision-making powers within the household, time use dynamics, and strategic priorities and goals for males and males. Therefore, discourses referring to who does what, who has control over what resources, what benefits might be realised from mini-grid installation, and how and will females, males and others participate in realising the benefits over which they may or may not have control (Johnson et al., 2019: 169, 2020: 1).

An effective gender analysis exercise with gender indicators requires generating gender-disaggregated data (Sibyl & Kuriakose, 2017: 3; Tsagkari, 2022: 41-42). This data may include but is not limited to resources needed or used by women and men, activities done by men and women, control and access to resources, women and men activity profiles (Clancy & Mohlakoana, 2020: 1-2), and other qualitative and quantitative indicators, as outlined in the former paragraphs. This data allows for assessments plus intra- and inter-comparisons of women, men, and others, and the same data is subsequently used to monitor impacts and disparities. Operators should generate this data and other gender-sensitive indicators in a participatory manner using participatory appraisal tools (Percy, 1999: 395). In addition, the tools should be relevant to energy, clearly defined and easy to understand, quantitatively and quantitatively disaggregated, valid and reliable. They (tools) can be refined during the project implementation and have the capacity to capture changes over time. During the gender analysis, it is also imperative to determine the level of men's and women's (and others) participation in the three categories of roles, that is, productive, reproductive and community management roles concerning gender energy needs (Anditi et al., 2022: 1; Ceschin et al., 2023: 1ff), and examine how these roles may impact men's and women's (and others') participation in the activities of the mini-grid but also how the mini-grid activities may impact these roles. In addition to roles, the gender feasibility analysis should examine women's and men's needs and classify them into

practical ²⁵ and strategic gender needs.²⁶ Consequently, the planners need to assess how the prospective or existing mini-grid addresses or interferes with the practical and strategic needs of all and incorporate strategies to maximise those benefits in the medium and long term. Addressing the practical and strategic gender needs would contribute to greater (mini-grid) sustainability (Moser, 1989: 1803; Quisumbing & Pandolfelli, 2010: 581) while empowering the community and promoting gender justice. Furthermore, due to the criticality of gender (Ceschin et al., 2023: 1; Fathallah & Pyakurel, 2020: 1ff; Tsagkari, 2022: 40), even other social safeguard interventions like environmental and social impact assessments, conflict mapping and assessments to address the risks of the mini-grid infrastructure development should be gender-sensitive (Fathallah & Pyakurel, 2020: 1), and the results or mitigation measures should be disaggregated by gender.

In addition, in gender analysis, it is prudent to unpack the discursive practices that act to maintain specific structures, rules, and perceptions about women and men and their basis of inequality and how some of the forces driving inequality have diachronically developed, normalised and become part of local reality to truths that are hard to challenge (David et al., 2010: 1154; Shi-xu, 2005: 13). Based on the field results observed in chapters 4 and 5, it can be deduced that these seemingly ‘unchallengeable’ and ‘normalised’ beliefs and entrenched forms of domination have often influenced women’s participation in renewable energy projects and other technological investments due to the structural imbalance these forces propagate in society. Once they are understood, planners can design ways of working with these discourses and practices to facilitate the gender-equitable participation of all in renewable energy or mini-

²⁵ Practical gender needs “are those needs which are formulated from the concrete conditions women experience in their engendered position within the sexual division of labour, and deriving out of this their practical gender interests for human survival. Unlike strategic gender needs, they are formulated directly by women in these positions rather than through external interventions. Practical needs, therefore, are usually a response to an immediate perceived necessity which is identified by women within a specific context” (Moser, 1989: 1803)

²⁶ Strategic gender needs are “those needs which are formulated from the analysis of women’s subordination to men, and deriving out of this the strategic gender interest identified for an alternative, more equal and satisfactory organization of society than that which exists at present in terms of both the structure and nature of relationships between men and women’s The strategic gender needs identified to overcome women’s subordination will vary depending on the particular cultural and socio-political context within which they are formulated” (Moser, 1989: 1803).

grid value chains in the community in a manner that enhances social justice (Resurrección, 2013: 33-36; Tsagkari, 2022: 41-43).

Having explained the importance of gender analysis and gender mainstreaming, it is worth noting that for all the over 20 mini-grids visited, no developer reported to have conducted a gender analysis as part of their pre-investment studies, mainly because most saw it as an expensive venture while others did not know its relevancy as one respondent (project manager) revealed:

Honestly, if I have set up my solar plant, the sunshine is adequate, the power generation is optimum, the batteries are charging well, I have my customers well connected to the grid, and they are paying well, then I would say my mini-grid is sustainable. I do not see the reason why I should bother whether women are participating in the activities or not. However, from the discussion with you, in hind thought, I now realise how gender analysis would have been critical. But still, you may need to appreciate that our bosses look at any additional activity as increased overhead costs and would be less interested in undertaking an exercise that adds on costs” (Interview with a site manager of one of the mini-grids (KT) in central Uganda).

Such comments from the manager (who happened to be an engineer) reveal the difficulty of making investors appreciate the importance of comprehensive gender analyses, the different interpretations of gender and sustainability and how engineers in the renewable energy sector may pay limited attention to social factors, which strengthens the need for interdisciplinary approaches in the development and management of renewable energy facilities.

For instance, evidence from most mini-grid villages indicated that most mini-grid planners tend to undermine the views of women during feasibility studies on the premise that women do not make decisions about the administration of family property. It was reported in chapter 4.1 that during initial surveys or mobilisation, the data collectors only talk to men as heads of households, and even when they find the female partner at home and interview her, the name that was registered in the book is the husband’s name. This observation may appear minor, but such practices tend to curtail women’s participation while propagating the prevailing discourse undermining women’s agency. Minigrid planners and other decision-makers thus need a proactive approach to ensuring that women’s concerns matter equally to men’s.

In addition, the relevant stakeholders, like local leaders, grid developers, and education managers, need to address the many stereotypes and beliefs about femininity and masculinity prevalent in interviews, discussions, and media to improve female agency and subsequent participation. For instance, discourses like “man is the head of the household”, thus

undermining women's views, technical work is exclusively meant for males, STEM courses are meant for males, and men are more intelligent than women are some of the hostile discourses undermining women's agency. Other forms of social restraint include forbidding women to wear trousers, ride, speak freely in public and climb. These need to be addressed by relevant stakeholders and other actors like non-governmental organisations supporting mini-grid communities in East Africa. Dealing with such stereotypes lessens hegemonic masculinities and gives women more space to participate not only in energy decisions but also in other private and public affairs in society (Bejeno, 2021: 20,30; Mininni, 2020: 48-56; Sibyl & Kuriakose, 2017: 2).

Although the number of female technicians in the electrical sector is steadily improving, the numbers are still comparatively low. Thus, more females need to be trained in electrical-related trades to increase their share of energy work. Training can also be done in income generation activities and small-scale business enterprises to improve clients' benefits through the productive use of energy. These benefits, in turn, allow them to generate more income and comfortably pay for electricity, contributing to its sustainability.

6.3.2 Participatory and Conflict-sensitive Approach to Mini-grid Project Implementation

One of the challenges found in almost all mini-grids visited was the absence of meaningful consultations, community needs assessment to understand the local context, and the minimal involvement of local authorities by some mini-grid company officials. However, approaches that do not involve participation by the local people risk providing top-down interventions that do not align with the existing realities (Bishoge et al., 2020: 121; Fraser et al., 2006: 114).

For instance, as found in the field, some mini-grid companies usually provide equipment to the beneficiaries to improve their production capacity and income generation potentials while generating forward and backward linkages that enable customers to afford power tariffs. This equipment and other forms of 'support' are supplied either on hire purchase or for free. However, these companies need to conduct a proper feasibility analysis and assessment to provide equipment commensurate with the technical and commercial realities on the ground. For example, instances like that of supplying cheese makers to communities that have never consumed cheese, a case witnessed in some mini-grid villages in Uganda, would be avoided if meaningful participatory assessment studies had been done. In a similar interpretation, the selection of grid beneficiaries to be provided with initial power connections should be

consultative, participatory, and community-based, involving local leaders and actual beneficiaries rather than using top-down approaches where beneficiary lists are compiled from the company headquarters without beneficiary input as has been the case with some of the mini-grids visited. These omissions created discontent and connections that omitted critical institutions like schools and health centres and left consumers with many unanswered questions.

Frequent community engagement sessions which are gender sensitive would help to curtail these questions and possible conflicts. In addition, where community engagement sessions are held, their scheduling and arrangement need to consider the reality that in most rural areas, women and men spend their time differently and thus schedule them at times that allow both females and males to attend with convenience.

It was observed that some of the mini-grids visited suffered from conflicts that threatened their sustainability and general social harmony in the communities. Minigrid developers and other stakeholders ought to appreciate that some latent conflicts might have existed before the mini-grid investments in the communities, while others result from mini-grid operations. Irrespective of the source of conflict, it is prudent for mini-grid developers to conduct a thorough conflict mapping and analysis before and after setting up the projects to ascertain the existing and potential conflicts and design strategies for working with the identified conflicts (Lomax et al., 2023: 1-2; Tacconi & Warner, 2018: 1-2). The idea here is not to avoid conflicts, as some may be beyond the control of the grid operators, but having the correct information empowers operators to mitigate or professionally deal with the existing or potential conflicts.

6.3.3 Promote Gender Justice in Education Delivery and Training.

A well-streamlined education and training system provides a critical mass of professionals to work in the renewable energy sector and other fields necessary for local and international development. However, as some empirical results in chapter 5 indicate, an education system that is gender insensitive may end up creating inverse results, as was the case in East Africa. As already discussed in the previous chapters, there is a gender inequity in the education system in East Africa, which stems from the unbalanced gender relations characterised by a complex culture of gendered social systems, because of which females in most countries participate and benefit less particularly STEM subjects in general and renewable energy in particular. This state of affairs, in consequence, is considered a danger to sustainability and needs to be addressed.

To change this trajectory, actors in the education sector will need to work in unison to create and purposively nurture a conducive and gender-sensitive teaching and learning environment that treats males, females and other genders as equal participants in the education systems with similar capacities to pursue similar subject combinations and careers with no discrimination. Stakeholders must address the several (mis)conceptions (as highlighted in the preceding chapters) about females' intellectual and physical capacity and suitability to pursue STEM subjects and related careers. This intervention should target schools, households, investors, the community and policy-making agencies. Teachers and other educators also need to develop and be helped to develop gender-sensitive teaching methods and language that promote gender justice instead of widening the gender gaps in the learning system, as has mainly been the case.

Teachers, therefore, need to deliberately educate all learners about the importance of all subjects in the education curriculum and specifically encourage females to pursue STEM subjects since, according to the findings, females are disproportionately underrepresented in these subjects. Likewise, teachers should provide males and females with diverse activities and resources that make learning enjoyable. Finally, as guided by scholars (e.g. Muntoni & Retelsdorf, 2018: 212-213; Sinnes & Løken, 2014: 343,345; van der Vleuten et al., 2016: 181-182, 194; Watera, 2018: 55) the teaching and learning aids ought to also be gender-responsive to guard against the creation of biases, as was the case in many schools and communities covered in this study.

To encourage females to stay in school, be competitive and improve their career development opportunities in STEM, teachers and other trainers must promote balanced participation and involvement of boys and girls in all class activities. Equal participation may, for instance, involve giving males and females equal opportunities to answer questions, equal access to learning materials, equal distribution of leadership roles and positions in class or school, and offering non-prejudiced career advice during career guidance and mentoring sessions (van der Vleuten et al., 2016: 181). Educators also need to be aware of and consider the specific needs of girls, for example, menstruation issues and create a conducive environment for girls to stay in school, such as ensuring girls' safety and security in school while contesting destructive cultural practices such as early marriages and female genital mutilation by empowering girls to overcome these barriers to their education (Adomßent et al., 2014; Chapin & Warne, 2020: 1ff). Otherwise, without addressing such obstacles, the education system in East Africa might be akin to what Blickenstaff (2005: 369) calls a “leaky pipeline” that keeps dropping females out of the system, and by the time students reach the university level, many females have already

been thrown out of the schooling system (Schreuders et al., 2009: 97) due to the previously mentioned structural challenges and discourses. This ‘leaking’ renders the affirmative action initiatives that start at the top end of the education pipeline almost irrelevant for such disadvantaged females. During data collection, it was evident that considerable knowledge gaps in gender-balanced teaching existed. A host of gender discourses and conceptions about females' capacity to perform in the STEM sector and gender-responsive education delivery exist among learners, teachers, government and even policymakers. Therefore, thoughtful retooling and capacity-building interventions are recommended to create gender awareness amongst the mentioned stakeholders.

6.3.4 Address Gender Discourses and Biased Content in the Textbooks

The influence of gender-biased content and other educational media on the formation of learners' gender perceptions has been noted in previous discussions. The textbook content and illustrations therein greatly influence learners' knowledge and subjectivities, influencing their subject and career choices (Namatende-Sakwa, 2019: 72-73; Smith, 2011: 1001-1002; Sovič & Hus, 2015: 495). However, as observed in chapter five, the textbooks analysed were heavily gendered regarding content, illustrations, assignments, and examples. For instance, illustrations showing technological careers or functionaries are publicised as male throughout, and the opposite is true for illustrations depicting non-technical and non-managerial careers that are assigned feminine representations. In the process, the textbooks create or reinforce the discourses and other social constructions of gender roles. There is a pressing need to review the books on the education curriculum, especially for the primary school level, to ascertain the extent to which they carry gender-biased or gender-insensitive content and rectify the many gendered preconceptions in those teaching materials. The new textbooks should also be subjected to a gender parity assessment by proven gender experts to ensure they are not released into the education system with excessively 'gender blind' content. Revising book content should go hand in hand with training teachers in pedagogical and didactic approaches and lesson designs that promote gender inclusiveness.

To conclude this subsection on the need to lessen the gender gap in the education sector, I reiterate the discourses from two key leaders in Uganda's education sector. These comments were made while releasing the Uganda Advanced Certificate of Education (High School) exams on 3rd March 2023. The first recommendation was from the Minister of Higher Education, who noted “that whereas other courses like humanities are important for proper morals and social

development, industrial growth heavily depends on STEM courses, and we do not want females to be left behind in this part of development”²⁷. At the same time, the chairperson of Uganda National Examinations Board (UNEB) added that “there is, therefore, an urgent need for national policy to address the increasing gender gap in STEM subjects if we are to realise proper development”²⁸ (Prof. Mary Okwakol, chairperson of Uganda National Examinations Board).

6.3.5 Promote an Interdisciplinary and Context-responsive Mini-Grid Project Planning and Implementation

The ideal phases and methods of project planning and implementation that ensure sustainability depend on the project and the local context where the mini-grid is implemented. However, this study underscores that mini-grid implementers need to apply an interdisciplinary approach that responds to the mini-grid projects' technical, economic, social, educational and ecological parameters. The engineering and economic objectives need not override other objectives, as evidenced in the mini-grids visited for this study. This calls for recruiting multidisciplinary project staff that also answer the requirements of those fields. Mini-grid implementors need to use a participatory approach and consult the clients and other stakeholders from the feasibility study phase up to the decommissioning phase of the projects. In this way, they will carry out interventions that address not only the energy needs of the consumers but also other contextual requirements that affect the sustainability of the mini-grid.

At all levels of implementation, gender sensitivity should be at the centre of all steps to ensure that the mini-grids address all gender needs, other specific needs and all social minorities. Implementors need to be cognizant of the need to be conflict-sensitive and carry out interventions that do not escalate existing conflicts or create new ones; this has always been absent in many of the grids visited for this study. For example, one of the mini-grid field staff at the managerial level, when asked how he ensures conflict mitigation in the selection of beneficiaries who get PUE support items, remarked, “I am not supposed to be managing conflicts here, although some wives run away with the refrigerators after I have given them to

²⁷ Hon. Chrysostom Muyingo, State Minister for Higher Education, Republic of Uganda, during the release of the Uganda Certificate of Education Exams on 3rd March 2023.

²⁸ Prof. Mary Okwakol Chairperson, Uganda National Examinations Board during the of the Uganda Advanced Certificate of Education on March 03, 2023.

their households”²⁹. Such staff members need real training in conflict and gender mainstreaming of projects, first to appreciate their importance and then be able to apply them in the day-to-day operations of the mini-grid.

From a commercial point of view, it was observed, despite the benefits, that electricity from mini-grids is priced expensively compared to electricity from the national utility grid. Moreover, mini-grid developers noted that they had to levy higher prices to cover operational costs. Thus, I recommend that profound ways of minimising operational costs and reducing power tariffs to make them affordable have to be sought or studied.

In summary, several recommendations can be made for improving and sustaining the mini-grids in East Africa, but a few have been highlighted. The overall argument here, however, is that whatever interventions to be implemented, they must be context-specific, participatory, interdisciplinary, gender and conflict-sensitive while aiming at building the capacity of the beneficiaries in all spheres of their livelihoods while providing a reasonable return on investment for the mini-grid investors.

6.4 Contribution to the Academic Fields of Gender, Renewable Energy and Sustainable Development

Scholars who have attempted to study the gender, energy and sustainability themes, e.g. (IRENA, 2019: 1ff; Schmidt & Weigt:206-19, 2015; Skutsch, 2005: 37-52) have provided insights into the implications of access to energy supply to women and men and their implications for sustainable development. They have analysed these implications with a significant focus on the Asian and Western contexts, but throughout this research, I did not come across prior significant studies that focus on the East African contexts. Whatever existed were scattered anecdotal statistics that were hard to rely on to make comprehensive academic arguments and conclusions. I also found that no previous study mainly centred on discourses and discursive practices and how they influence men's and women's participation in the renewable energy sector. Although some other authors stress the importance of mainstreaming gender in renewable energy development (e.g. Clancy et al., 2006: 17; Fraune, 2015: 55-65; Hanitsch, 2019; IRENA, 2019: 16-21; Kuriakose & de Boer, 2015: 1ff; Woodworth, 2015: 1ff),

²⁹ An extract from an interview with manager of an organisation that does financial capacity building of minigrid customers in Uganda.

I have provided a comprehensive and holistic picture of this requirement based on practical lived experiences of the energy customers and developers in the field through a thorough interrogation of enablers and disablers of women's and men's participation in the renewable sector.

In this study, I, therefore, have been able to provide an empirically driven analysis detailing whether and how gender discourses affect the participation of various players in the renewable sector and how these, in turn, affect sustainability in general. This study has brought debates on the extent of these discourses into the academic domain, and it is hoped that these debates will be taken further by other researchers. I have also made some proposals on how these gender discourses can be dealt with, not only in the community but also in the education sector that trains many men and women who end up taking up careers in the renewable industry. In addition, there are gender challenges in the teaching and learning environment that stakeholders take for granted but which have an observed potential to create a wedge in the educational attainments of females and males. This field of analysis had been a grey area, especially in the East African context. Understanding these dynamics and relations is essential for formulating inclusive gender-sensitive energy and education policies and approaches that promote inclusivity and sustainability.

Finally, in agreement with proponents for women's inclusion and access to the energy sector, e.g. (Allen et al., 2019: 1; Baruah, 2015: 53; Clancy et al., 2006; Fraune, 2015: 15-17; Sibyl & Kuriakose, 2017: 2), findings from this study support the argument that access to energy reduces gender conflicts at the household level as electrification simplifies women's work, lessening their traditional triple burden of reproductive, productive and community work (Clancy & Dutta, 2005: 1). However, this study brings an additional dimension to this argument that previous researchers had scarcely observed; that access to energy and subsequent income opportunities can generate more gender-based conflicts and intimate partner violence, especially at the household level. These cases of intimate partner conflicts and violence arise in some households when wives start spending more time at work (e.g. in their retail shops), hence not attending to household reproductive chores to the satisfaction of their male spouses, making (some) husbands respond with violence. Furthermore, violence against (some) women may occur when they start earning income, and this income threatens the power of their husbands. Fears emanate from discourses that wives reportedly "become difficult to control when they are economically empowered since they would no longer depend on the husband to meet their

needs.”³⁰ This study brought such converse revelations to the fore and will generate more academic debates in the future.

6.5 Directions for Future Research

This research is situated within the context of gender, renewable energy and sustainable development. From the comprehensive analysis of the correlation between gender, discourses and participation in renewable energy that I have investigated, significant issues and questions have been answered. However, the analysis has raised other questions that require further investigation. These are questions and issues triggered by this study but are not comprehensively answered within the scope of this thesis. However, they are potential areas of inquiry for future research. Though the questions are many, I pick out only four. The questions include: how can the gender discourses that have existed for centuries and intertwined with society's ecosystems be addressed to reduce the gender inequalities they create? Second, are there any policies or strategies by the governments of Tanzania and Uganda to ensure inclusion and gender equity in the renewable energy sector? Third, how can the education environment be designed appropriately to eliminate gender inequalities, especially in STEM education and occupations? Fourth, how can mini-grid power projects be robustly and optimally designed and implemented to make them cost-effective and charge competitive power tariffs?

With these concerns in mind, I discuss the opportunity for further research.

Concerning the first and second questions, there is evidence of the existence of gender discourses and stereotypes at all levels of the social structure that constrain women's participation in the energy sector and the overall development of society (Eagly & Steffen, 2000: 735; Powell et al., 2012: 541). However, solid scholarship about how they can be confronted is scarce rather than simply recognising and condemning or lamenting them. Therefore, researchers need to explore practical ways of promoting gender-sensitive policies and practices that address the gaps at all levels. When implementing energy projects in rural communities, advocacy and awareness-raising, especially about the role of women, are central to project sustainability (Danielsen, 2012: 12). However, it is evident that the linkage between gender equity and sustainable energy development is often undermined by mini-grid developers

³⁰ A claim made by several male respondents in the interviews in Uganda but also corroborated by many respondents in Tanzania.

(Tsagkari, 2022: 40) and other policymakers though as several discourses have argued, gender equity is critical for attaining gender justice and sustainable development (ENERGIA, 2019: 30; UNDP, 2023: 10-12). This goes hand in hand with deliberately promoting women's participation in development activities. To achieve sustainable energy transition, gender justice in all sectors and ultimately sustainable development, more research is needed to interrogate context-specific discursive, economic and policy barriers to gender-balanced energy project implementation (Mininni, 2020: ii-iii) as well as in other development interventions.

More studies regarding the question of gendered education are necessary, with the limitations examined before, for instance, the pedagogical language and content that reinforce stereotypes against females' participation and performance in STEM fields. Further research could include investigating how these stereotypes can be dealt with within the education setting and how textbooks and other educational media can be adequately designed to avoid spreading academically regressive perceptions about women. This study did much to explore the existence and how they affect students' career decisions but did not offer a comprehensive analysis of how they can be practically minimised. I propose that this can be supplemented by rigorous advocacy and capacity building for students, parents, teachers, and policymakers to appreciate and challenge the discourses, plus skills in gender-responsive education planning, gender-sensitive curriculum design and delivery.

Regarding the question of robustness and power costs per unit of electricity from mini-grids, there is overwhelming literature suggesting mini-grids are the optimal energy solutions for hard-to-reach rural areas, as well as claims that mini-grids offer cheaper energy prices compared to electricity from national utility grids. However, based on the data collected and interactions with energy consumers, there is evidence that mini-grids help far-placed communities access energy, but the field findings do not entirely agree with robustness, pricing, and affordability. For instance, all the grids visited in Uganda operated by different companies were found to be charging a higher price per unit than the electricity offered by the national utility grid, which leaves many potential consumers unserved because of affordability.

The average electricity price per unit from mini-grids was Uganda Shillings 1300 (33 cents) compared to an average of Uganda Shillings 700 (18 cents) for power from the national utility grid. Therefore, I suggest that more research is needed to answer why these tariffs are prohibitively higher and how the mini-grids investment cost mix can best be managed to produce energy at relatively cheaper tariffs than the current ones. Accompanying studies should

focus on robustly setting up mini-grids to deliver stable power to limit the frequent power outages and resultant crises since power stability was a thorny issue in almost all grids sampled in East Africa. The solutions from this further research will make grids more robust and enable more customers to connect since it is evident in places like the islands of Lake Victoria in Uganda that mini-grid energy remains one of the few possible power supply options in the short and medium term.

6.6 Final Remarks

As observed from this thesis, discourses shape and are also shaped by people's lived realities in particular settings (Wang, 2021: 585-586). Second, the global discourse on the meaning of gender in sustainable energy development intersects with local discourse-shaped realities that have influenced the participation of males, females and others in renewable energy. These discourses further influence how energy projects like mini-grids are designed, implemented, and operated and the national policies governing their deployment. Discourse also influences education systems design and delivery and differentiated educational outcomes for men and women. For example, the gendered discourses have created complexities for females to participate in science education, which is one of the essential requirements for students to pursue courses like electrical engineering and civil engineering, which are vital for one to penetrate the renewable energy sector. Using, for example, the theory of social learning (Bandura, 1986: 95; Maisto et al., 1999: 106) and the gender schema theory (Bem, 1981: 354; Scott, 1986:1053-1059), which emphasise the impact of socialisation (through discourse and practice) on people's life outcomes, it is safe to argue that in the East African case, where females and males grow and study in heavily patriarchal gendered environments (Adjoh-Davoh et al., 2021: 1; Hopwood et al., 2018: 140), where both are trained and socialised to consider technologically related fields like energy as an exclusively masculine domain, it becomes challenging for females to join the sector. As the discussions have shown, such discourses and their impact may not be limited to Africa but also exist in other Western countries considered to be developed or modern; see (Friedmann & Efrat-Treister, 2023: 32; Froehlich et al., 2022: 1-15; Knirnschild, 2019: 28; Rani & Bharati, 2018: 727; Reilly et al., 2022: 1-6).

Despite the impact played by discourse, a few females have started to 'break the glass ceiling' to join the technology and renewable energy, including pursuing STEM subjects and careers (IRENA, 2019: 12). With continued education and other forms of social transformation, the power of some of the discourses is likely to shrink so that, eventually, gender gaps in the energy

sector are progressively narrowed. As significant parts of the discourse against females in renewable energy and technology-related business are critical contributions and examples given against anti-female practices, this study on existing discourse opens new dimensions for analysing renewable energy, gender, sustainability and even educational realities.

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Appendix: Participants Consent Statement

The researcher has explained the procedures, benefits, and my rights as a participant in this study. I understand that my choice to participate will not impact me in any way. My identity will remain confidential when the information is used. I am also aware that I can withdraw from the study at any time. I willingly agree to participate in this study

Name Signature/ the participant..... Date

Name..... Signature of interviewer..... Date.....