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# **Bundle of Powers to Access Solar Energy**

Search for an enabling environment for women-to-women network  
in solar energy enhancement initiatives in Tanzania

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## **Abstract**

Irrespective of the abundance of solar energy resources, its access to the low-income communities of rural Tanzania is challenged by multifaceted barriers. Again, the current access goal in energy ignored the gender perspective of access. There is no alternative to establishing women-led solar energy enhancement initiatives to mitigate those access barriers and equally address gender inequality in energy access. But the effectiveness of this access mechanism depends on an integrated support system that offers them an enabling environment. Through the lens of the theory of access and gender system theory, this paper aims to identify the required support to facilitate the women-to-women network enhancing energy access and reducing gender inequality. A qualitative research method was explored through a case study and literature review. The study identified a bundle of support, including technical and entrepreneurial skills, market linkage, social acceptance, and financial inclusion mandatory for such mechanism. This study also seeks women-centric energy access data and more research on the women-centric approach in the solar energy sector to bring confidence among the financial institutions, demand women-centric energy access goals and policies, and promote integrated actions to address solar energy access barriers in the future.

**Key words: Gender in Energy Access, Solar Energy Access Barriers, Solar Energy Adoption Initiatives, Support System, Tanzania, Women Entrepreneurship,**

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## **Abbreviations:**

AMP: Awareness, Motivation and Pathway

EAUSS: Energy Access and Use Situation Survey

IEA: International Energy Agency

FI: Financial Institution

HH: Households

MFI: Microfinance Institutions

NEP: National Energy Policy

NGO: Non-Government Organization

REA: Renewable Energy Agency

RET: Renewable Energy Technology

SDG: Sustainable Development Goals

UN: United Nations

W2W: Women to Women Network

WEE: Women's Economic Empowerment

# **Chapter 1: Introduction**

## **1.1 Problem formulation:**

Out of an approximation of 860 million people who live without electricity in this world, more than 600 million of them are from rural areas of Sab-Saharan Africa (Kizilcec, Parikh and Bisaga, 2021; and Simpson *et al.*, 2021). While the current threshold of minimum electricity need per capita stands at 50kwh-100kwh, where 50kwh represents rural areas and 100kwh for urban (Mainali, 2014)), the electricity connectivity plan and infrastructural development have been mostly limited to urban areas neglecting the large marginalized and low-income population in the rural areas (Simpson *et al.*, 2021). Thus, the majority of the people in the developing nation remains highly dependent on traditional fuel choices, which has detrimental consequences on their health, life and livelihood chances, and the overall environment they are surrounded by (Katikiro 2016). Though researchers see a positive correlation between electricity consumption and well-being to produce increased income, improved health, and a sustainable environment (Moss *et al.*, 2020), many developing nations still lagged in ensuring uninterrupted electricity connections for their millions of people (Barry and Creti, 2020). This lack of access to electricity put Sustainable Development Goal 7 into a threat that aims to achieve universal access to “affordable, reliable, sustainable and modern energy” (Simpson *et al.*, 2021).

Rationales for this failure of enhancing on-grid or off-grid connectivity are complex and, in many cases, unknown (Simpson *et al.*, 2021), but solar energy technologies, as modern energy tools, are considered to be the best sustainable alternatives available on earth (Ahlborg and Hammar, 2014; Mainali, 2014; Simpson *et al.*, 2021). Recent innovations in the solar energy technology sector have also shown hope to the people with energy poverty (Mainali, 2014). This hope brought ambitious proposals about setting a new threshold for minimum electricity access by increasing tenfolds of the current threshold (Moss *et al.*, 2020). It argues that the International Energy Agency’s (IEA) current minimum threshold of electricity access of 50-100kwh considered a very low standard of electricity consumption which is not enough to reduce energy poverty, nor is it helping to end global poverty (*ibid*).

However, many countries worldwide are far behind the previous threshold even (Simpson *et al.*, 2021). The United Republic of Tanzania is one of them. This East African country has an abundance of solar energy sources, which are largely underutilized by their government and individuals (Simpson *et al.*, 2021). The country has a high level of sunshine- between the range of a yearly 2800-3500 hours, and its average solar radiation of 4.2 to 5 kWh/m<sup>2</sup> per day equals 210 million tons of oil energy (Garcia *et al.*, 2017). Despite



being a great source of renewable energy, solar has a tiny share of contribution to the country's total energy mix (Sarakikya, 2015). Traditional biomass still makes up 90% of total energy consumption in Tanzania in spite of its destructive impact on health and the environment (ibid). Also, poor electrification networks all over the country, mostly in rural areas, made 64% of its households dependent on wood fire, kerosene, and candles for lighting and cooking solution (Innovation Energie Développement, 2013). Clean energy has been considered to be the best option for those last-mile households to reduce the share of using traditional unhealthy energy sources (Ahlborg and Hammar, 2014; Mainali, 2014; Simpson *et al.*, 2021). Thus many service providers thrive on innovating solar-led technologies and providing access to it. But uptake of such solutions was very slow (Katikiro 2016).

Moreover, gender perspectives have been ignored in the energy sector (Gray *et al.*, 2019). Gender inequality is prevalent in electricity connectivity, where women are in the disadvantaged group (REA 2020). Women's position in society and men's dominance in the energy sector are two main reasons for this ignorance (Gray *et al.*, 2019). While men are involved and focused on energy policy design and modern energy technology development, women remain excluded (ibid).

Therefore, in the pathway to enhance the uptake of green energy solutions, establishing a women-to-women entrepreneurial energy network is getting recognized as an innovative instrument (Heuër, 2017). By unfolding socio-economic and environmental needs, this instrument has the potential to contribute to multiple SDGs of a developing nation. The number of unsolved challenges faced by public and private investments and partnerships in energy access projects is numerous (Dutta, 2019; Heuër, 2017). These challenges include attaining local community buy-in, understanding local needs, tailoring innovation, mitigating the high cost of growing networks and service deliveries, building awareness and local trust, providing customer services, and offering a wide range of long-lasting and high-quality clean energy solutions (Heuër, 2017). Women-led energy entrepreneurial initiatives have proved to address those challenges and fill that gap by adding instrumental value to the energy value chain (Heuër, 2017, Gray *et al.*, 2019). Like many other countries, this model has fitted in Tanzania to increase access to solar energy technologies among the poor people in rural and urban areas (Heuër, 2017). This model served in three dimensions in addressing energy poverty enabling intrinsic factors to overcome barriers to access, scale, and sustain mainly in the hard to reach areas: creating local trust and network, linking green energy to socio-economic empowerment by engaging women in energy entrepreneurship, and finally, unleashing business development potentials in the green energy sector (ibid).

But the efficacy of such a model in producing substantive evidence of increasing access to energy in a sustained way is still questionable in the academic literature (Shankar, Elam and Glinski, 2019). Though outcomes from various programmatic approaches that engaged and empowered women to become energy entrepreneurs at a subsistence level have reported concrete evidence showing a positive connection between women's energy entrepreneurship and increased access to solar energy, academic literature identified a long list of research gaps. The literature argues that women in energy entrepreneurship initiatives are still in the very early stage to confide adequately significant quantitative results, connect unified theories, and analyze counterfactual data from systematic control groups, including various forms of entrepreneurial engagements and types of energy options (Shankar, Elam and Glinski, 2019). On the other hand, much literature also highlights the barriers and challenges in women's energy entrepreneurship that may affect this business model from working effectively (Ahlborg and Hammar, 2014; Aly *et al.* 2019; Dutta, 2019; Heuër, 2017; Painuly, 2001). It is sought to have an immense scope of further research in this field (Shankar, Elam and Glinski, 2019). With that curiosity, this paper intends to understand through what conditions and enabling environment, in terms of required support, this women-to-women network provides the optimum outcome for increasing electricity access through enhancing the adoption of solar energy technologies in a situation where electricity access is already poor, and gender system causes additional barriers.

To investigate the issue, this paper studies a solar energy value chain project being implemented by multiple national and international organizations, including Non-government Organization (N2) that design and implement development programs targeting women, Social Enterprise that has solar distribution network (SD1), a Microfinance institution (F2) that offers credit facility to women, and solar energy solutions providers<sup>1</sup>. The project is called 'W2W'<sup>2</sup>, which promotes women's entrepreneurship to enhance solar energy access in rural Tanzania.

This paper is inspired by two theories- the theory of access by Peluso and Ribot (2003) and the gender system theory by Yvonne Hirdman (1990). The Theory of Access is used because it distinguishes between 'ability' and 'right' to access and derive benefits from things as Peluso and Ribot, (2003) emphasized that access analysis is critical to reveal how ability facilitates rights to get benefits from resources. So, with the lens of access theory, this study wants to understand the specifically required abilities for entrepreneurs and user groups to access solar energy devices and derive benefits from them. On the other hand, gender system theory is used to understand the context of social subordination towards women that affect their role as an

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<sup>1</sup> For the sake of anonymity, this paper did not disclose the project partners and framed them using a coding system. The coding used (N2, SD1 and F2) in this paragraph are explained in the methodology part.

<sup>2</sup> A pseudonym is used to maintain anonymity of the project.

entrepreneur of solar energy products and decision-maker to access them for domestic and business purposes. More details on the theories are explained in chapter 4.

## **1.2 Research Question:**

This study aims to disseminate knowledge to future researchers and development practitioners regarding women's energy entrepreneurship initiatives, prevalent barriers, and needful enabling environment. The key research question it asks, therefore, is:

What support system enables the women-to-women network to overcome barriers to enhance access to solar energy products in rural Tanzania?

To address the above primary research question, this paper considers diverse factors to study and thus formulates the following supporting questions:

- 1) Why are women important actors in solar energy enhancement initiatives?
- 2) What are access barriers in the adoption of solar energy technologies identified?
- 3) What is the structural and relational mechanism in the enabling environment of accessing solar energy technologies identified?
- 4) Do financial service providers see Solar Energy as a potential sector?

## **1.3 Delamination of the study:**

The scope of this paper is not to evaluate any business models in the solar energy distribution pathway, nor does it intend to design or propose any new business model. Instead, it only seeks to unfold knowledge from the selected case and other institutions engaged in solar energy distribution initiatives.

## **1.4 Structure:**

There are seven chapters in this paper. While the first chapter formulates the research problem and question, the second chapter describes the context of the research topic, the alternative pathway, and the case. The third chapter focuses on literature reviews on the role of women in energy entrepreneurship, energy access barriers, and required support systems. Chapter four deals with the theoretical framework introducing two theories used in this research. Chapter five explains the methodologies, data collection process, analytical framework, study limitations, ethical views, and researcher's positionality. In chapter six, the relevant findings are shared and analyzed. Finally, in chapter 7, the paper has drawn the conclusion and suggestions for future academics and policy discussions.

## Chapter 2: Background

Tanzania has been keeping a track record of energy access and its use situation across the country. Ensuring universal access to energy and its use in Tanzania has been a demand and well-stated promise from every government, which resulted in setting national electrification targets as addressed in its development vision SDGs 2030 (REA, 2020; Rocco *et al.*, 2020). In meeting the commitment to improved access to modern energy, the government adopted National Energy Policy (NEP) in 2015 to enhance electricity connectivity to urban and rural networks (REA, 2020). To track the progress, its Ministry of Energy has conducted two nationwide surveys through Rural Energy Agency in 2016 and 2019/2020. This report (table 1) is the latest record of the energy access situation in Tanzania that highlights the level of electrification, households perception, affordability condition, benefits and impacts, and energy sources (*ibid.*).

### **2.1 Electrification status:**

According to REA’s (2020) national electrification survey conducted between the end of 2019 and early 2020, the country has connected its 78.4 percent population, an 11 percent increase from 2016/2017 (Rocco *et al.*, 2020). The survey revealed that people who live in urban areas have almost 100 percent connectivity. In rural areas, 21 percentage points more people, from 49.3 to 69.8 percent, have electricity than in the last survey done in 2016/2017 (*ibid.*).

However, the ratio of household connectivity does not reflect the progress. In those four years, there have been only a five percentage points increase at 37.7 percent of all households in the mainland of Tanzania from 32.8 percent point in 2016/17. The differentials between urban and rural households suggest that 73.2 percent of the urban households are connected to electricity compared to 24.5 percent of households in rural areas.

Electrification	Tanzania		Rural		Urban	
	2016/2017	2019/2020	2016/2017	2019/2020	2016/2017	2019/2020
Population connected to electricity	67.5%	78.4%	49.3%	69.8%	97.3%	99.6%
Households connected to electricity	32.8%	37.7%	16.9%	24.5%	65.3%	73.2%

Table 1: Electrification situation in Tanzania (REA 2020)

The latest available national-level data, as described above, clearly presents the access gap in Tanzania. No other data was identified at this level of information to compare with this government-led survey results.

## 2.2 Gender inequality in accessing electricity:

The Energy Access and Use Situation Survey (EAUSS) report also spotted gender inequality in accessing electricity. At the national level, 70 percent of electricity connectivity is observed in male-headed households against 30 percent in female-headed households. Again, the ratio is worse in rural areas than in urban male-headed households. While 39.3 percent of female-headed households in urban areas have access to electricity, the percentage for rural female-headed households is 26 (REA, 2020). This inequality in the distribution of electricity connectivity does not promote SDG 5 and SDG 7 (Dutta, 2019). Rather it intensifies the problem (Shankar, Elam and Glinski, 2019).

## 2.3 The main source of energy:

The following table (table 2) shows the trend of the main source of energy for lighting in the HHs of Mainland Tanzania (REA, 2020)

Source	2012 <sup>3</sup>	2016/17 <sup>4</sup>	2017/18 <sup>5</sup>	2019/2020 <sup>6</sup>
Kerosene/Wick Lamp	40.06	20.8	7.0	7.0
Candle	1.3	1.0	1.0	0.7
Firewood	2.0	0.8	1.3	0.3
Electricity	18.9	25.1	29.0	34.2
Solar Power	1.4	7.6	26.5	33.0
Rechargeable Lamps	14.9	39.9	27.5	21.8

Table 2: Trend of the main source of energy usage by households.

Over the trend, households of Tanzania has reduced the use of kerosene, candle, and firewood drastically as a source of energy for lighting purpose. In parallel to the increased use of electricity, solar power has become the second-largest energy source for households for lighting. The use of solar power in households

<sup>3</sup> Population and Housing Census (PHC)

<sup>4</sup> EASS (Energy Access Situation Survey)

<sup>5</sup> Household Budget Survey (HBS)

<sup>6</sup> Energy Access and Use Situation Survey (EAUSS)

has grown from 1.4 percent in 2012 to 33 percent in 2021/20. (REA, 2020). This trend of adopting solar power as an energy source in Tanzania also shows the increased demand for solar energy technologies. However, households' gap in adopting solar energy is still high (Katikiro, 2016). Indeed, different pathways resulted in some progress, but looking at the high gap requires studying and applying the most suitable way to contribute to the attainment of SDGs (Katikiro, 2016; Sy and Mokaddem, 2022).

## **2.4 Alternative pathways to reduce the access gap:**

The worldwide energy access gap has created a large market opportunity for clean energy solutions like solar energy. It has opened up new windows of hope, offering an affordable and accessible range of quality solar devices for both productive and household uses, targeting the rural people who mostly live in energy poverty. To increase the reach and access of such technologies at the bottom of the pyramid, people in remote rural areas where the grid connection is hard to distribute to many developing nations' energy sectors have initiated and tried with different pathways and innovative business and distribution models. However, many of the pathways could not tap that market for mainly two reasons- difficulties in setting up and challenges in operating the last mile distribution channel (Dutta, 2019). Regarding addressing these two main bottlenecks, women engagement is considered one of the milestone distribution models that desired to solve another twin challenge- women empowerment and energy access (Dutta, 2019; Heuër, 2017). Empowering women to engage in energy entrepreneurship is also recognized as an innovative and efficient strategy in addressing the United Nation's two of the most challenging Sustainable Development Agenda 2030- gender equality (SDG 5) and the universal access to energy (SDG7) (Dutta, 2019). This strategy can achieve faster growth in connecting last-mile households with energy needs for the national policymakers and national and international development agencies. On top of that, this woman (energy entrepreneur)-to-women(energy users) network adds multifaceted and transformational outcomes in achieving gender equality and women empowerment (Dutta, 2019; Heuër, 2017).

## **2.5 Describing the Case: The 'W2W'<sup>7</sup>Project:**

The 'W2W' project initiated with a core objective to enhance access to clean energy in rural Tanzania by creating entrepreneurship opportunities for women. This project addresses two problems in Tanzania: lack of employment and economic opportunities for women and lack of access to clean energy (Lyne, 2020). This multi-year consortium project evolved in a situations where rural people in Tanzania cannot access

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<sup>7</sup> A pseudonym is used to maintain anonymity of the project.

consistent electricity due to lower connectivity and affordability, lack market access, awareness, and supply of quality solar solutions to replace traditional unhealthy means like kerosene charcoal and candles. (Interview 4).

To address those twin challenges- the lack of employment and economic development opportunities for women in rural Tanzania and the lack of access to clean energy, the activities of this woman empowering solar energy value chain project grouped into three main categories: (i) creation and expansion of last-mile distribution network of solar energy product through women entrepreneurship development and capacity building; (ii) promotion of quality solar products to improve demand by creating a robust supply chain that includes a partnership with certified manufacturers and consumer awareness programs; (iii) offering innovative consumer financing to enhance access of solar energy technologies among the low-income rural communities (Interview 4).

The project has partnered with NGOs, solar distributors, solar solutions producers, and microfinance institutions to implement the above activities. These partners play four different roles in the project that include– project management , microfinance service provision, solar distribution, and solar manufacturing (Interview 2, , Interview 4).

## **2.6 The distribution model of the W2W<sup>8</sup> project:**

From the interviews and follow-up questions, it is understood that the W2W project had three<sup>9</sup> different models in the project design, but it ended up testing two models of them. After testing those two models, the project ended up with scaling one model with necessary amendments. One of the interviewees explained the two models illustrated below. It was not possible to capture the step-by-step process of the distribution model, but it is drawn the way it is understood from the interview.

The first model (figure 1) comprises a network of women entrepreneurs, locally recruited and facilitated by ‘SD1<sup>10</sup>’, connected to another large women group of ‘MF2<sup>11</sup>’ members to pitch and sell quality solar products supplied by Solar Sister. This group of microfinance members was chosen as potential consumers

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<sup>8</sup> A pseudonym is used to maintain anonymity of the project.

<sup>9</sup> They said about having three models but described only two.

<sup>10</sup> Solar Distributor 1 as per interview reference coding system explained in Data analysis

<sup>11</sup> Microfinance 2 as per interview reference coding system explained in Data analysis

because they lack electricity access in their households and business. Moreover, if they do not afford to buy a product, ‘MF2’ offers a credit facility to the consumers and pays the product's price to the solar entrepreneur. (Interview 2 and 4).

## Model 1

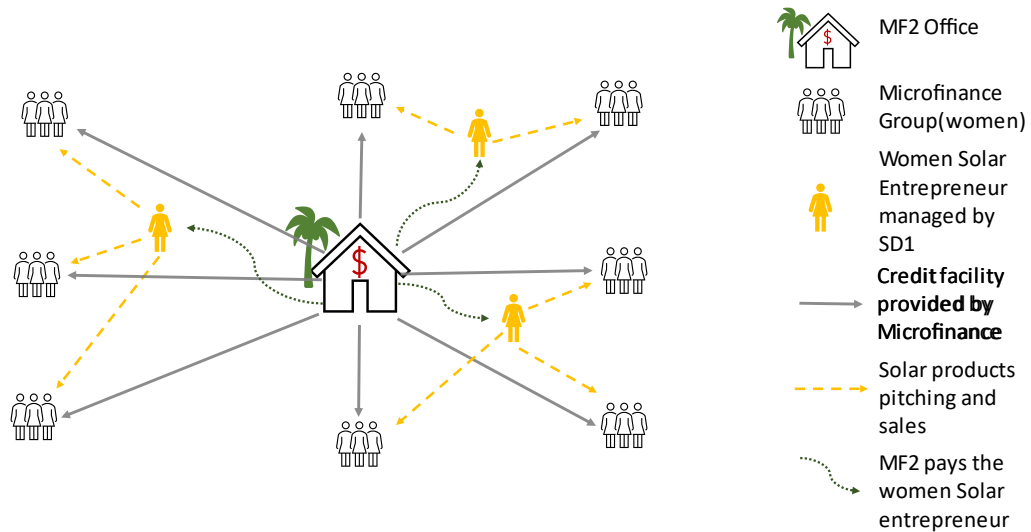


Figure 1: W2W’s first business model

In the second model, the project builds a network of women entrepreneurs outside the areas where microfinance does not have clients but has potential for up-taking solar energy products. The women entrepreneurs had to pitch door-to-door to advocate using solar energy and make households get interested in buying one according to their needs. The households who could not purchase in cash were registered for credit facilities provided by ‘MF2’. Indirectly, this network of women entrepreneurs was promoting credit facilities to households challenged with affordability, bringing a new client base for ‘MF2’. This arrangement was taken to increase the reach of solar energy products beyond the catchment area of ‘MF2’ offices (Interview 4).



## Model 2

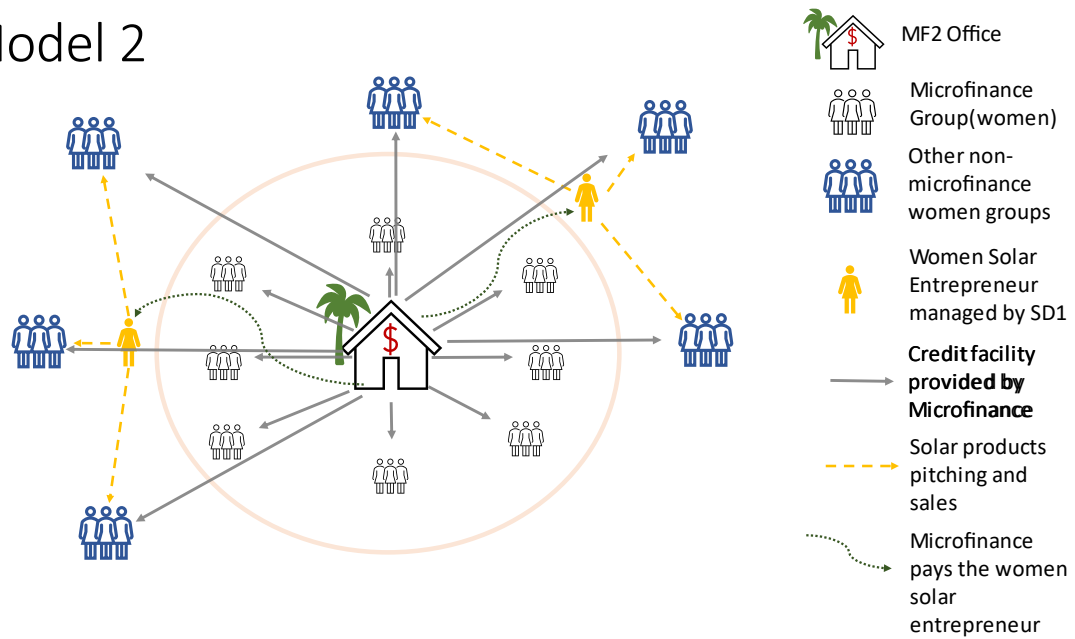


Figure 2: W2W's second business model

## Women Solar Entrepreneurs connection with Solar Enterprise-'SD1'

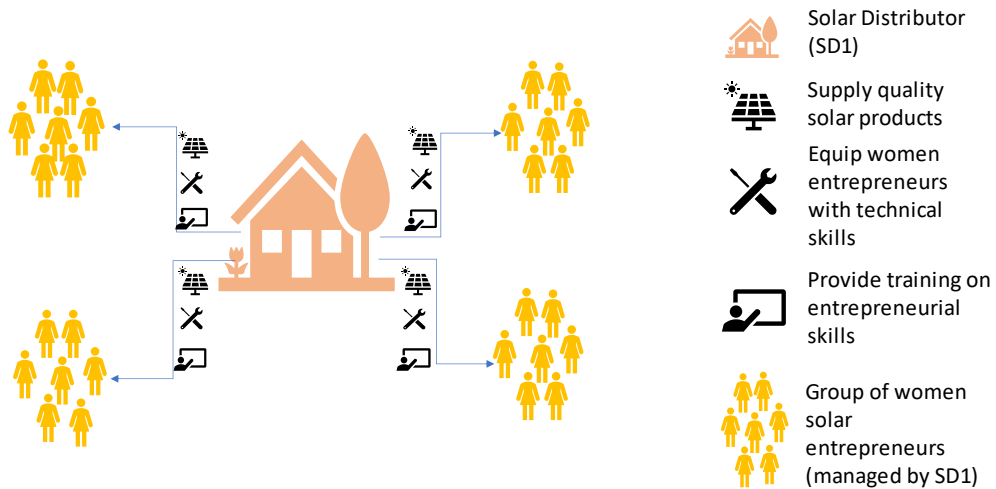


Figure 3: Supports solar entrepreneurs receive from social enterprise 'SD1'

## **Chapter 3: Literature Review:**

### **3.1 Defining Energy Access**

Definition of energy access found controversial (Sy and Mokaddem, 2022). There is a lack of consensus about the essential energy services and the minimum energy requirements to meet those essential energy services. Among the researchers, there are many arguments about determining what should be the basic energy services and what not. Some considered cooking and lighting for household use enough, whereas others went beyond cooking and lighting, including energy for cooling, heating, education, entertainment, transport, life style, information, and communication technologies. On the other hand, due to relative differences in the context, climate and season, it is also difficult to draw basic energy services and minimum energy requirements (ibid). Some conceptualized energy access with physical availability dimensions, whereas others thought it was more complex and multidimensional, including affordability, acceptability, reliability, quality, and adequacy (Mainali, 2014). By physical availability dimension, for a long time, energy access has been defined as electricity access, which refers to access to the grid connectivity mostly with no mention of off-grid availability. Researchers believe that this central thought on-grid connectivity has again a relation with developing countries rather than developed ones (Sy and Mokaddem, 2022). It is mainly because ensuring access to electricity is a major challenge for developing countries which is traditionally considered to be solved by government initiatives. Nevertheless, failing to implement government commitments leads to traditional and modern energy sources being part of the physical availability dimension (ibid).

While on-grid electricity solutions are not only scarce and demand for new connectivity is surging, off-grid technologies are sought to be the right solutions to fill that energy access gap (Shankar, Elam and Glinski, 2019). Off-grid technologies do not use public electrical supply system; instead, it depends on utilizing water, wind, or solar as a renewable energy source (ibid). Regarding the modern and sustainable source of electricity, solar energy is universally considered a bottomless and abandoned source of lighting and heating (Mownika *et al.*, 2021). Solar as a source of electricity for both domestic and commercial use is emphasized to be more efficient than any other source of electricity, e.g., biomass is pivotal to addressing the issue of energy access and reduction of energy poverty ((Mownika *et al.*, 2021; Shankar, Elam and Glinski, 2019). Therefore, while this paper discusses energy access, it refers to the means of solar energy access.

## 3.2 The role of women in energy Access

### 3.2.1 Women run energy initiative:

Policymakers worldwide have appreciated women's engagement in solar energy distribution through the entrepreneurship model. As women are historically engaged in the collection, cultivation, and use of traditional and domestic energy sources, it is evident that their involvement in the distribution of solar energy products and services has a significant social, economic and environmental impact (Shankar, Elam and Glinski, 2019).

Heuër (2017) researched the women-to-women entrepreneurial network and concluded it is a significant pathway to increasing solar energy access at a large scale for developing countries. Capitalizing on the social network of family, friends, and neighbors, women have the potential to be the trusted energy advisor for the community. On top of that, many other researchers believe that engaging women in the solar energy value chain will empower them economically and socially and also helps to bring positive business outcomes for the solar-led energy producers (Shankar, Elam and Glinski, 2019). According to their views, it enables producers to produce solar products and offer related services that are better targeted to meet rural needs and sell to primarily female customers in hard-to-reach areas.

The business model for engaging women in the energy sector is multifaceted. There are diverse views in the literature on how women can be engaged to gain more effective and sustainable outcomes. Apart from entrepreneurial activities, researchers also see women getting engaged as commission-based sales agents that also increase their household income, social identity, network, technical knowledge and skills, and self-confidence. Considering the associated financial risk with entrepreneurship, it is argued that poor women should not be engaged in the energy entrepreneurship program (Baruah, 2015; Shankar, Elam and Glinski, 2019). Instead, sales, distribution, maintenance, and post-sales services would be better as a sustainable income source for women (Shankar, Elam and Glinski, 2019). The programs that engage women in entrepreneurship should consider the risk factor and have a risk mitigation strategy (ibid).

### 3.2.2 Women to advance energy access:

Only one systematic literature review on the topic of women's engagement in clean energy entrepreneurship initiatives was conducted by ENERGIA (Shankar, Elam and Glinski, 2019) to unfold the women's contribution to advancing energy access for all. It addressed women's role as energy entrepreneurs, its benefits to women and their families, and best practices to support women entrepreneurs in the energy sector. The review concluded that women's engagement in energy entrepreneurship is highly potential to benefit themselves, their families, and their communities. However, this initiative is still at the very early stage of development to generate substantial evidence of holistic impact. The available literature on

women's energy entrepreneurship is based on programmatic reports and descriptive and perspective studies that lack theory, control groups, and counterfactual analysis to draw extensive evidence regarding women's engagement in energy entrepreneurship. Program failures to understand the local context and structural factors are also some possible reasons why the evidence in favor of women in advancing energy access for all is not substantial (ibid).

The report argued that the primary objective of most solar energy distribution programs and services is not exclusively linked with women empowerment; instead, they are designed to scale the distribution of energy products to the greatest number of people (ibid). This mechanism addresses gender perspectives to varying degrees depending on the nature of the engagement in the energy value chain. Building on the findings from different studies and considering different ranges of solar products, availability of resources, and required skills set, it stated that roles in sales and distribution, technicians, post-sales services, maintenance, and repair are more attractive and effective to women. However, these roles are still at the subsistence level and could not reach toward a more growth-oriented business. Women are still vastly underrepresented in leadership and technical roles in the energy sector (Heuër, 2017).

### 3.2.3 Women vs. men entrepreneurship in general:

While women in the energy sector are in the discussion, it is also essential to look at their role in other entrepreneurial sectors. Irrespective of any specific entrepreneurial sector, this report suggested that women have more socially oriented goals than men (Hechavarría *et al.*, 2017). Moreover, within the same sector, it is found that female entrepreneurs are as good as or better than their male counterparts. However, in terms of economic indicators, male entrepreneurs are still ahead of women. (Shankar, Elam and Glinski, 2019).

Specific to the women-led energy entrepreneurship initiative, there is encouraging evidence that participation of men in the programs towards women empowerment has helped improve the outcome of the programmes and benefited the women and their families (Shankar, Elam and Glinski, 2019). In developing countries, women have longer working days that deter their ability to participate in income-generating activities and thus experience time poverty than men (Blackden and Wodon, 2006). This time poverty impedes women than men in dedicating efforts towards entrepreneurial activities, which is an important context to realize while designing solar energy enhancement programs through women's involvement

### 3.2.4 SDG addressing gender in energy access:

Though UN SDGs have a specific goal number 5 that dedicates to ensuring gender equality and empowerment of all women and girls (UN SDGs, n.d., n.p.), it lacks to clearly or directly indicate gender issues in energy access goals in SDGs (Hellqvist, 2021). The only goal is SDG 7, which urges to ensure energy access for all and acknowledges the adverse effect of traditional energy uses on women and girls,

but there is no specific target or indicator to serve women and girls with this accessibility. It has kept universal even knowing that women and girls are the prime actors in meeting the energy need at home. This gap has a detrimental effect in planning, addressing, and implementing energy initiatives, mainly in countries where gender inequality is high (ibid). Thus, this paper intends to contribute to the discussion on SDG attainment and asks to set women-specific energy access indicators.

### **3.3 Solar energy access barriers:**

Studies related to solar energy access and barriers to uptake among rural households in developing and underdeveloped nations have been a popular topic among researchers. As the context differs, so do the barriers, but there are also many common stressing factors among the nations. Before understanding the required supports, it is crucial to understand what makes the pathway challenging to create a large-scale impact. The pressing access barriers that different research findings have identified can be summarized by unaffordability, inaccessibility to finance, inadequate community awareness, technical incompetency, absence of political priorities, market inefficiencies, and gender stereotypes (Ahlborg and Hammar, 2014; Aly *et al.* 2019; Dutta, 2019; Heuër, 2017; Mainali, 2014; Painuly, 2001).

The studies related to Tanzania also capture the barriers mentioned above, but specifically, one study has made three categories: Institutional, Financial and Technological (Aly *et al.*, 2019). The study found that the institutional barriers are predominant in Tanzania that trigger financial and technological barriers. The list of institutional barriers identified in that study consists of uncertainty in government commitments, negative perception from the decision-makers about the impact of solar power technologies, unfriendly business environments for the private investors involved in solar energy technologies, and political interference that hinders investment decisions adding the risk of unpredictability and uncertainty (ibid). This correlates with another study done in Nepal that addressed the absence of pro-poor policies hindering the outreach of on-grid and off-grid solutions (Mainali, 2014). A study from Nepal on their rural electrification effort and market-oriented policies to promote affordable off-grid Renewable Energy Technologies (RET) revealed that a richer section of the population in the isolated and last-mile rural areas has higher access to electricity than its poorer section the population. Policies that made the technologies affordable and accessible did not benefit the poor households due to a lack of credit facilities for the device's upfront cost, which challenged the expansion of rural electrification drive primarily for poor communities. Similar scenarios were identified in China in dealing with the transmission of modern energy choices (ibid). Political priority is also a barrier in a survey conducted in Tanzania and Mozambique (Ahlborg and Hammar, 2014). The analysis of its seventeen semi-structured interviews (9 in Tanzania and 8 in Mozambique) of government officials, international donors, technical consultants, and the civil society

organization. The study identified political priority as the main driver for rural electrification and pointed out that rural electrification issues are often used as an election-related endowment. The study found that barriers are strongly related to the roles of national and local (rural) actors in planning and implementation (ibid).

In the financial barriers, the absence of sufficient credit facilities, and the high upfront cost of the device and accessibility challenged the expansion of energy access drive among the rural communities where poverty is prominent (Mainali, 2014). Highlight the positive relationship between the income level of households and their use of electricity; Mainali (2014) observed that unaffordability among rural households hinders electricity access. The financial barriers also marked off-takers non-payment risk and the unwelcoming financing mechanism in large-scale solar energy projects (Aly *et al.*, 2019).

The technological barriers identified in the study (Aly *et al.*, 2019) consist of the absence of empirical studies and reliable data to back up large-scale solar energy projects, insufficient quality human resources, and a limit on the utility of electricity generation from renewable energy. Painuly (2001) identified market failures, distortions, and technical and social-cultural behaviors from the stakeholder perspective. Though that study was 20 years old, the barriers are still persistent.

A review of a multi-country women's economic empowerment (WEE) Programme launched by Energia to understand what it takes to design, sustain, and scale in facilitating modern energy access and services to last-mile rural communities has identified some market barriers as critical challenges in enhancing solar energy access (Dutta, 2019). High operation cost, lack of capital and consumer financing, struggle to get the right partners, high import tax, price sensitiveness, lower and faulty quality products in the market, and logistical barriers to last-mile distributions were among those market barriers that affected women's energy entrepreneurs growth and mobility (ibid).

Another study identified lack of finance, lack of community awareness and engagement, lack of political priorities, and lack of technical knowledge, skills, and support as the key barriers to the entrepreneurial initiatives in solar energy access (Heuër, 2017). This study calls for multi-stakeholder partnerships as an instrumental tool in addressing systematic challenges and enabling the entrepreneurial ecosystem in the solar energy value chain to sustainably create social and environmental impact (ibid). Through this value chain, women get a social position offering trust within the community in delivering and servicing solar products. However, according to some researchers, building this trust is not easy and requires community awareness and engagement (Katikiro 2016, Heuër, 2017). Many energy access projects fail due to not earning buy-in from the community.

Reviewing all the above literature, it is realized that the pathways in enhancing solar energy access consist of multifaced challenges. It is also reflected that each of the barriers interacts with each other. However, those barriers were not studied through the lens of gender perspectives. Moreover, there are limited studies that specify barriers for women as entrepreneurs and consumers of solar energy. They mainly were, in general, energy in a broad sense. Therefore, this paper addresses these research gaps to offer new knowledge in the solar energy academy.

### **3.4 Required supports:**

A self-reflection document (Dutta, 2019), produced by Energia on its four-year (2014-2018) multi-countries women-run energy access project, shared five lessons regarding women's entrepreneurial development in the solar energy value chain. It highlighted enabling environment, access to finance, adoption of eco-system approach, alignment with national priorities, and engaging family members, including men, as the key factors in considering women in energy initiative. It has also emphasized the need for continuous training and mentoring to build self-confidence among women. When women enter energy entrepreneurship, they are mostly unfamiliar with the technologies; they lack market knowledge, entrepreneurial skills, and self-confidence to run the business profitably (ibid).

Shankar, Elam and Glinski (2019), in their only systematic literature review on women's energy entrepreneurship initiatives, insisted on the adoption of proven best practices and strategies in the design of women's energy entrepreneurship programs. Hence, an integrated approach of offering required support is advised to enhance solar energy access. It has highlighted the importance of having support at individual and business levels. This empirical study identified business skills, financial literacy and personal empowerment training, use of technologies, capital, coaching, mentoring, networking, and men engagement in women's energy entrepreneurship initiatives as the required functional support system.

De-risking the investments is another necessary support that women entrepreneurs need. Studies found an element of financial risk in inventory purchase and management that discourage women from getting engaged Shankar, Elam and Glinski (2019). Women also lack credibility and buy-in to commit the supplying companies to exempt upfront investment. Therefore, in terms of financing mechanisms, de-risking factors are thought to be a critical element to consider.

A case study by Simpson *et al.* (2021) explored how low-income actors in Tanzania adopt solar energy products and their effect on their living conditions. By using the AMP (Awareness, Motivation, and Pathway) framework, the study explored adoption rationales that indicate awareness, motivational factors in terms of the utility of the technology, the cost in the form of affordability, warranty in terms of quality, and customer services as influential factors of early adoption decisions among the low-income rural communities (ibid). Apart from these awareness and motivational aspects of adoption, the study emphasized the significance of a suitable pathway to enable sustainable energy access among targeted communities. In terms of that feasible pathways, it has proposed the engagement of non-state and indigenous actors in driving the energy access initiatives in rural and low-income communities. Public, private, and cost-sharing infrastructures are unfit pathways for underprivileged rural communities. The role of non-state entities to provide off-grid solutions to a large group population is an alternative pathway to the traditional public service delivery model (ibid).



## **Chapter 4: Theoretical framework:**

### **4.1 Theory of Access:**

Peluso and Ribot (2003) developed the theory of access that proposes a knowledge that distinguishes between individuals right to access specific resources and ability to derive benefits from those resources. According to the theorist, holding the right to access is not enough, nor is it adequate to extract desired productivity from a certain resource. It requires the individual who holds the right to access the resource has an ability to derive benefits from those resources. By having an ability, the theorists link to access corresponding structural and relational mechanisms such as capital, knowledge, labor, technology, market, identity, and social relations (Ribot and Peluso, 2003; Mutea, Rist and Jacobi, 2020).

Access is conceptualized beyond the right to benefit and incorporates the ability to derive benefits from things (Mutea et al.,2020). This theory argues that rights to resources, denoted as a ‘bundle of rights, maybe guaranteed, but they are not always accessible due to a lack of certain abilities, denoted as a ‘bundle of powers’ (Peluso and Ribot, 2020). These two variables mediate each other or operate in parallel to ensure how resource users gain control over the resource and maintain enjoying benefits from it (Mutea et al.,2020).

Access to energy resources such as electricity, gas, fuel oil, biomass, solar, etc., is fundamental to modern living and economic prosperity(Moss *et al.*, 2020). However, access to this fundamental need is beyond the power of millions of households who lack energy security. For a sustainable livelihood opportunity, use and access to stable energy are indispensable. Among the long list of the energy mix, electricity is considered the most efficient and sustainable means of energy security (Mownika *et al.*, 2021). Thus, in most cases, energy security is favored by nationwide on-grid electricity connectivity. However, due to technological advancement, the world has already discovered a more efficient energy source by converting solar power into electricity, which is yet to reach the large group of energy poverty communities (Sy and Mokaddem, 2022). This gap in accessing an alternative source of energy by the majority of the population in the developing nations is influenced by multiple interconnected factors “represented within a “bundle of powers”. Guided and inspired by the Theory of Access defined by Ribot and Peluso, this paper, thus, unveils/uncovers those main factors in the solar energy sector in respect to the “bundle of rights and powers” that influence households energy security for rural Tanzania (Peluso and Ribot, 2003).

Having access to own solar energy technology is not enough to benefit from it. Instead, other abilities are the main factors that deter how the benefits will be derived. By exploring the bundle of powers and rights, this paper aims to identify those main factors that can enable rural households to derive benefits, the electricity need, from solar energy sources. This paper connects the theory of access and utilizes the ‘bundle of powers’ to analyze who benefits from things and at what conditions. Thus, the bundle of powers comprises target beneficiaries and their ability to access solar energy solutions. This paper mainly focuses on women as entrepreneurs and users in the target beneficiaries. In terms of abilities as a subset of power, this paper focuses on the structural and relational mechanism of access in the form of a critical support system to enable the environment to derive benefits from the access.

## **4.2 Gender system theory:**

Apart from the theory of access that helps the capability perspectives of access, this paper also intends to understand gender perspectives in the form of cultural beliefs and social-relational context that may affect the accessibility of solar energy technologies. This paper uses gender system as a theory to evaluate persisting gender beliefs and the social situation where these beliefs interact and produce gender inequality. The concept of gender system theory is brought by Yvonne Hirdman (1990), a professor in history in Sweden. According to her, each society views men and women as different entities having opposite traits and hence assigns jobs, roles, responsibilities, and social positions accordingly. The gender system theory, thus, is based on two main principles- the separation between men and women; and the superiority of males in society. The separation occurs by specifying or drawing the line between men and women regarding their roles and tasks in society. The gendered role and tasks become dominant to differentiate between men and women. On the other hand, the male superiority principle values male activities higher than women and thus positions male status above the women in the society (ibid).

Gender hierarchy is persistent worldwide, where man is given greater status and instrumental competence over women. The horizontal dimension of gender beliefs, on the other hand, shows a “*fundamental difference that associates each sex with what the other is not*” (Ridgeway and Correll, 2004, p. 19). These dimensions interact and support each other, building a dynamic social-relational context where the perceived competence gap and social status persist. However, there is some encouraging evidence of narrowing the gap between men and women. The social situations are influenced by gender beliefs that consider men and women are different, with men being of the higher status. Improved socioeconomic

conditions or increased individual and collective resistance can modify gender beliefs a bit but cannot eliminate its core structure from the root (Ridgeway and Correll, 2004).

Gender role has been a prevalent research issue in entrepreneurship initiatives. Many research findings tagged women with under-performance in women-led businesses on a lack of entrepreneurial capital. Not surprisingly, modern researchers have over-ruled traditional views of women as weaker entities in entrepreneurship roles than their male counterparts. They find that the challenges women face in any form of entrepreneurship should not be analyzed with economic terms only but require contextual discussion (Henry et al., 2015).

The developing nations are already accustomed to and habituated to a certain level of gendered norms and biases that unjustly differentiates roles and rights between men and women (Shankar, Elam and Glinski, 2019). These unjust social norms and habits hinder women's righteous ownership of resources and equal participation beyond household responsibilities (ibid). Specifically to the research topic, entrepreneurship is male-dominated in the perspective of the gender system. So, the barriers that affect women entrepreneurs, in general, are the same and should involve the women in energy entrepreneurship (Henry et al., 2015). Therefore, to understand the role of support for women energy entrepreneurs to advance energy access, it is important to explore the prevailing gender norms, power structure, and societal habits that create barriers. This will help justify the need for a bundle of powers exploring their multidimensional categories in the field of development.

Women play a significant role in ensuring holistic and sustainable development. Their role in development was first coined by a Danish agricultural economist, Ester Boserup, in her book on "*Women's role in economic development*," published in 1970 (Peet and Hartwick, 2015). She criticized the concept of modernization, freeing women in the third world nations. According to her argument, the modernization process marginalized women by placing new technologies under the control of men. This access control allowed men to position themselves with higher social status, power, and income, which provoked gender inequality. Therefore, she proposed a new phenomenon of integrating women in the development process that was later got adopted by national governments and international agencies. Since then, women's participation in the development process evolved through various progressive theories and practices and has become a basic norm for bringing sustainable development impact (ibid). Being inspired to that phenomenon, this paper also considered women as a key actors in bringing the development opportunities for themselves and their surroundings.

## **Chapter 5: Research methodology**

This chapter describes the research design, methodology, research questions, interview guide, and data collection process and limitations.

### **5.1 Motivation**

This research is driven by my interest in women empowerment and rural electrification. The Women empowerment agenda has grown in me from my professional experience, but the need for an electricity agenda is attached to my childhood when I experienced irregular power supplies in my country, Bangladesh, hampering my studies. I felt the same realization when I was deployed in Tanzania, where the majority of the rural population is not accessing electricity. I have seen how women-led solar energy entrepreneurship initiatives are emerging to provide an alternative solution. My interest in this field has grown since then. By studying this topic, I want to generate knowledge that will help the UN to realize the gap in the target for SDGs 5<sup>12</sup> and 7<sup>13</sup>, where gender inequality in energy is not specifically introduced. This study will also encourage all the solar energy value chain actors to evaluate their offerings for potential growth opportunities.

### **5.2 Ontological and Epistemological**

This paper investigates the existence and effectiveness of engaging women in solar energy enhancement initiatives as facts (the ontological position) and the institutional perception regarding the conditions towards effectiveness as how knowledge is gained (epistemological position). For ontological position, this paper holds a constructivism approach as it asserts that social phenomena are dependent to social actors and thus continuously being produced through social interaction (Bryman, 2012). For epistemological position it holds critical realism approach as it is best suited to produce knowledge gained through the interpretations of the participants by establishing connections between theories and social practices (ibid).

### **5.3 Research design:**

This paper intends to use a case study as a research design. Yin (2014) suggests emphasizing the research questions and their extensive relations to social phenomenons to choose the right research design. He

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<sup>12</sup> Achieve gender equality (United Nations, 2020)

<sup>13</sup> Achieve universal energy access (United Nations, 2020)

explained that a case study should be a more relevant research methodology when the research questions intend to investigate a real world contemporary phenomenon with ‘why’ or ‘how’ denoted questions. One more fundamental characteristic of research to use the case study as a design is a need for an extensive description of the case, or phenomenon over which the researcher has no or little control and findings cannot be manipulated (Gomm, *et al.*, 2000; Yin, 2014). These characteristics resemble this thesis paper's research questions, hence choosing a case study as the research design.

The case selected for this research is based on a project currently being implemented in Tanzania that addresses two problems: the lack of employment and economic development opportunities for women and the lack of access to clean energy. This project is relevant to the research because of mainly two reasons: (i) no other project was found that addresses twin problems at a time, and (ii) it can offer the latest knowledge in this sector as it is still running (though soon it will be phased out).

#### **5.4 Research method:**

This study adopts a qualitative approach as a research method. In regards to the research questions of this study that requires an understanding of the context, its social and institutional perspectives, and participants' view, experiences, and learnings, the qualitative research approach is considered to be the best-suited approach to analyze data collected in the field through intensive individual interviewing process (Bryman, 2012). It completely matches with Creswell (2014), who attributes qualitative research as an approach to exploring and understanding how people realize a social or human problem. Moreover, as this study does not require statistics or other quantitative data for analysis, the qualitative approach seems to be a more appropriate design than the quantitative (Hammett, Twyman and Graham, 2015). This study demands to generate the meaning of diverse views from different organizations that currently engage or are willing to engage women in solar energy entrepreneurship initiatives. Being largely inductive and exploratory in nature, the qualitative approach serves the best as a research method (Creswell, 2014).

#### **5.5 Data collection process:**

Eleven organizations were targeted to collect data in terms of practice, experience, observation, and opinion, which will be analyzed through theoretical framework and literature reviews. The chosen organizations are among the implementing partners of the case this thesis is based on, and its relevant institutional stakeholders include NGOs, advocacy networks, microfinance institutions, solar energy solutions producers, distributing companies, and foundations. Nine out of the targeted eleven organizations

finally participated in the interview, which ranged from 30 to 60 minutes long. A summary introduction of the organization interviewed is written in the following table-3. The detailed description are given in the Appendix.

<b>Interview sequence</b>	<b>Organization Type</b>	<b>Summery description</b>
<b>1</b>	NGO	Promotes the participation of women in Tanzania by creating a professional platform to develop a career for women in the energy sector. It only operates in Tanzania (Interview 1).
<b>2</b>	Solar distributor/ Social enterprise	Empowers women through energy entrepreneurship opportunities with a mission to eradicate energy poverty among the communities across sub-Saharan Africa (Misra, 2015)
<b>3</b>	Solar distributor/ Profit-making	Serves off-grid people in developing countries by offering user-friendly and affordable solar technologies for electricity and internet connectivity. Operates only in Tanzania (Interview 3)
<b>4</b>	NGO	Creates development opportunities for people living in poverty, mostly women, youth, and children, in Asia and Africa. It operates in agriculture, education, youth empowerment, water, sanitation and hygiene, and the solar energy sector (Interview 4, N1, 18 Mar 2022).
<b>5</b>	Solar distributor/ Profit-making	Equips rural off-grid farmers with solar systems for productive use. The company also offers innovative financing mechanisms to make adoption quick, simple, and affordable. Operates in Tanzania and Uganda (Interview 5).
<b>6</b>	Microfinance Institution	Offers small loans to low-income women entrepreneurs to enhance their business portfolios. Operates in Asia and Africa (Interview 6)
<b>7</b>	Microfinance Institution	Offers financial services to empower women and support their economic development. Operates in Asia and Africa (Interview 7).
<b>8</b>	NGO	Promotes and advocates the accessibility and the use of RETs across Tanzania (Interview 8).
<b>9</b>	Foundation/ Donor	Serves underprivileged and underserved communities with lighting solutions (Interview 9).

Table 3: Summary description of the interviewed organization

The data collection process used three online communication platforms called Google Meet, Zoom, and WhatsApp to conduct the interviews. Extra recorders were used to record the conversation. Due to the distant location between the researcher and the interviewees, online interviews was the best option. The interviewees were spread across Tanzania, and one of them was located in Netherland. Apart from the interviews, this paper used some statistical data from REA's (2020) national electrification survey to formulate the problem.

### 5.5.1 The interview guide

A set of semi-structured questions is developed to collect data from the field work. The questionnaire is divided into two-part- general and thematic questions. General questions captured the introductory part of the interview to stimulate the discussion and guide the interview session (Bryman, 2012). On the other hand, thematic questions covered specific questions related to the research's critical issues. There are two specific themes- who benefits and by what means. The 'who benefits' represents the target groups and the 'by what means' describes the use of a bundle of support that comprises both financial and non-financial supports.

As the qualitative interview is one of the methods applied for this study, it has adopt flexibility in asking questions to elicit interviewees' points of view on the research topic. Therefore, questions are structured based on the types of organizations that participated in the interview, considering that different organizations have different exposures and contribute to the research area. For example, social enterprises differ from microfinance institutions regarding their role in solar energy entrepreneurship initiatives; the thematic questions were also varied accordingly.

### 5.5.2 Reference code for interviews:

The following (Table 4) codes are used to refer to quotes from different interviewees. As it is stated earlier, the name of the organizations interviewed for this study was kept anonymous. This is mainly because the project selected for this study is still in operation, and thus this study does not want to influence or provoke any public perception whatsoever. As the project name and project partners' information is kept anonymous, the same rules are followed for other interviewed organizations for consistency of the research work.

<b>Interviews</b>	<b>Organization type</b>	<b>Organization Pseudonym</b>	<b>Interview date</b>	<b>Interview place</b>	<b>Reference code</b>
Interview 1	NGO	N1	15 Mar 2022	Online- Google Meet	Interview 1, N1, 15 Mar 2022
Interview 2	Solar distributor/ Social enterprise	SD1	16 Mar 2022	Online- Zoom	Interview 2, SD1, 16 Mar 2022
Interview 3	Solar distributor/ Profit making	SD2	17 Mar 2022	Online- Zoom	Interview 3, SD2, 17 Mar 2022
Interview 4	NGO	N2	18 Mar 2022	Online- Zoom	Interview 4, N1, 18 Mar 2022
Interview 5	Solar distributor/ Profit making	SD3	18 Mar 2022	Online- Zoom	Interview 5, SD3, 18 Mar 2022
Interview 6	Microfinance Institution	F1	20 Mar 2022	Online- Whatsapp	Interview 6, F1, 20 Mar 2022
Interview 7	Microfinance Institution	F2	22 Mar 2022	Online- Zoom	Interview 7, F2, 22 Mar 2022
Interview 8	NGO	N3	23 Mar 2022	Online- Whatsapp	Interview 8, N3, 23 Mar 2022
Interview 9	Foundation/ Donor	D1	1 April 2022	Online- Zoom	Interview 9, D1, 1 April 2022

Table 4: Reference coding system for interviewed organizations.

### 5.5.3 Challenges in data collection:

This section intends to acknowledge the number of challenges faced during data collection and processing. Firstly, though the majority of the targeted interviewees responded quickly, it took a while to get confirmation from two. It affected the schedules and delayed data collection. Secondly, audio problems during the interview and background noises affected the conversation, which may lose some crucial points that required more discussion. As all the interviews were taken on online platforms like zoom and WhatsApp, it was challenging to manage the background noises during the interview session. Moreover, due to poor internet quality, video recording was not suitable that could catch some non-verbal cues to elaborate on the important topics during conversation. Finally, the diversity in pronunciation affected smooth and timely transcription.



Though I used a software called 'Otter' to transcribe the interview, it took a long time to correct the transcription as it required repeated hearing of the same conversation to understand the pronunciation and the meaning. Also, the flow of interview questions was not always the same, which challenged the theme coding process. There is an overflow of information, and not all are relevant to my topic. In the transcription, some information is beyond the main objective of this paper. So, it was time-consuming to sort out the relevant vs. non-relevant data.

## **5.6 Data Analysis**

For the data analysis of this qualitative research, this paper followed simple strategies as suggested by Creswell and Poth (P. 251, 2018) with three simple steps: (i) preparing and organizing the data for analysis, coding the data into themes relevant to the topic and present the findings through analytical discussion.

Firstly, to prepare the collected data from interviews, I transcribed them using an online platform called 'Otter.' The subscription was purchased on share with other LUMID students. And then, the collected data were thematically organized. To do so, I have used software called 'NVIVO.' This software was accessed from Lund University's student platform called 'Ladok.' Initially, I created 16 codes and many sub-codes but later, for the analysis, I organized them into a few thematic areas that this study focuses. Finally, findings are described and analyzed based on the theoretical lens and literature reviews. An analytical framework is designed for this research which is drawn under 5.6.2 in figure 4- below:

### **5.6.1 Thematic areas:**

Thematically the paper divides the collected data into two major parts. The first part covers gender perspectives to understand the significance and social acceptance of engaging women in solar energy entrepreneurship over men. Social norms, barriers, and other factors have been discussed in this perspective. The second part goes deep into the bundle of supports as mandatory requirements to enable the targeted people to access and derive benefits from solar energy products. The bundle of support is further categorized into four sections: four sections- financial support: Access to loans and capital; technical & entrepreneurial skills, market linkage and market creation, and social acceptance; financial and non-financial parts.

### **5.6.2 Analytical framework:**

The data analysis of this research addresses the enabling environment in the form of a support system that empowers women-to-women networks to act for universal energy access and gender equality. Figure 4

(mentioned below) shows the analytical framework of this paper, where the required bundle of supports is studied through the lens of the theory of access and gender system. This framework shows an enabling pathway for women-led solar energy enhancement initiatives powered by a bundle of supports focusing on achieving two SDGs- Gender Equality (SDG 5) and Universal Energy Access (SDG 7) ((Dutta, 2019).

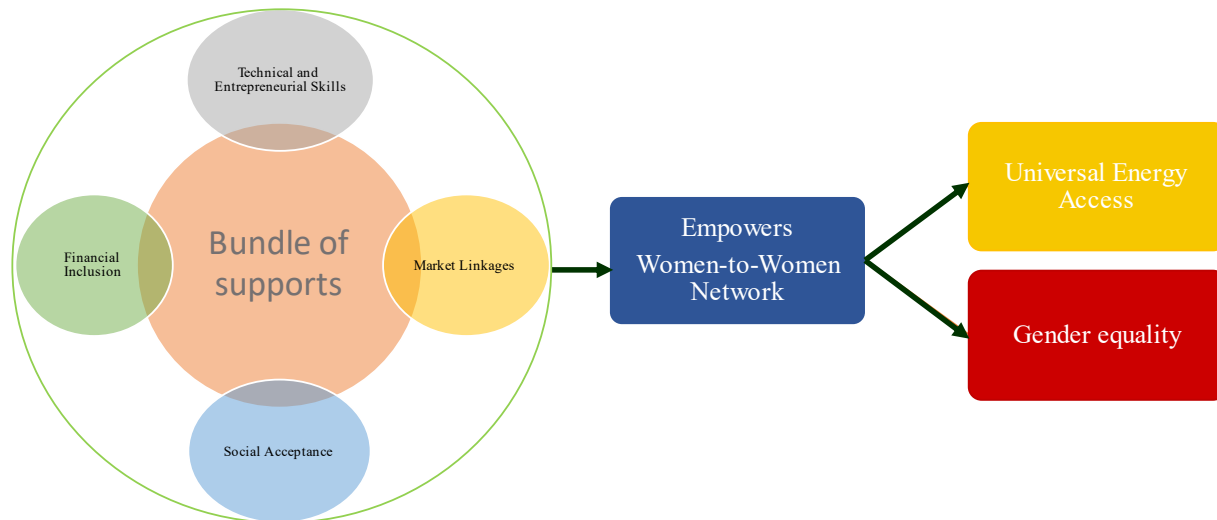


Figure 4: Analytical framework

## 5.7 Limitations of the methodology and theory

The main limitation of the methodology used for this study is the absence of interviewing none of the beneficiaries (women as solar entrepreneurs and women as solar users). It could have been more resourceful to hear from them about the barriers they face and supports they need. Moreover, I always felt the need for quantitative data in the form of results or outcome to justify the efficiencies of engaging women and offering different support systems. Furthermore, studying a running project, an ongoing case, may limit to get broad insights of the phenomenon. And I agree, the distant interviews and diverse accent may affect my understanding the insights.

About the theory, the theory of access was never used for solar energy. Reading the theory seemed relevant for one critical part, 'the bundle of power' only, but the other part, 'the bundle of rights,' was irrelevant. It might be a misuse of the theory, but this research tried to use it carefully.

Interpretation of the findings may lack understanding of the broad cultural context other than the energy sector impacting the country's representation as a whole. In many cases participants referred statistical data in their statements but this paper did not verify them. It was also beyond the scope of the study to focus on details.

## **5.8 Ethics**

The entire thesis work was guided by the ethical consideration checklist provided by LUMID. As the nature of this research does not seek any sorts of sensitive data nor has any connection with vulnerable groups, it did not formulate any written consent form but relied on oral consent for voluntary participation in the interview and recording of the interview. Also, participants received a commitment to data security which is carefully maintained throughout this research work. However, it was informed that this study would ensure the confidentiality and anonymity of the data collected from different partners. The project (the case) is still running, and all the partners were interviewed.

The organizations involved in the interviews are all within my network of professional experience. I also had past working experience with them. For example, I worked with one of the organizations that participated here in the interview. However, my ethical views were totally unbiased to any of the organizations involved here. Wherever needed, I have critically analyzed their views as well.

## **5.9 Positionality**

I am a development professional with more than 11 years of working experience in the NGO sector doing this research as a part of my Master's course on International Development and Management at Lund University. Though my past working experience inspires the topic, this paper does not have any liable association with organizations interviewed as it has no commercial purpose. This is simply an independently motivated and executed research aiming to meet MIDM19: Master's Thesis course requirements. As an independent and ethically guided researcher, the entire paper is influenced by learnings from the LUMID<sup>14</sup> course, knowledge gained from work experiences, and personal attachment to research problems.

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<sup>14</sup> Lund University Master of Science in International Development and Management

## **Chapter 6: Findings and Analysis**

### **6.1 Women as an important actor**

Women as a target group in distributing and using solar energy products have a ‘social and relational context’ constructed by gender dimension (Ridgeway and Correll, 2004; Heuër, 2017). This context was identified while speaking with the organizations running different projects in the solar energy sector. For the W2W<sup>15</sup> project, the beneficiaries group are specifically women as entrepreneurs “*to provide them access to income opportunities*” and women as end consumers as “*they are the ones who are the most consumer of this energy products, they are the ones who are suffering the most and they are the ones who takes care of the household*” (Interview 4, N1, 18 Mar 2022). The project did not target men “*mainly because the research findings show “that the woman is the most disadvantaged group and partners...aim is to empower people and communities, particularly women*” (Interview 4, N1, 18 Mar 2022).

According to the participating organizations, women plays a vital role in advocating other women who are the primary user of energy solutions in the household. They believe that depending on the types of energy and engagement mechanism, “*women have a better chance of accelerating the energy access & consumption*” (Interview 8, N3, 23 Mar 2022). Women trust other women’s life experiences; hence it is easier for them to convince than men. Some stated that women are mostly connected in society, and they always join the talk (Interviews 4 and 8). Interview 4 (N1, 18 Mar 2022) adds saying that “*this would be very comfortable for the women entrepreneur to directly sell to a woman who she understands*”. Another participant thinks, “*through the involvement of women, the message spreads faster*” and “*people say, if you want the information to reach faster to other people or to the community then just use women*” (Interview 2, SD1, 16 Mar 2022). These statements refer to the significance of women in the solar energy sector. Culturally they have social acceptance, but that is not enough. It is to ask how these women are better supported (Interview 9).

### **6.2 Barriers to the adoption of solar energy technologies identified**

Regarding the barriers to accessing solar energy products, the participating organizations have shared diverse challenges depending on their varying roles and experience. They used different terms to define challenges. For example, lack of capacity, lack of capital and collateral, poor awareness, unaffordability,

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<sup>15</sup> A pseudonym is used to maintain anonymity of the project.

burden of debts, cultural and social norms, inequality in asset ownership, stock insufficiency, high prices, and imposed tax were among the most highlighted challenges in the solar energy sector as they mentioned. However, affordability, financing, and gender stereotypes stand out as the main issues to address. A statement from one of the participants can serve as the summary, which says,

*women are still the early adopters of the business because they still have challenges on capital, they still have challenges on decision making at the family level, everything they do, they have to involve men. And also, they don't have collateral to seek loans or access to loans as men do. So that's why they're still behind compared to men who are the frontline in this business (Interview 2, SD1, 16 Mar 2022).*

This statement acknowledges the gender system theory by illustrating socially constructed discriminatory behaviors and actions prevalent in Tanzania that constrain the pathways of women empowerment programs (Ridgeway and Correll, 2004).

In addition to that, participants showed severe concern about gendering the types of challenges faced by entrepreneurs and differentiating them between men and women. The relevant question asked here is why “*we say women entrepreneurs differ from men entrepreneurs in solar*” where “*the challenges faced by men entrepreneurs and the female entrepreneurs should be the same*” (Interview 8, N3, 23 Mar 2022). While finding the answer to this question is not the scope of this paper, from the participants' viewpoints, it is realized that cultural and social norms play a role in creating barriers to enabling women to participate in some activities in the energy sector (Interview 1 and 8).

On the consumer side, for the women as a user group, financing is an issue in accessing solar energy products (Interview 8). While the importance of solar for the off-grid communities is highly recognized, they cannot avail of the solution due to lack of affordability. One of the participants gave a specific example saying,

*solar being very important to the communities which are off-grid, because they cannot afford paying \$150 at par, to get connected with electricity and they still have to pay the electricity bills, while their daily income is less than \$1. So you find that the nightmare for those communities (Interview 2, SD1, 16 Mar 2022)<sup>16</sup>.*

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<sup>16</sup> Requires cross check of the data stated by the participant

This statement matched with Ahlborg and Hammar, (2014) findings where it was stated that only 10 percent of the rural population can both afford and have houses suitable for grid connectivity.

To respond to the need for financial services, the grassroots financial institutions (FIs), which serves the unserved community- i.e., microfinance institutions, did not find their potential as an untapped market for growth and thus “*not active in Tanzania to support solar energy sector*” (Interview 2, SD1, 16 Mar 2022). FIs see risks in offering credit facilities against solar energy products as a consumer loan. They argue that consumer loan is an unproductive sector that puts additional pressure on borrowers with poor income sources (Interview 7). Moreover, they think the price and quality of the products should go hand in hand and be attractive to the consumers. Consumers' negative experiences may put loan repayment schedules at risk, affecting their portfolios. In response to the argument, some participants would like to criticize FI's unwillingness to serve the sector as it may not be perceived as profitable as compared to business loans. In their words, “*FIs don't know what we want*” (Interview 2, SD1, 16 Mar 2022).

From the perspective of the theory of access, the barriers mentioned above form “fluid multi-layered social hierarchies” where women as a targeted group lack access control and fail to gain or maintain the limited control they have (Peluso and Ribot, 2020, p.301). Nevertheless, service providers enjoy the full control to decide whom to serve, what to serve, and how to serve, which is mainly influenced by the greater status holders in the community. Therefore, in addition to the constraints from socio-cultural and economic contexts, I argue to address institutional context separately.

### **6.3 Structural and relational mechanisms identified:**

This analysis section denotes the enabling environment facilitated by a support system. It captured an overall perspective relevant to solar energy access initiatives from the different organizational points of view. The support can be divided broadly into four sections- Financial support: Access to loans and capital; technical & entrepreneurial skills; market linkage and market creation; and social acceptance. The categories are inspired by the concept of bundle of powers stated in the access theory. Financial support means the micro-credit facilities required by both the women entrepreneurs and the household consumers in the form of business capital and consumer financing, respectively. Market linkage and creation means connection with potential customer base, involvement of quality solar products supplier, consumer awareness, and customer services. In the social acceptance, it is mainly considered women's acceptability

to become a solar entrepreneur. As stated above, the main focus of this chapter is to understand the support that needs further concentration.

Inspired by Peluso and Ribot (2003, p.12), this support system can be as a “structural and relational access mechanism” that shapes and influences solar energy access. Again, access to these support systems has the strength to empower women solar entrepreneurs to serve the community in advancing the use of solar energy technologies in their domestic and income-generating activities

This theory does not restrict the categories of structural and relational access mechanisms. The categories can be developed based on the circumstances or situations where power operates. Therefore, the above four sections derived from other themes identified in the qualitative data collected through interviews are carefully picked to understand and do the access analysis of solar energy products in the low-income rural communities of Tanzania. The analytical framework is designed and described accordingly. In the following paragraphs, the reflection of the interviewees are explained in detail:

### 6.3.1 Technical & entrepreneurial skills:

All the participants had a unified response to the need for technical and entrepreneurial skills. One of the interviewees considered training three times in a row as mandatory required support to intensify the importance. The participants said, *“number one, I would say training, training, training. Like if someone trains you how to fish is more important than giving your fish so if we train them how to do that we can do any business”* (Interview 2, SD1, 16 Mar 2022). Another organization stressed the capacity and familiarity of the entrepreneur on the new technologies available in the market. It said, *“most of the women entrepreneurs need to have soft skill of understanding the nitty-gritty details of their products before doing that business. Because going to the community and selling one thing and selling the best quality in another thing”* (Interview 8, N3, 23 Mar 2022)

The interviewees highlighted the key areas of training: product and customer knowledge, selling and connecting, customer service, financial management, record keeping, business planning, self-awareness, and confidence-boosting (Interviews 2 and 4). Also, one more module evolved due to the COVID-19<sup>17</sup> effect where those entrepreneurs had to learn a digital approach to know *“how to advertise products through smartphone...and sell the products through smartphone”* Interview 2, SD1, 16 Mar 2022. Whatsapp, Facebook, phone calls, and virtual training tools have become the new approach to doing business. This

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<sup>17</sup> Pandemic caused by the virus SARS-CoV- 2(Karunanayake and Hospital, 2020)

timely, innovative support helped the women entrepreneurs stay in the solar energy business within COVID protocols (Interview 4).

One of the lessons learned from this project was adaptability to the uncertain and volatile business environment. The situation of COVID-19 can be a great example. Changing mindset and comfort zone to learn new approaches and behaviors to do business is crucial. As one of the participants pointed out, *“during covid-19, it changed the way how people used to do the business, but it did not change the way how people used to what they do”* (Interview 4, N1, 18 Mar 2022). So, COVID-19 has brought new requirements for skills set- adaptability and digital literacy.

However, there was one concern identified about the delivery of those training. According to one participant, men’s engagement in training women in energy-related projects revealed new knowledge. They realized that women are not receiving the right message when men train them. Instead of men, they engaged women to train other women, resulting in effective communication with the target customers and convincing them to buy solar products (Interview 8). This separation of engagement indicates the persistent gender system where social and cultural norms influence the acceptance of men by women. Though the participation of men in women empowerment programs is sought positively (Shankar, Elam and Glinski, 2019) but to be effective it also requires contextual knowledge in designing of the project activities.

### 6.3.2 Market linkage and market creation:

#### **Customer base:**

Connecting a potential customer base with women entrepreneurs is instrumental in enhancing solar energy access. Studying the case of W2W<sup>18</sup> project, it is understood that this connectivity benefits both the target group. W2W connects women entrepreneurs with micro-credit groups to make their sales pitches (Interview 4). The provision of loan offerings is also an encouraging tool for potential consumers to access solar products. It saves time, builds trust, and brings social recognition to both groups. Moreover, it opens the door for microfinance group members to be solar entrepreneurs. In terms of organization, it helps distributors recruit potential entrepreneurs quickly (Interview 4).

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<sup>18</sup> A pseudonym is used to maintain anonymity of the project.



## Consumer awareness:

In a large country like Tanzania with dispersed settlements, reaching the last-mile market with solar energy technologies is challenging (Ahlborg and Hammar, 2014). The required service provision to address those challenges are not even integrated enough to bring synergies making the energy access gap bigger (Dutta, 2019). However, this gap offers a large market opportunity in the solar energy sector which is yet to capture by the traditional public and private sector actors (Shankar, Elam and Glinski, 2019). One participant believes that

*a lot of opportunities out there, but people are not aware of that....may be there should have like a hub or like an incubation sort of thing for this type of initiatives or skills whereby people can be able to get information about the available opportunities out there in the areas of renewables (Interview 4, N1, 18 Mar 2022).*

As an alternative pathway in addressing those ‘distribution barriers’ or ‘access barriers’, the case of W2W<sup>19</sup> project also revealed the importance of market linkage that needs to ensure the creation of consumer awareness, have a robust supply of quality solar products, provide post-sale customer services and setting the right price to capture the market.

Interviewees think that there is an awareness gap about the use of solar energy technology and a misconception around the price of the technology. It requires changing the mindset of households in terms of the importance and utilities of solar energy products in their livelihoods. From the interviews, it is realized that the knowledge gap among the targeted households is a barrier to large-scale solar energy access. To show the persisting knowledge gap about the available solar energy products, one of the participants said,

*95%<sup>20</sup> of the farmers in Tanzania just rely completely on rain for irrigating their farms. So first of all, they haven't used pumps before and secondly they haven't heard of solar water pumps so it's all very new and you know everyone's always skeptical about a new technology (Interview 5, SD3, 18 Mar 2022).*

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<sup>19</sup> A pseudonym is used to maintain anonymity of the project.

<sup>20</sup> Requires cross check of this data

Moreover, the interviewing organization also highlighted the extent of knowledge the targeted user group must-have in this regard. For example, one participant made a demarcation of knowledge consumer needs by saying, *“the consumer does not need all the technical aspects inside the product. But one needs to know that this differs from the other cheaper products”* (Interview 8, N3, 23 Mar 2022). Another organization said that the awareness campaign should cover *“the importance of using solar energy products, the benefit that comes with it and how they can be able to save and use this to increase their income”* (Interview 4, N1, 18 Mar 2022). Changing the mindset should enable the target groups *“to be able to see the benefit of moving from using kerosene and candles to using this clean energy products”* (Interview 4, N1, 18 Mar 2022). Even the mindset has been changed it is found that the user group must know where they can avail the quality solar products. A participant said, *“the awareness has been created almost in all the communities and people know about solar but most of the people in underserved communities don’t know where to get these”* (Interview 4, N1, 18 Mar 2022). All these reflections match the other studies that firmly acknowledged the consumer awareness gap at community, household and individual levels (Heuër, 2017; Shankar, Elam and Glinski, 2019). It indicates the need to evaluate and redesign the current initiatives around solar energy enhancement programs.

### **Customer Service:**

Prompt customer service is identified as another important element of required integrated support (Interviews 2, 3, and 7). It has a connection with the reputation and performance of Microfinance Institutions that provide consumer loan facilities on the products. One of the interviewees said, *“an instant support should be given to that particular customer so that, he or she can keep on repaying for the loans. You delay on that you delay even getting the repayment”* (Interview 3, SD2, 17 Mar 2022).

From the collected data, the required customer service in solar energy delivery can be defined simply as three services: providing product training, warranty servicing, and credit facility referencing (Interviews 2, 3, and 7). The W2W project combined product replacement and repair warranty mechanisms to ensure that customer service is delivered timely. In this mechanism, each consumer receives a receipt from the entrepreneurs that includes product serial number and gives the consumer a right to claim for return or repair services within the warranty period. To explain the warranty servicing, one of the interviewees said, *“entrepreneurs are trained on some technical aspects of the product. So, the entrepreneur will test the product to see whether the product needs replacement or repair”* (Interview 2, SD1, 16 Mar 2022). The entrepreneurs are also trained to train the consumers on the use of the product. Through the partnership of Microfinance Institutions, the project enables entrepreneurs to link customers with credit facilities (ibid).

### 6.3.3 Social acceptance:

Regarding the question of the social acceptance level for women to become entrepreneurs, there are different observations identified. According to some interviewees, the social acceptance of women being an entrepreneur is found not a problem in Tanzania, but a division of labor role is observed (Interview 8, 9). Also, certain field positions are not attractive to women (Interview 5). For example, culturally, the role of being a technician or doing hard work is considered not a women job. One of the participants said, “*when you talk of a technician...the first impression I have with that should be a man. If it is not a man then that is unique*” (Interview 8, N3, 23 Mar 2022).

Consequently, men mostly occupy fieldwork, hardware technical, and IT jobs compared to women. The main reason behind it, according to the interviewee, is that women are less willing to go out to the field every day, and also, they are not considered for technical training; hence “*it is definitely slanted heavily towards men*” (Interview 5, SD3, 18 Mar 2022). There are safety aspects, as well,

*[that] affect women than men because you can find a man working in the street at night and there is no problem. But you will rarely find women working or daring to do any business at night because of safety issues* (Interview 8, N3, 23 Mar 2022).

Moreover, to become an entrepreneur, women are not independent in making decisions. They have to ask for permission from their male counterparts, mostly their husband (Interview 2, SD1, 16 Mar 2022; Interview 4, N1, 18 Mar 2022; 8). As one of the participants said, “*in Tanzania, you cannot do anything without the permission of your husband*” (Interview 4, N1, 18 Mar 2022). Another participant added that “*in most of the Tanzanian community...it is the man making the decision and the women following the orders*” (Interview 8, N3, 23 Mar 2022). On the other hand, asset ownership distinguishes the role of men in the solar energy sector from women considering men are the best fit for high ranged “*productive use of energy*” products as they have capital and wealth that women do not (Interview 1, N1, 15 Mar 2022 and Interview 4, N1, 18 Mar 2022). It also affects the purchase decision “*because before a woman decides to purchase the product, they will have to ask their men for permission*” (Interview 4, N1, 18 Mar 2022).

The gender lens has to view energy access more critically. The gap in practically available productive working hours between men and women is high where “*men can work eight hours a day [compared to] two hours [for women]*” (Interview 9, D1, 1 April 2022). It is not only the energy sector; rather, according to the participants, the social and cultural norms prohibit women from engaging or growing in any sector.

Thus, the gender system is prevalent in the solar energy sector in Tanzania, where cultural beliefs and social and relational context distinguishes the characteristics and roles between men and women (Ridgeway and Correll, 2004). Though this element of peer influence and trust is significant in spreading information and encouraging other women to buy solar products (Heuër, 2017), it is not enough for women. Positioning men at high status and competence over women may implicitly shape self-fulfilling behaviors among men and may risk addressing gender inequality issues in energy access initiatives (ibid). Therefore, there is a need to explore ways to support women by integrating gender awareness programs and accommodating their available time more productively and objectively without distorting social values. In that regard, participants mostly agree on the need for innovation in designing culturally acceptable projects where gender stereotypes are carefully addressed. One participant says, *“there is no universal access to energy if there is no gender equality, because otherwise we’re achieving one goal and really missing a big piece on the other side”* (Interview 9, D1, 1 April 2022).

#### 6.3.4 Financial support:

Before going to the importance of the financial support in the solar energy sector, we need to understand who needs this support- entrepreneurs or consumers. According to the W2W<sup>21</sup> project, both entrepreneurs and consumers need financial support (Interviews 1, 2, 4 and 7). In response to why entrepreneurs need this support one interviewee said,

*“when we're talking about advancing the solar, in this whole value chain, credit facility is very very important for the women entrepreneurs. Because then, they will be able to purchase this product on capital basis. That means they use their own money to purchase this product and they can be able to sell it and earn a profit. That means they don't need to depend on a commission basis”* (Interview 4, N1, 18 Mar 2022).

This interviewee linked credit facilities to freedom of economic activities.

On the other hand, regarding why consumers need this support, the answers to the question were very straightforward *“lack of affordability”* (Interview 1, N1, 15 Mar 2022, Interview 2, SD1, 16 Mar 2022, Interview 4, N1, 18 Mar 2022, Interview 5, SD3, 18 Mar 2022). To insist on the significance, one

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<sup>21</sup> A pseudonym is used to maintain anonymity of the project.

interviewee said, “currently in Tanzania, if you go to urban areas, mostly people can afford getting the energy, but when you go to rural areas, they don’t afford” (Interview 1, N1, 15 Mar 2022). Another said, “roughly 90% of our customers take advantage of financing. Without financing, they just simply can't afford the equipment.” (Interview 5, SD3, 18 Mar 2022). From these statements, it is clear that financing is critical for entrepreneurs and consumers.

## **6.4 Willingness of Financial service providers:**

Following to the previous section, the question arises that do financial service providers see solar energy as a potential sector to serve? Are they willing to support? These are indeed very crucial questions, and responses were received from every participant. The summary of the response can be framed by saying that the concept of financing in the last-mile solar energy distribution sector is not very active in Tanzania and the industry lacks credible data or evidence to build the confidence of financial institutions to proactively design credit schemes (Interview 2, SD1, 16 Mar 2022, 4). One of the W2W<sup>22</sup> project partners said, “this is the third year now for struggles getting the financial institution to partner with, such as micro finance institution” (Interview 2, SD1, 16 Mar 2022).

I have found a few reasons for the lack of confidence among the financial institutions. Firstly, “microfinance institution are very cautious [of the] issues like ... customer support” additionally needed from solar entrepreneurs (Interview 4, N1, 18 Mar 2022). The interviewee added saying that

*they (financial institutions) are not very comfortable with the ability of the producers of this product to be able to supply, they're not very comfortable with the quality of this product, they're not comfortable with the customer service, they're also not comfortable with the data out there, there's actually no data that shows that people really need this product (ibid).*

Secondly, from the interviews, it is also realized that credit offerings (through Microfinance Institutions) against solar products also get tagged with the branding and reputation of microfinance institutions. Therefore, Microfinance Institutions want to ensure product quality and customer services as a commitment from the distributors to provide financial service. In this regard, one of the interviewees said,

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<sup>22</sup> A pseudonym is used to maintain anonymity of the project.

*product quality is very important for our beneficiaries because beneficiaries do not know whatever this distributors who are giving this product. They know it's a Microfinance organization's product. So from our end also, we want to make ensure the quality of the product. Client trust us and think when I receive something through 'F2<sup>23</sup>', it means it's a good quality (Interview 7, F2, 22 Mar 2022)*

Thirdly, it is the default risk if the loan applicants, mostly in the hard-to-reach areas, do not have enough source of income to be able to repay the loan (Interview 7, F2, 22 Mar 2022). It matches with another participant who said, *"we do have customers who do not keep up their payments, and then we have to go repossess the equipment. And of course, that's a loss for us"* (Interview 5, SD3, 18 Mar 2022).

Furthermore, the fourth reason could be the profitability of the microfinance institution compared to their cash loan offerings. One of the interviewees said, *"we are struggling to partner with microfinance institution. It has been a challenge. This is because renewable energy is not as profitable compared to cash loans"* (Interview 2, SD1, 16 Mar 2022).

However, though collateral is not identified as an issue, it is apparent that entrepreneurs accessing credit facilities is not as difficult as consumers. Even formal and informal financial institutions are willing to offer business loans to women entrepreneurs if they have a flow of income that consumers may not have (Interview 7, F2, 22 Mar 2022). However, one interviewee argues that the flow of income for the consumers depends on their livelihoods choice and seasons (Interview 8, N3, 23 Mar 2022). It says, *"affordability depends with the community. I know some communities, farmers, some are livestock keepers. if you do the proper timings during the harvesting season, these people have real money and afford it to buy solar energy product"* (Interview 8, N3, 23 Mar 2022). It seems microfinance institutions do not see it as a significant market opportunity for their business in Tanzania. Their main objective is to serve a group of people, mostly women in rural areas, who are engaged in income-generating activities and consider solar entrepreneurship an optional business for the women (Interview 7, F2, 22 Mar 2022).

To ease the process of credit facility for accessing solar products, there is also an innovation in the product design which has embedded PAYGo (Pay-As-You-Go) technology that allows households to pay the price of the device with weekly instalments directly to the distributors without involvement of any formal or informal financial institutions (Interview 4, N1, 18 Mar 2022, Interview 5, SD3, 18 Mar 2022, and,

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<sup>23</sup> F2 refers to the one of the financial institutions interviewed at interview 7.

Interview 8, N3, 23 Mar 2022). This technology has gained popularity in the solar energy sector worldwide but also it has earned criticism for its service conditions. Some think it is *“the right solutions”* but the ultimate cost of products may go *“double or if not triple”* (Interview 8, N3, 23 Mar 2022). Other think *“PAYGO have some sort of characteristic, if you don't pay they switch off and when you have to switch off the system, then you're not helping that person”* (Interview 4, N1, 18 Mar 2022). It also added that

*PAYGo model is great, because a person can use this whenever they feel like, but when you look at it, in the long term, the amount of money that the client is paying is so huge. It's also not helpful in a way because the client has to pay more and also can be spending heavily on electricity (ibid).*

Praising the PAYGO technology and its potential to enhance solar energy technology, on the other hand, another participant said that *“it is a right solutions but maybe we are not prepared for that solution. I know there are a lot of communities in the rural areas that benefited from the PAYGO technologies”* (Interview 8, N3, 23 Mar 2022).

## **Chapter 7: Conclusion**

The positive association between the adoption of solar energy products in last-mile rural areas and women's engagement in this process is well recognized in academic literature and non-state entities' practices. This association can contribute directly to achieving gender and energy equality (Heuër, 2017; Dutta, 2019; Gray et al., 2019; Shankar, Elam and Glinski, 2019; Simpson et al. Looking at the importance of this potential, this paper has studied on the enabling environment in the form of support system that should facilitate women-led solar energy enhancement initiatives with greater effectiveness and out-reach. From the literature reviews and institutional points of view, this support system must include technical and entrepreneurial skills, market linkage, social acceptance, and financial inclusion.

Learning from the case of the W2W project and other associated organizations in Tanzania, it is realized that the critical areas of technical and entrepreneurial skills are well known with established delivery mechanisms contributed by profit and non-profit organizations. In market linkage, it is realized that there is a lack of community awareness of solar energy technologies among the off-grid communities in Tanzania. Also, the prevalent information gap among the households regarding the availability of quality products, credit offerings, and product use has to be addressed. To address the awareness and information gap connecting women solar entrepreneurs with other women groups, i.e., Microfinance groups, found promising which also serve to increase the customer base for those women entrepreneurs and households to access credit facilities to purchase solar products. However, customer service seems to be a great concern for solar distributors and financial service providers that requires extra care.

The social acceptance for women to be part of solar entrepreneurship and access solar energy solutions is challenged by the gender system prevalent in Tanzania. Division of labor choices, purchase decision authority, productive working hour opportunities, and social status are all gender biased that prohibit women from acting and performing in the energy sector and other sectors. There is a need to integrate gender awareness programs in solar energy enhancement initiatives where gender stereotypes are carefully addressed.

Finally, the lack of financial support seems to be a big gap that requires concentration from every actor in the solar energy sector. According to NGOs and solar distributors, the financial institutions are unaware of this untapped financial market and inactive in Tanzania to serve the community in this sector. Lack of confidence due to unavailable data, reputation, and default risk, and profitability concerns are the main reasons of the financial institutions inactive role in the solar energy sector. Though there is an alternative



financing mechanism, the PAYGo system, is available but it is highly criticized for its effectiveness at the household level.

Writing this paper also realized the gap in target setting in SDG 7, where the goal of universal energy access did not specify a target for energy access for women(Shankar, Elam and Glinski, 2019). It has implications for SDG 5 as well. The data available on the impact and contribution of the women-centric approach in enhancing solar energy access among the low-income communities are primarily sourced from programmatic reports (ibid). There is no aggregated academic data on the number of women employed or engaged and the number of women at the household level accessing solar energy (Dutta, 2019; Shankar, Elam and Glinski, 2019). In the future, designing solar energy adoption-related projects must consider the context and gender perspectives, participation of male counterparts in the project activities, and inclusion of customer-centric financial access provision. Therefore, more research is needed in this sector to bring confidence among the financial institutions, demand women-centric energy access goals and policies, and promote integrated actions to address the solar energy access barriers.

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## Appendix:

### Appendix 1: Organizations joined in the interview

To be more objective to the data analysis, this paper has kept the name of the organizations participated in the Interviews anonymous. However, this study interviewed the implementing partners of W2W<sup>24</sup>, project and other similar organizations who either work in solar energy distribution or financial service provision. The choice of organizations beyond ‘W2W’ project partners is rationalized to understand the others perspective about engaging women in energy entrepreneurship and the enabling environment that can facilitate the access of solar energy technologies. The following chart introduces those organizations in a sequence of interviews taken

Interviews	Organization Pseudonym <sup>25</sup>	Description
<b>Interview 1</b>	N1	An NGO that was established in 2019 with an aim to promote the participation of women in the energy sector of Tanzania. The main objective of this organization is to support women who are already established or willing to establish a career in the energy sector and enable them with numerous career-building opportunities to be in the leadership position. This network creates a professional platform for women that builds capacities through diverse training, offers internship opportunities to gain experience, and expands connectivity to career development opportunities in the energy sector. They are also active in conducting research, developing a business case, and advocating gender roles in the energy sector (TaWoE, n.d., TaWoE, 2022)
<b>Interview 2</b>	SD1	A social enterprise that empowers women through energy entrepreneurship opportunities with a mission to eradicate energy poverty among the communities across sub-Saharan Africa (Misra, 2015). Its energy-driven, women-centered, and market-oriented program creates a network of entrepreneurs dedicated to advancing access to off-grid solar and clean energy technologies in rural Africa’s underserved, hard-to-reach areas (Misra, 2015; Solar Sister, n.d.). It integrates a

<sup>24</sup> A pseudonym is used to maintain anonymity of the project.

<sup>25</sup> According to the description given in Table 4 of this paper

Interviews	Organization Pseudonym <sup>25</sup>	Description
		<p>business model that serves the dual mission of empowering women economically through entrepreneurship opportunities and cultivating a women-run sales network that creates a last-mile distribution channel to enhance solar energy adoption (Gray <i>et al.</i>, 2019).</p> <p>The organization enables those entrepreneurs to procure quality solar and clean energy solutions, e.g., solar lanterns and cookstoves, and sell and deliver them to their own family, relatives, friends, and neighboring communities. In this enabling process, the women entrepreneurs receive essential training on business and entrepreneurial skills, technical knowledge on solar energy products and service delivery, and market creation and linkage. And thus, the organization has created a network of 6690 women entrepreneurs, delivered more than 600 thousand clean energy products, and impacted the life chances of nearly three million people across Africa (Solar Sister, n.d.).</p>
Interview 3	SD2	<p>A renewable energy technology company that enables off-grid people to access solar-powered modern technologies- e.g., solar lights, smartphones, internet, television, etc. This company began its journey in 2015 with a mission to serve off-grid people in developing countries by offering user-friendly and affordable solar technologies for electricity and internet connectivity. Targeting low-income households, the company designs, distributes, and finances a wide range of solar home systems for both domestic and commercial purposes powered with PAYGO (pay-as-you-go) technologies which makes them unique in the solar energy sector (Trendsolar, n.d.; GOGLA, n.d.).</p>
Interview 4	N2	<p>A leading non-government organization (NGO) registered in Tanzania in 2006. The organization is dedicated to creating opportunities and realizing potential by empowering marginalized people, mostly women, youth, and children, in Asia and Africa (BRAC International, no date a). In Tanzania, it operates in the field of health, agriculture, education, youth empowerment, water, sanitation and hygiene, and the solar energy</p>



Interviews	Organization Pseudonym <sup>25</sup>	Description
		sector. it has scaled its development programs and projects across the country, impacting the life of almost 4 million people (ibid).
<b>Interview 5</b>	SD3	A solar-powered productivity-enhancing agricultural equipment provider to rural East Africa. The company, founded in Tanzania in 2014, equips rural off-grid farmers with solar systems for productive use. Increasing agriculture productivity as its primary focus, the company targets off-grid communities and delivers affordable solar water pumps to farmers and fishing lights to fishers. Apart from Tanzania, the company has expanded its operation in Uganda, enabling rural smallholder entrepreneurs and farmers in agriculture sectors and impacting their profitability. In addition to solar equipment, the company offers innovative financing mechanisms to make adoption quick, simple, and affordable. Through building partnerships with different organizations in the agriculture value chain, the organization leverages its network and design offerings of integrated support systems (SimuSolar, n.d.)
<b>Interview 6</b>	F1	A leading Microfinance Institution (MFI) operating in Tanzania since 2014. The organization offers small loans to low-income women entrepreneurs to enhance their business portfolios. This for-profit organization has 143 branches in 8 regions serving 174 thousand clients in Tanzania (ASA Tanzania. n.d.).
<b>Interview 7</b>	F2	An international microfinance service provider operating in Tanzania offering financial services to empower women and support their economic development. Founded in 2007, it is the largest Microfinance Institute (MFI) in Tanzania, with 155 branch offices in 23 regions reaching 83 districts of Tanzania. The company has a large client base with 216 thousand borrowers, of which 97% are women. (BRAC International, no date b).
<b>Interview 8</b>	N3	A non-governmental organization founded in 2001 with a mission to promote and advocate the accessibility and the use of renewable energy technologies across Tanzania. It forms the biggest renewable energy

Interviews	Organization Pseudonym <sup>25</sup>	Description
		<p>network in Tanzania by engaging more than 877 members as of 2020. objective to promote. In addition to building a strong network of stakeholders, this organization builds capacity through training programs, implements awareness campaigns, influences favorable renewable energy policy formation, disseminates knowledge and information, empowers end-users access to quality energy solutions, conducts research, and becomes the voice of the off-grid community in Tanzania (TAREA, n.d.).</p>
<p><b>Interview 9</b></p>	<p>D1</p>	<p>A foundation that serves underprivileged and underserved communities with lighting solutions. This foundation is a part of a public company and a global leader in energy-efficient lighting products, systems, and services that manufactures lighting products for professionals, consumers, and the Internet of Things and enables them with high-quality and safer lighting solutions. In 2021, the company had sales of EUR 6.9 billion, employed 37 thousand full-time employees, and unlocked brighter lighting experience in over 70 countries (Signify, n.d.). The foundation receives funds and in-kind donations from that public company to promote access to quality solar energy technologies at the rural areas (Signify Foundation   Signify Company Website, no date).</p>

## Appendix 2: Thesis Interview Guide

### **Main research questions:**

What support system enables the women-to-women network to overcome barriers to enhance access to solar energy products in rural Tanzania?

### **Sub:**

- 1) Why are women important actors in solar energy enhancement initiatives?
- 2) What are access barriers in the adoption of solar energy technologies identified?
- 3) What is the structural and relational mechanism in the enabling environment of accessing solar energy technologies identified?
- 4) Do financial service providers see Solar Energy as a potential sector?

### **Literature ground:**

Academically, the evidence of the efficacy of engaging and empowering women with energy entrepreneurship initiatives in advancing access to energy is not substantive. However, outcomes from various programmatic approaches that engaged and empowered women to become energy entrepreneurs at a subsistence level have reported concrete evidence showing a positive connection between women energy entrepreneurship and increased access to solar energy. Despite such claims, academic literature argues that such initiatives are still in the very early stage to confide adequately significant quantitative results, to connect suitable theories, and to analyze counterfactual data from systematic control groups, including various forms of entrepreneurial engagements and types of energy options (Shankar, Elam and Glinski, 2019).

While researchers have hinted a long list of unknown areas as further research scope, focusing on one of them, this paper intends to understand what is the role of bundle of supports for scaling/increasing energy access while empowering women in specific to solar energy type entrepreneurship.

### **Introductory Questions: These are the common introductory questions for all interviewees:**

1. May I know about yourself, your background, work etc.
2. Can you describe your project / programme / initiative (solar energy distribution / Solar energy Entrepreneurship / Microfinance) and how you operate?

3. Does your project/ programme/initiative engage men or women in entrepreneurship / Microfinance / solar energy distribution initiative or both and why?
  - a. Or, Who is your target group/beneficiaries and why?
4. What are the key objectives of your project / programme / initiative?
5. How do you describe recent developments in solar energy connectivity in Tanzania? (Recent national level survey report (REA 2020)<sup>26</sup> suggests that the second main source of energy for lighting in the households in the mainland Tanzania is solar energy the access of which has increased from 1.4 percent in 2012 to 33 percent in 2019/20): (irrelevant for F2)
  - a. How will you connect the contribution of your project/programme/initiative to this development?
  - b. How do you describe/explain gender roles in connection to this development

**Thematic questions: With ‘the theory of access’ in mind, the thematic questions are divided into two main categories: who gets the benefit and under what conditions/means:**

**SD1, SD2, SD3, N1 and N3<sup>27</sup>:**

**Who Benefits (same questions to all):**

- How many entrepreneurs you have created so far and how many are active now? (To understand the size of the impact)
- How many units of quality solar solutions you have sold so far? ? (To understand the size of the impact)

**By what means:** The means represent process, mechanism and conditions that enable actors derive benefits from resources. In the theory of access, it has identified seven means that include capital, technologies, market, knowledge, authorities, social identities and social relations. For the sake of the relevancy of the thesis objective, this paper uses them carefully.

**General:**

- Why would women be interested to be a solar energy entrepreneur with you? What benefits them and their family (eg. engagement in income generating activities, business skills, increased social

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<sup>26</sup> Renewable Energy Agency , (2020), “Energy Access and Use Situation Survey in Tanzania Mainland 2019/2020”, *Ministry of Energy*

<sup>27</sup> Organization pseudonym according to table 4 under 5.5.2

acceptance/identities, being able to access solar energy for their own families, longer study and business time, reduced energy expense etc.)?

- How would you describe the benefits that your entrepreneurs offer to the targeted consumers/communities (e.g. reasonable price, credibility, door-to-door service, easy transaction access, quality devices, quickly accessible customer services, credit facilities)?

W2W partnership (only for Solar Sister):

- How partnership with W2W contributed to your objectives/mission?
- What is the uniqueness of W2W compared with other partnership that you have (market linkage and ready customer base, credit facility, network, coaching and mentoring) ?
- Can you give us an approximate data on the growth of women network and distribution of solar energy technology through this network within the platform of W2W? From inception to end.

Particulars	Base line (2018)	As of now (Feb 2022)
No of Women Entrepreneurs		
No of units sold		

Skills/knowledge/coaching:

- What skills/abilities/capacities are critical for entrepreneurs and how they are developed?
- Is it required to conduct a refreshment training for new product items?
- How regular coaching and mentoring is key element of bundle support?

Social relations:

- What is your opinion about engaging both men and women in energy entrepreneurship?
- How will you explain the acceptance of women engaging in energy entrepreneurship by their male counterparts in the family and community surrounding them?

Enabling environment (market linkage):

- How important the community awareness campaign is in the adoption of solar energy products?
- How setting product price plays a critical role to retain women entrepreneurs as well as maximize customer base?
- Do you think offering any kinds of promotional tools (e.g. branded T-shirts, umbrellas, kiosks, bag, cycle etc) are important for women entrepreneur to reach more people.
- Is partnership a good idea to access potential customer base? Why?

Globally certified quality and varieties solar devices:

- How sourcing quality solar products is important in such women entrepreneurship?

Financial service (capital/consumer loan):

- How do you see the importance of credit facility for both women solar energy entrepreneur and consumers in increasing access?
- Who needs the credit facility most- consumer or entrepreneur?
- How this financial need can be met? What innovative ways are in practice?
- How do you see partnership with non-banking financial institutions(e.g. Microfinance institutions, cooperatives, savings groups)?
- Does these financial institutions see solar energy entrepreneurship and consumer credit need as a potential sector to serve?

Bundle of service

- What are the other support/services you think could help boost solar energy access faster?
- How important it is to have integrated/bundle support system for a sustainable mechanism or process in the women solar energy entrepreneurship initiatives?

Reflective question

- How do you imagine this field will look in 10 years and how do you see your role to that?

Follow-up

- May I connect you in future for any clarification?

N2<sup>28</sup>:

General:

- Can you explain the W2W model? How does it function? Desired outcome?
- What are the supports W2W project offered to enable its women entrepreneurs
- How do you evaluate the success of W2W project in achieving the desired outcome? Any quantifiable evidence?

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<sup>28</sup> Organization pseudonym according to table 4 under 5.5.2

- How do you see the commitment among the project partners to continue providing support system to enable women entrepreneurship?

Enabling environment (market linkage):

- How important the community awareness campaign is in the adoption of solar energy products?
- How setting product price plays a critical role to retain women entrepreneurs as well as maximize customer base?
- Do you think offering any kinds of promotional tools (e.g. branded T-shirts, umbrellas, kiosks, bag, cycle etc) are important for women entrepreneur to reach more people.
- Is partnership a good idea to access potential customer base? Why?

Financial service (capital/consumer loan):

- How do you see the importance of credit facilities for women's solar energy entrepreneurs and consumers in increasing access?
- Who needs the credit facility most- consumer or entrepreneur?
- How can this financial need be met? What innovative ways are in practice?
- How do you see a partnership with non-banking financial institutions(e.g. Microfinance instructions, cooperatives, savings groups)?
- Do these financial institutions see solar energy entrepreneurship and consumer credit need as a potential sector to serve?

Bundle of service

- What other support/services do you think could help boost solar energy access faster?
- How important is it to have an integrated support system for a sustainable mechanism or process in the women solar energy entrepreneurship initiatives?

**F2<sup>29</sup>:**

General:

- What role do you play in W2W project?
- How is this role aligned with your overall programme mission?

Financial service (capital/consumer loan):

- How important the financial service that you are providing is for advancing energy access?

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<sup>29</sup> Organization pseudonym according to table 4 under 5.5.2

- Why will you be willing to continue serving the need even after the phasing out of the project?
- From a business point of view, who is your preferred client: entrepreneur or consumer? Why?
- What are the key challenges in offering this service to this target group?
- How potential is solar energy sector for your programme growth?

Bundle of services:

- Other than financial services, what additional support do you think critically important for such women's social energy entrepreneurship initiatives?

**F1<sup>30</sup>:**

Financial service (capital/consumer loan):

- How will you explain financial inclusion as an integral part of sustainable development?
  - o Why it is important? Is MF alone enough? Or we need more services/ factors to consider (capacity building, social inclusion, market linkage)?
  - o What are the other services must combine with financial service to achieve sustainable impact
- Who are your target groups?
  - o Only women? Only entrepreneur? New or established entrepreneur? Only rural?
  - o Is it everyone eligible to get a credit facility from you?
  - o How about consumer loan? Do you provide consumer loan?
- Finance/capital is undoubtedly very important for any entrepreneurial initiatives. In relation to that, how do you see women entrepreneurship as a potential sector for your programme growth? Do you serve them?
- You might have a different sectors e.g. trade, agriculture, service (hotels and restaurants) etc where you provide loans to. How do you see 'energy sector'?
- There are many women are leading to entrepreneurship in energy sector, specifically solar energy sector. How potential this women entrepreneurship in solar sector for your programme growth? Have you ever thought about it?
- If you asked for a partnership, will you be willing to offer a consumer credit facility to people who cannot afford to buy a solar energy product?

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<sup>30</sup> Organization pseudonym according to table 4 under 5.5.2



- Would you have preferred to offer an entrepreneurship loan over a consumer loan? Why?

### **D1**<sup>31</sup>

#### General:

- Your background and D1's role in solar energy technologies (lighting and beyond)

#### Thematic

##### Who benefits:

- Role of Signify in W2W project and how it was aligned with Signify's mission/vision

##### By What means:

- How do you see the partnership in W2W project in enhancing solar energy access - women engagement in solar energy entrepreneurship initiative,
- How effective this business model is for rural setup, challenges and opportunities
- What bundle of support are important to ensure the efficacy of such initiative

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<sup>31</sup> Organization pseudonym according to table 4 under 5.5.2

**ETHICAL REVIEW- SELF EVALUATION<sup>32</sup>**

**First-Stage Ethical Review**

The Lund University Masters in International Development (LUMID) recognizes *self-evaluation* as the general principle guiding the enactment of an ethically-aware research among its staff and students. To this scope, the following document lists a set of questions to be taken into consideration prior to the design of all research projects. All researchers at the department are encouraged to complete this form; however this rests in no ways prescriptive or associated to any form of ethical clearance or approval.

Should your answers point at some specific ethical issues with regards to your research, you're welcome to contact the LUMID Ethics Advisory Board through the LUMID Director of Studies.

TITLE OF RESEARCH: Barriers in last mile distribution channel of solar lighting solutions in Tanzania.

NAME(S): Mohammad Al Amin Sardar√

*Please answer each question YES or NO by ticking the boxes in the Checklist below.*

	YES	NO
1. Will the project involve gathering personal information on identifiable living individuals that will remain in non-anonymized form?		√
2. Does the research involve vulnerable groups, which would include such people as: children, those with cognitive impairment, refugees, undocumented migrants, asylum seekers, prisoners or victims of violence?		√
3. Will the project require the co-operation of a gatekeeper (i.e. an authority figure who has the power to grant access to individuals and information possibly without their knowledge or informed consent) for initial access to the groups or individuals to be recruited?		√
4. Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. through covert observation or recording)		√
5. Will the research involve topics that may be deemed to be politically, socially, or culturally sensitive?		√
6. Will the research use data that requires permission from the appropriate authorities or owners before use?		√
7. Will financial inducements or gifts (other than reasonable expenses and compensation for time) be offered to participants?		√
8. Will the research involve gathering and/or sharing data or confidential information beyond the initial consent given?		√
9. Will the research involve means that potentially make respondents identifiable <i>who have requested, or might reasonably anticipate, anonymity?</i> Such means	√	

<sup>32</sup> Please notice that this draft checklist is a combination of similar questionnaires adopted at SOAS and Edinburgh University and adapted from the questionnaire at the Department of Political Science, Lund University.

might include, as examples, ISP addresses, video or voice recordings, visual images, or specification of personal characteristics likely to identify an unnamed individual.		
10. Does the research entail potential security risks to research subjects (e.g. police interrogation, kidnapping, illness) that exceed those experienced in their everyday lives?		√
11. Does the research involve any physically invasive or potentially physically harmful procedures?		√
12. Will the research take place in a location or manner that could expose the researcher or research assistants to risks that exceed those experienced in their everyday lives?		√
13. Could the research induce any psychological stress or discomfort?		√
14. To the best of your knowledge, will the research raise any other issues which should be the subject of ethical consideration and/or review?		√

- If you have responded ‘**no**’ to all of these questions, then your research project entails minimal risk.
- If you have responded ‘**yes**’ to any other questions, your research project entails more than a minimal risk and you are encouraged to contact the LUMID Ethics Advisory Board through the LUMID Director of Studies.