Women's Energy Entrepreneurship: A Guiding Framework and Systematic Literature Review

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Since its founding in 1916, the Johns Hopkins Bloomberg School of Public Health (JHSPH) has been dedicated to the improvement of health for all people through the discovery, dissemination, and translation of knowledge, and the education of a diverse global community of research scientists, public health professionals, and others in positions to advance the public's health and development. JHSPH is the world's largest school of public health and has been ranked #1 by U.S. News & World Report since 1994.

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The Center for Women's Entrepreneurial Leadership (CWEL) at Babson College was established in 1999 to educate, inspire and empower the next generation of women entrepreneurial leaders. As the first ever academic center focused on women entrepreneurial leaders at a business school, CWEL is one of the most visible and important ways that Babson College supports women entrepreneurs, through award-winning programs, exclusive events, hands-on coaching, and access to cutting-edge research, including the Diana International Research Program, the Global Entrepreneurship Report on Women, and the Women Innovating Now (WIN) Lab.

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For more than 40 years, ICRW has been the premier applied research institute focused on gender equity, inclusion and the alleviation of poverty. Headquartered in Washington, D.C., with regional offices in India and Uganda, ICRW works with non-profit, government and private sector partners to conduct research, develop and guide strategy and build capacity to promote evidence-based policies, programs and practices. Learn more at www.icrw.org

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GLOSSARY OF KEY CONCEPTS AND ABBREVIATIONS

TERMS

Agency: ability to define and act upon one's goals or make decisions and take action.

Business model: describes the value that a company offers to its customers via the architecture of interconnected business processes from the cost structure to the revenue model, including the key activities, resources, and partners in the production, sale, and delivery of the product or service offering to the customer, in order to generate sustainable, profitable revenue streams.

Clean energy: refers to any source of power that does not pollute or harm the environment and may or may not be renewable. This can include solar, wind, geothermal, liquid petroleum gas (LPG), etc.

Economic empowerment: the combination of: (1) the ability (including access to skills and resources) to succeed and advance economically and (2) the power and agency to make and act on economic decisions.[1]

Entrepreneurial ecosystem: refers to a collection of interconnected elements in the local and macro-environment that work together to facilitate commercial innovation and the growth of new and small ventures, including but not limited to a supportive culture, availability and access to financing, supply and development of human capital, new/existing markets for products and services, and a range of institutional and infrastructural supports.

Empowerment: the expansion of the ability to make choices, through acquisition of information, resources, participation, and voice.[2,3,4] Empowerment is comprised of the following dimensions: resources, agency, and achievements. (Resources defined as the necessary skills and information; agency defined as the ability to define one's goals and act upon them; and achievement defined as the outcomes of the empowerment process.)

Energy: the power from a range of sources, such as electricity, biomass, solar, and coal, that provides light, heat, or machines work.

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[1] Golla, A. & Malhotra, A., Nanda, P, & Mehra, R. (2011). *Understanding and Measuring Women's Economic Empowerment: Definition, Framework, and Indicators.* Washington, D.C.: ICRW.

[2] Kabeer, N. (2012). Women's Economic Empowerment and Inclusive Growth: Labour Markets and Enterprise Development. *IDRC Discussion Paper:* 29/12.

[3] Narayan, D. (2002). *Empowerment and Poverty: A Sourcebook.* PREM World Bank.

[4] Klugman, J. Hanmer, L., Twigg, S., Hasan, T., McCleary-Sills, J., & Santamaria, J. (2014*). Voice and Agency: Empowering Women and Girls for Shared Prosperity.* Washington, DC: World Bank Group. https://openknowledge.worldbank.org/handle/10986/19036

Entrepreneur: an individual who assumes the risks of organizing, starting, and growing a business, in hopes of generating revenue and making a profit by creating significant value for customers, owners, and their stakeholders.

Entrepreneurship: the process of organizing, starting, and growing a business along with associated risks, in hopes of generating revenue and making a profit by creating significant value for customers, owners, and other stakeholders.

Gender: social status categorization (usually dichotomous) based on biological sex that defines social ideals, norms, and expectations for traits, behaviours, and group roles based on social constructions of what it means to be female and male in a society.[5] Social categories of gender are typically ranked in terms of status expectations relative to a specific context or task set, resulting in high expectations of competency for different activities, such as stereotypes suggesting that men make better business leaders while women are better at caring for a home and children.

Gender system: comprised of processes that both define males and females as different in socially significant ways and justify inequality on the basis of those differences.

Micro-finance institutions: a financial institution specializing in banking services for low-income groups or individuals.

Off-grid: not using electricity from the public electrical supply system.

Non-governmental Organizations (NGOs): any non-profit, voluntary citizens group that is organized on a local, national or international level.

Sales agent: one who is authorized or appointed by a manufacturer to sell or distribute products. Sales agents are generally self-employed although in some cases are provided a stipend to support their activities.

Self-efficacy: the belief that one will be able to accomplish the things he/she sets out to do.

Supply chain: A network of individuals, organizations, resources, activities, processes, and technology involved in the creation and sale of a product or service, from design and

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[5] Gender roles and expectations are learned. They can change over time and they vary within and between cultures. Systems of social differentiation and status assignment such as class, ethnicity, physical and mental disability, sexual orientation and age further modify gender ideals and expectations.
The concept of gender is vital because, applied to social analysis, it reveals how women's and men s roles and relationships are largely socially constructed. In most societies there are differences and inequalities between women and men in decision-making opportunities, responsibilities assigned, activities undertaken, and access to and control over resources.
UNESCO s Gender Mainstreaming Implementation Framework: Baseline definitions of key concepts and terms. *http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/BSP/GENDER/PDF/1.%20Baseline%20Definitions%20of%20key%20gender-related%20concepts.pdf*
OCHA Gender Toolkit: Gender Definitions and Mandates
https://docs.unocha.org/sites/dms/Documents/GenderToolkit1_2_GenderDefinitionsandMandates.pdf

source material supply to manufacturing, distribution, marketing and sales through to final delivery to the end user.

ABBREVIATIONS

CWEL	Center for Women's Entrepreneurial Leadership
GEM	Global Entrepreneurship Monitor
ICRW	International Center for Research on Women
ICT	Information and communication technologies
IEA	International Energy Agency
IFC	International Finance Corporation
ILO	International Labour Organization
IRENA	International Renewable Energy Agency
IUCN	International Union for Conservation of Nature
JHSPH	Johns Hopkins School of Public Health
LPG	Liquid petroleum gas
MFP	Multifunctional platform
MSME	Micro, small and medium sized enterprises
NGO	Non-governmental organization
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OECD	Organisation for Economic Co-operation and Development
SAGEN	Southern African Gender and Sustainable Energy Network
SDG	Sustainable development goal
SE4ALL	Sustainable energy for all
SE4ALL-PCA	Sustainable energy for all- People centred accelerator
SEWA	Self-employed Women's Association
SHG	Self-help groups
SLR	Systematic literature review
SME	Small and medium sized enterprises
STEM	Science, technology, engineering and math
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
VSLA	Village savings and loan associations
WE	Women's entrepreneurship
WEE	Women's energy entrepreneurship
WHO	World Health Organization
WIN	Women Innovating Now

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EXECUTIVE SUMMARY

Policy-makers have expressed an increasing interest in expanding energy access through women's entrepreneurship (Habtezion 2016). Engaging women at all levels of clean energy value chains is thought to not only economically empower these women but also to have positive business outcomes (HEDON 2015). Many believe that women's involvement in the clean energy industry will enable energy companies to produce products and services that are better targeted to female customers and help sell to female customers in hard-to-reach locations, which in turn will increase women's access to energy (Reiss 2015). Moreover, engaging women as product designers, manufacturers, and sales agents is expected to contribute to their access to income, business networks, technical knowledge and skills, economic opportunities, and self-confidence (Cecelski 2000; 2004; Clancy 2003).

Despite these policy goals and priorities, there is limited data on the impact and contribution of women-centric approaches to expanding both access and effective use of clean energy technology and/or energy-based services (Clancy et al. 2004; Rewald 2017). At this time, there are no national data sets available that provide exact or even approximate numbers of women employed in informal jobs or activities related to energy such as fuelwood (as biomass) collection and charcoal production. Since informal sector economies dominate in regions where significant deficits in energy access exist, this provides an important opportunity to advance energy access. A targeted policy and research agenda for gender and entrepreneurship is needed in the energy sector focused on an evidence-based understanding on how women's involvement in energy enterprises in developing nations will forward not only Sustainable Development Goal 7 (energy access for all), but also several other goals including improving health, educational outcomes, reducing inequalities, reducing poverty and creating sustainable environments.

To investigate the existing evidence and to identify gaps in understandings around gender and entrepreneurship in the energy sector, we undertook a systematic literature review (SLR) of policy papers, grey literature and academic peer-reviewed papers. With the resulting sample of publications and reports, we examined the quality of evidence clarifying how women's energy entrepreneurship may contribute to key SDGs, including energy access for all individuals (SDG7), gender equality (SDG5), health and well-being (SDG3), poverty alleviation (SDG1), and sustainable economic growth (SDG8). Our primary research objectives for this review were to outline key business and behavioural drivers of success of women's involvement in energy-based enterprises, to examine the role of the private sector and market-based approaches, and to identify current program innovations to strengthen women's agency and economic empowerment in order to scale energy access through business start-up and growth. Importantly, we applied a "gender system" theoretical perspective (Elam 2008; Ridgeway et al 2004; Ridgeway et al 1999) and multilevel research model to guide this literature review of women's energy entrepreneurship.

In this report, we provide a summary of our SLR findings based on the following three questions:

1) How does women's energy entrepreneurship advance energy access for all?

2) How does women's energy entrepreneurship benefit women and their families?

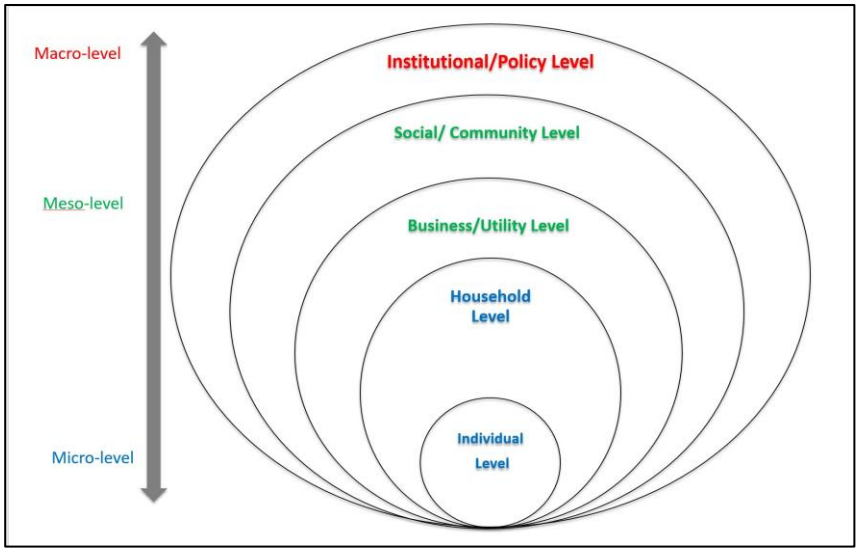
3) What are the best practices to support women's entrepreneurship in the energy sector?

In the following chapters, we specifically address the state of the science on women's energy entrepreneurship, contribute to theory development around the potential impact of women's entrepreneurship on energy access and benefits to families and communities, and recommend solutions that may inform policy and programming supportive of women's energy entrepreneurship.

Gender System Perspective

Female entrepreneurs encounter both barriers and enabling factors every day, driven by gendered social norms, across the multiple levels in analysis, from sense of agency at the individual level to enabling policies at the institutional level. Our aim in presenting this gender system framework is to identify key barriers to women's entrepreneurship at each of five levels of analysis with an eye towards cross-level interactions, as shown in Figure A.

Figure A: Gender Systems Research Model



At the individual and household levels, one's psychology, which is both historical and concurrently shaped by social norms, often puts women at a disadvantage compared to men, especially inside their households. Women's time is less valued in the household and female family roles tend to put most of the caring work and household labour on female shoulders.

At the business level, women more often pursue opportunities in more competitive, low margin industries or markets and are more likely to start businesses with an emphasis on meeting social needs which results in very different business goals, business models and outcomes than men (Hechavarria 2017; Kelley et al 2017).

At the societal and community levels, support for women's entrepreneurship can be hard to come by, not only because the act of women leading businesses can challenge traditional gender norms regarding women, paid work, and leadership, but also because resources may be scarce and seen as better directed towards more legitimate and established firms, which tend to be businesses led by men.

At the policy/institutional level, considerable work has been done to ensure equality under the law in many, but not in all countries (Brush et al. 2009; Manolova et al. 2018). Unfortunately, ensuring equal access to occupations, industries and resources may not change individual-level psychology or prompt shifts in gender norms and ideology. Even after structural changes have taken place, it is not unusual for cultural change to lag; in other words, it can take a while for individual thought and action to adapt to new circumstances (Ogburn 1966).

Study Methodology

To investigate the intersections of gender and energy entrepreneurship, we conducted a systematic literature review (SLR) scanning a wide range of literature from across databases and employing several rounds of targeted elimination to identify articles most relevant to our research questions. In addition, this review was supported by case studies and primary data collection from active intervention programs; the results of which are described in this report. The systematic literature review was based on established best practices (Tsafnat et al. 2014; Tranfield et al. 2003).

We searched a total of 15 databases and employed a list of 15 pre-defined keywords relevant to gender/women, energy and entrepreneurship to identify articles published over the last 20 years between 1998 and 2018. Given the frequent absence of highly relevant grey literature from academic search databases, including Google Scholar, we also used a snowballing technique to supplement our database search by identifying additional resources that were not uncovered in our systematic process. We searched out highly relevant references in footnotes and bibliographies of articles and other research documents. In addition, we collated a list of organizations working with women entrepreneurs from several sources including ENERGIA, the Clean Cooking Alliance (previously Global Alliance for Clean Cookstoves), wPOWER and Sustainable Energy for All – People Centred Accelerator; we included descriptive references of the work being done by these organizations to bolster key elements of the analysis. The initial database search generated 12,474,493 results across the 15 selected databases, with heavy overlap between databases. After filtering based on our exclusionary criteria, we identified 595 articles eligible for coding and saved them in a Zotero bibliographic database. We identified 208 research articles suitable for full coding.

Question 1: How does women's energy entrepreneurship advance energy access for all?

Overall, we found the published literature on women's energy entrepreneurship to be at a very early stage of development with a focus on informal, subsistence-level business activity in emerging economies, low levels of methodological rigor, absence of theory development, murky use of key constructs, absence of control groups for counterfactual analysis, and few significant quantitative findings outside of program impact reports. In other words, the literature is primarily comprised of prescriptive and descriptive studies and program reports, confirming the need for more rigorous research

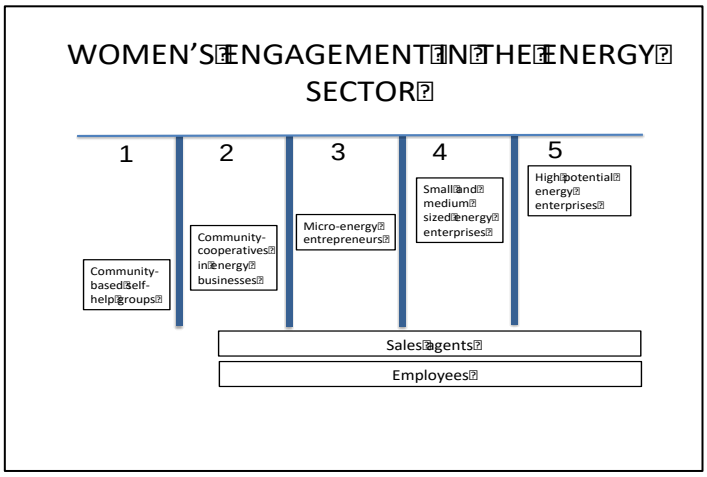
to address the lack of evidence regarding the potential impact of women's entrepreneurship on energy access for all (SE4ALL-PCA 2017a; Oparaocha & Dutta 2011; Avato & Madeira 2010; Bardouille 2012).

We summarize the descriptive evidence linking women's entrepreneurship to access to energy for all, identify some gaps in the literature and opportunities for powering research on women's energy entrepreneurship and identify key factors at each level of analysis that deserve attention from researchers, policy makers, and program implementers. Throughout the research and programmatic literature on women's energy entrepreneurship research, there is a clear and immediate need for more explicitly defined business constructs, such as entrepreneurship, business models, supply chain, and ecosystems. We provide brief descriptions of each of these terms to provide further clarification.

While there is descriptive research and programmatic summaries of approaches that have engaged female entrepreneurs in the production and distribution of energy products and services, there is little empirical research that presents a counterfactual analysis to show that engagement of female entrepreneurs leads to greater energy access than non-engagement of women. Nonetheless, reviewing women's energy programming provides important insights into the state of this sector. As we consider women's engagement within the energy sector, it is important to first examine the roles women have played and investigate how these roles can be enriched or expanded to advance energy access. As women have historically been engaged in the collection and cultivation of traditional energy sources, it is a natural shift to also include them in the creation and distribution of clean energy products and services. Data from field programs suggests that much of the discussion related to women's entrepreneurship in energy is in fact referring to a range of women's engagement in the sector, from informal women's groups, micro and small businesses, high potential entrepreneurial endeavours as well as independent sales agents and employees (See figure B).

It is important to recognize that the majority of energy distribution programs and services are not designed to create women's businesses or to reinforce the gender system. The primary goals are, generally, to distribute energy product or services to the greatest number of people while maintaining sufficient profits to stay in business. Nonetheless, each of the mechanisms described below do support both the gender social system and entrepreneurial ecosystem for women to varying degrees.

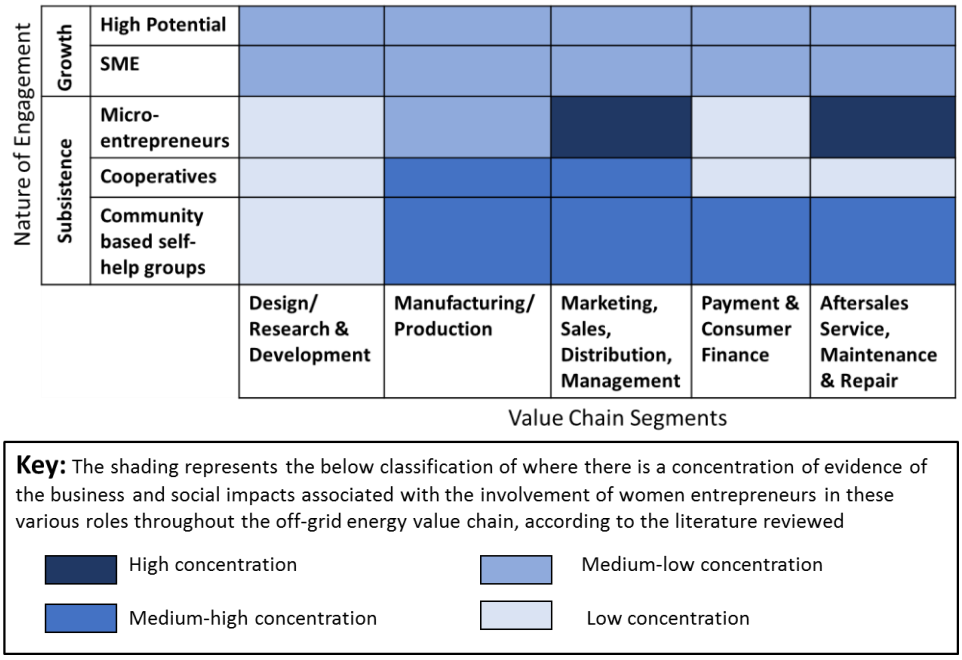
Figure B. Various forms of women's engagement in the energy sector



How and why women should be engaged throughout energy value chains differs by value chain segment and mode of engagement. Building on frameworks and findings from several studies, Figure C depicts the main roles where women entrepreneurs have been engaged in off-grid energy value chains, and below we provide more detail on what women's entrepreneurship looks like at each of these value chain segments (O'Dell et al. 2014; Misana & Karlsson 2001; Bardouille 2012; Kohlin et al. 2011; Baruah 2016; Cecelski 2000). Sales and distribution roles may be more effective for the distribution of smaller home products and women's roles as technicians may be better suited for larger solar home systems. It does appear that engagement in aftersales service, maintenance and repair may be more attractive to women from poorer households as this involves less capital risk, helps them gain technical skills that can be used in their professional and personal lives, and doesn't require the need to consistently find new customers outside of their social networks.

Based on the available grey literature, there are multiple ways that women can effectively engage within the energy sector to advance access of energy for all. However, there is no substantive evidence, beyond favourable program reports, that the current efforts have significantly increased household access to energy in a sustained way. While there have been thousands of women entrepreneurs supported through many of these programs, the bulk of these women are micro-entrepreneurs. Building their businesses beyond necessity towards more growth-oriented opportunity-based businesses is a challenge. This is due in part to the transient nature of clean energy technology products and the need to continue to maintain and update products to continually serve household energy needs. Given the numerous challenges women face at all levels of engagement and along the value chains, it is unlikely that these programs will significantly scale without concurrently reinforcing the gender inequality.

Figure C: Integration of Female Entrepreneurs in Off-grid Energy Value Chains



Question 2: How does women's energy entrepreneurship benefit women and their families?

Women's participation in energy entrepreneurship has the potential to address several of the Sustainable Development Goals (SDGs) through the direct empowerment of women, through women's investments in their families and communities, and through benefits associated with access to energy. Women's participation in income-generation, and as ambassadors of new energy technology products or services can contribute to: increasing decent work and economic growth (SDG8) by providing women with a sustainable income generation opportunity, reducing poverty through women's increased incomes (SDG1), and improving gender equality (SDG5) as women are able to not only financially contribute to the family, but are also able to communicate, negotiate, and participate in household and community level decision making.

This review describes the unique bi-directional relationship between participation in energy entrepreneurship opportunities and the use of time saving energy products and services. The presence of income generating opportunities can increase the value of women's time thus motivating the purchase and use of energy products/services, and the use of energy products/services frees time for income-generating activities. Therefore, we propose that women's energy entrepreneurship is distinct from other forms of business activity because of the valued added through access to energy products and/or services. Moreover, these added benefits could be fully realized, we suggest, if other supports for both the gender equality and new/small businesses exist.

At the individual level, the most direct impact on female entrepreneurs engaged in energy value chains is increased income. In settings where women often have few opportunities for income-generation clean energy production and distribution initiatives can create a host of opportunities. Women engaged as clean energy entrepreneurs gain both business and technical skills. Women learn technical skills through involvement in

various value chain segments – women involved in manufacturing and producing energy products learn technical, craftsmanship skills, while women involved in sales and distribution gain an understanding of how to operate the energy products/services, and women engaged as technicians gain skills related to the repair and maintenance of energy technologies (World Bank 2004). Moreover, women engaged as energy entrepreneurs often gain access to social networks either directly through the enterprise structure, or through forming their own groups to share knowledge and best practices.

When women gain income and are engaged in roles where they are physically moving throughout the community and interacting with diverse community members, it can cause a shift in power dynamics and relationships in the household and community. Having roles that break with cultural stereotypes and gender norms, cause women, and their family members, to begin to question and challenge other gender norms. In particular, as women earn income and contribute to household earnings, household power dynamics can shift as they are given a larger role in household decision-making (e.g. how money earned is spent).

In addition to the benefits associated with having a female family member who is an energy entrepreneur, households benefit from the use of the energy products and services with which the entrepreneur works. Numerous studies in the developing world have found that access to electricity is associated with better school outcomes as students are able to study later into the night (Van de Walle et al. 2013; Khander et al. 2009; Cecelski et al. 2005). For example, a World Bank study in Bangladesh found that when villages are electrified, boys complete 0.23 more years of schooling and girls complete 0.47 more years, compared to those in non-electrified villages. When households themselves are electrified, the benefits are even greater. In villages that were electrified, boys who live in households that also have electricity complete an average of 1.13 more years of schooling, while girls average 1.07 more years of schooling, compared to those in non-electrified villages (Khander et al. 2009).

Increased visibility in the community and enhanced communications and self-confidence often enable women to rise to supervisory or management roles and also to serve in leadership roles in local community groups and committees. Khan (2001) describes how women who participated in the project in Char Montaz Bangladesh were able to not only gain technical skills, but also serve in supervisory positions through their experience and training in business. Njenga (2001) describes how women who participated in design, production, distribution, and installation of stoves in the Upesi Project in Kenya were able to leverage their increased confidence and status to serve on community development committees.

As women participate in roles that give them exposure to the community and also engage in the management and distribution of an important resource, their sense of status in the community often improves. When women are engaged as sales and repair agents, their visibility and reputation spreads throughout their community – a project in Rajasthan implemented by TERI described how lower-caste Gujar women experienced increased visibility and increased recognition of their socio-economic and political empowerment through their role as solar entrepreneurs (Baruah 2016). Social norms may also begin to shift as community members see women in roles that they previously did not think they were capable of, such as the case with older women trained as solar technicians with Barefoot College in India (Karlsson 2013).

While there are many economic and social benefits of participation in energy entrepreneurship, as outlined above, it should be noted that entrepreneurship may not be the best way to engage women from the poorest tiers of society. Baruah (2016) suggest that low-income women, from both developed and developing countries often do not become entrepreneurs because the level of risk associated with taking loans and having an unpredictable income is too high. Rather, these women are more interested in wage employment that offers stable hours and income (Baruah 2015). In addition, while the clean energy sector presents new and innovative ideas, poorer women may be hesitant to take risks on products and services that have not already been proven in the market. These women would prefer opportunities in the energy sector where they can earn an income without becoming indebted and do not have to depend on convincing potential customers to purchase a new, unknown product or service (Baruah 2016).

Women's energy entrepreneurship is not, on its own, the solution to gender inequity. Due to structural and cultural factors, energy entrepreneurship on its own will not create gender equity. Rather, it may just reinforce the existing inequitable systems and structures. For example, female entrepreneurs with less access to financing, restricted mobility, and limited access to business and technical skills will likely remain in more subsistence forms for entrepreneurship while male entrepreneurs are better able to overcome those barriers to progress to higher growth enterprises. Gender roles shape individuals' identity by prescribing how they are expected to think and behave and interact with those of the opposite gender (Clancy 2000). The "gender system" perspective suggests that all interactions happen between men and women both within and outside of the household as a result of pervasive institutional forces (Sidanius et al. 2004; Ridgeway & Correll 2004; Fowler 2003). Therefore, female entrepreneurs face unique barriers to equal participation and achieved benefits, which are driven by gendered social norms across the ecological framework – from agency at the individual level to enabling policies at the institutional level.

Question 3: What are the best practices to support women's entrepreneurship in the energy sector?

To address the question of best practices for women's energy entrepreneurship, we draw significantly from the existing entrepreneurship literature and the numerous field programs working with women's energy-related businesses. From the empirical literature, we find four types of supports identified that vastly enhance women's economic growth. These include at the individual level: a) business education and skill development and b) training to foster personal agency and initiative; and at the business level: c) access to finance and capital and d) access to coaches, mentors and networks (Glemarec et al 2016; Henry & Lewis 2018; Pittaway & Cope 2007; McKenzie & Woodruff 2013; Chitsike 2000; Buvinic et al. 2016; Campos et al. 2017; Shankar et al. 2015a). In this chapter, we present an overview of the evidence for each of these entrepreneurial supports, review field programs in the energy sector using these strategies and recommend best practices for organizations and programs working to expand women's energy entrepreneurship.

With respect to business supports, access to capital (as monetary services or goods) is one of the largest barriers faced by female entrepreneurs attempting to start and expand energy enterprises (Grewe & Stein 2011; Bardasi et al. 2011; Elwell et al. 2014; Sigalla & Carney 2012; Clancy 2000; Baruah 2016; Amatucci & Crawley 2010;

Pachauri & Rao 2013). The primary mechanisms for accessing finance include commercial banks, equity funds, micro-credit, angel investment, grant funding or venture capital. The case for gender equality in business, including entrepreneurship is strong, yet is remarkably underutilized (IFC 2017). Investors in businesses that have greater gender diversity have better returns and are able to adapt during times of economic volatility (IFC 2017).

Of course, basic businesses skills and financial literacy are also necessary to build strong women's businesses. Although there may be considerable variation in business education content, these programs tend to include accounting, financial planning, pricing and costing, marketing and inventory management (McKenzie & Woodruff 2013). Despite the clear necessity for business training, there have been a number of randomized experiments recently showing fairly strong evidence that business skills training alone are not sufficient for entrepreneurial success (McKenzie & Woodruff 2013; Buvinic et al. 2016). For any training program, constraints faced by women, such as travel and time, must be taken into consideration otherwise as it will likely to lead to lower retention rates. In addition, trainings that reduce travel costs and provide accommodation for childcare (or organizing the training to adjust for household obligations) are more likely to be successful.

Many university-based entrepreneurship training programs now incorporate training on "entrepreneurial mindsets" and growth mindsets, like Babson College's Entrepreneurial Thought and Action training methodology to support traditional business skills and planning. However, few of these novel programs have published rigorous scientific evidence that these entrepreneurship training approaches actually enhance business performance. Two exceptions are found in data from a series of randomized controlled experiments of entrepreneurial training program efficacy for women entrepreneurs that have produced consistent results across different developing country contexts. These data concern two approaches to personal empowerment training in entrepreneurship that can be further strengthened and expanded with supportive coaching and mentoring. One is a targeted action-regulation training approach focused on enhancing personal initiative (Campos et al. 2017; Frese et al. 2016; Glaub et al. 2014; Koop et al. 2000). The second is a personal agency approach that recognizes the integrated nature of various aspects of an entrepreneur's life and uses a cognitive-behavioural approach that considers how an individual's thoughts, feelings, and actions can lead to meaningful action when examined within one's specific sociocultural and situational context (Shankar et al 2018; Shankar et al 2015a).

In addition, a large body of literature supports the need for on-going support and mentoring to provide female entrepreneurs with the training and support they need to excel (IUCN 2014; Pailman 2016; Amatucci & Crawley 2010; O'Dell et al. 2014). Creating on-going touch points for mentoring and networking can help female entrepreneurs feel that they have a support network, to address business challenges as they arise and learn best practices from other entrepreneurs, and to expand their networks and reach. In the case of energy entrepreneurs, mentors with two types of skill are required, one to support business development and another to support the technological components of the energy product.

For organizations or programs that are designed to work with women, we suggest a number of best practices to support this process. First, identify the right people, as not

all women will be effective entrepreneurs or mentors. It is reasonable that enterprises might want to set criteria for their mentors and entrepreneurs, such as prior sales experience, owning of a shop, access to credit to purchase inventory, or energy technology knowledge. It is critical to have the right product. In many markets throughout the developing world, companies have struggled with convincing customers of the value and quality of clean energy products. Initially it can be difficult to convince someone to use a new clean energy product that seems entirely foreign. However, what is even more difficult is trying to win back their trust after they have purchased and used a clean energy product that they felt was of poor quality or quickly broke down.

Business networks, especially for women, become an important source of new information, and means of obtaining social support with other entrepreneurs. Through improved social networks, women feel a greater solidarity with peers, appear to demonstrate greater financial independence and can gain greater respect in their communities. However, any one type of business support is insufficient. Instead, it is important to bundle services and if possible provide targeted support. There is compelling evidence that bundled services, such as the provision of a capital transfer (as cash or in kind), business training and on-going supervision can be an effective support (Green et al. 2015).

Digital technology is likely the most important innovation for scaling small and medium sized entrepreneurs to emerge in recent decades (UNCTAD 2014). Information and communication technologies (ICTs) have been changing the global landscape of entrepreneurship, especially in resource poor settings by facilitating how people communicate, what type of information they have access to and simplifying of the exchange of money. In addition to the traditional methods of increasing communications, new forms of ICTs can enhance learning opportunities, mentoring and coaching support, linkages to markets and rapid feedback on community or environmental concerns. Increasing women's access to the latest technological advances in ICTs through reduced costs will be critical to build SMEs in energy-related businesses.

There is growing evidence that engaging men in programs targeted towards women can greatly improve the impacts of those programs for women and the family. A recent ILO-WED brief highlights the importance of engaging men at all levels - at the household, community and policy levels- in women's entrepreneurship. While existing interventions are increasing, most seek to engage men as either "gatekeepers" to gender equality or as potential agents of change in challenging established gender norms. Effective strategies towards this goal include providing capacity-building activities encouraging men to adopt positive masculinities, engaging them in trainings targeting women and identifying and supporting gender champions (ILO 2014).

As women are increasingly engaged in clean energy value chains, it is crucial to understand what business models, practices, and enabling conditions are most effective for both scaling energy access and empowering women. It is clear from the research that access to financing is one of the largest barriers that female entrepreneurs face in starting and growing energy businesses. More research is needed to better understand they types of financing mechanisms and bundled services are most effective in supporting female entrepreneurs through different forms of engagement (e.g., collectives, micro-entrepreneurs, SMEs) and growth stage.

Conclusion & Recommendations

While more research is needed, this review suggests that energy entrepreneurship may provide a unique combination of inputs for transforming women's lives through the provision of an income-generation opportunity and also a time-saving technology that has the potential to both reduce women's unpaid care work and increase the value of women's labour. This comparative systematic literature review set out to answer key questions related to the existing evidence that women's entrepreneurship as a viable means of advancing energy access for all and its potential to contribute to numerous other Sustainable Development Goals. Due to the scant scientific literature available on women's energy entrepreneurship, it is clear more rigorous research is required to generate evidence to address these assertions.

However, there are numerous programs and projects worldwide that are actively engaging with women along the energy value chain, ranging from informal to formal businesses, as individual entrepreneurs or are part of collective. Many of these projects have shown significant progress. Unfortunately, the methods of engagement to support women energy entrepreneurs are not sufficiently robust to catalyse small, medium and high potential women's businesses in the energy sector. Moreover, programs generally fail to understand the cultural and structural factors that constitute the gender system and the entrepreneurial ecosystem with sufficient depth and foresight to manage barriers and roadblocks. Within the context of energy related business, a clear understanding of the customer's journey with new technological products needs to be achieved in order to ensure steady revenue, maximum market reach, and a sustainable business model.

What is clear is that experts, academics, policy makers and program managers from multiple disciplines and fields should participate in working towards solutions. Perspectives from business, health and gender studies provide new insights and suggest ways to examine the intersections within the larger gender system. In addition, integrated interventions and bundled services benefit from rigorous testing prior to deployment and scale up.

While there was very little rigorous evidence that used experimental or quasi-experimental methods, this review identified intersections, key considerations, and opportunities for women's energy entrepreneurship. There are clear program and policy messages as well as research recommendations to be drawn from this literature review. On the programmatic and policy side, we propose the following messages for communication and integration into clean energy interventions and enterprises:

1. Women's energy entrepreneurship has great potential to benefit women, their families and to distribute energy products and services to their communities.

2. These benefits can be strengthened through integrative interventions to these women and their businesses.

3. Expanding women's engagement in energy businesses should not be considered a strategy for poverty alleviation and has potential risks unless there are sufficient supports in place.

4. Proven effective strategies for entrepreneurship support that should be adopted by programs included bundled business services, personal agency and initiative training, coaching/mentoring, use of information technologies support, and engagement of men both at home and in the community.

In this literature review, we find that there is a need more for rigorous experimental and quasi-experimental research to explore connections between women's energy entrepreneurship and access to energy, benefits for women and their families, and the types of training that are most effective. Here we outline a few key questions identified for further research:

- **What are the pros and cons of different types of women's energy engagement/entrepreneurship and how are they effective at expanding energy access**? This review presents a few studies that show that women energy entrepreneurs are able to effectively expand energy access for rural communities. However, more experimental and quasi-experimental research is needed to understand where within the value chain (e.g., design, production, sales, or aftersales) and in which mode of engagement (e.g., through self-help groups, as micro-entrepreneurs, or as owners of small/medium businesses) the skills and contributions of women entrepreneurs have the greatest potential to expand energy access. Studies should specifically compare the contributions of female and male entrepreneurs.

- **Which types of energy entrepreneurship provide the most sustainable income-generation options for women?** In order to understand which types of energy entrepreneurship opportunities create the most sustainable income-generation opportunities for women (such as consistent and sufficient earnings, formal contracts and job security, and social protections including insurance, leave, and other benefits), more systematic research is needed to compare the different roles that women entrepreneurs play throughout energy value chains, as well as in mode of engagement within and across resource-poor contexts. This research should look at the benefits associated with women's engagement in selling energy products versus fuels or energy services that require repeat purchases. Moreover, research to compare energy entrepreneurship with entrepreneurship in other sectors such as retail, food services, business services, software/technology, and manufacturing is needed. Understanding which types of financing models are best suited for different types and stages of entrepreneurship is key as well as research to address product/service offerings, the customer value propositions, customer journeys—all factors at the centre of the business model—and how and why gender might matter for the sales process.

- **What are the connections between women's energy entrepreneurship, the value of women's time and labour, and the use of time-saving energy technologies?** More research is needed to understand whether a woman's participation in energy entrepreneurship changes how her family values her time and labour and whether this therefore motivates families to purchase time-saving energy products or services (e.g., cleaner cookstoves and fuels, electric ovens, washing machines, etc.). Similarly, further exploration is needed to assess whether the presence of an energy entrepreneurship opportunity results in

greater likelihood of spending time saved through the use of an energy-efficient energy technology on income generation and ultimately shifting the value that families and communities place on women's time and labour. As part of this question, understanding whether community norm change interventions can help unleash opportunities for female energy entrepreneurs would be critical.

- **What are the differences in gender barriers faced women energy entrepreneurs engaged at the subsistence level, in small and medium businesses, and in high-potential, high-growth businesses**: While the business models and types of challenges encountered at these different levels of entrepreneurship vary greatly, little to no research has looked at the different gendered barriers that women energy entrepreneurs face at each level. More research is needed to explore these gendered barriers so that enterprises, enterprise development programs such as NGOs, incubators, and accelerators, and government policies can appropriately target and support women energy entrepreneurs at each level. Understanding that coaching and mentoring is key for all stages of entrepreneurship, understanding how to most effectively support and meet the specific needs of each type of entrepreneur to start and grow businesses is important. While it is clear that personal initiative and agency-based empowerment training has the potential to increase women's ability to be effective energy entrepreneurs, more research is needed to understand how to adapt these training methods to different types of entrepreneurs and different enterprise business models. In addition, more research is needed to explore how innovative information and communication technologies (ICTs) can be used to expand the reach and frequency of contact for coaching and mentoring programs.

1. INTRODUCTION

Policy-makers have expressed an increasing interest in expanding energy access through women's entrepreneurship (Habtezion 2016). Engaging women at all levels of clean energy value chains is thought to not only economically empower these women but also to have positive business outcomes (HEDON 2015). Many believe that women's involvement in the clean energy industry will enable energy companies to produce products and services that are better targeted to female customers and help sell to female customers in hard-to-reach locations, which in turn will increase women's access to energy (Reiss 2015). Moreover, engaging women as product designers, manufacturers, and sales agents is expected to contribute to their access to income, business networks, technical knowledge and skills, economic opportunities, and self-confidence (Cecelski 2000; 2004; Clancy 2003).

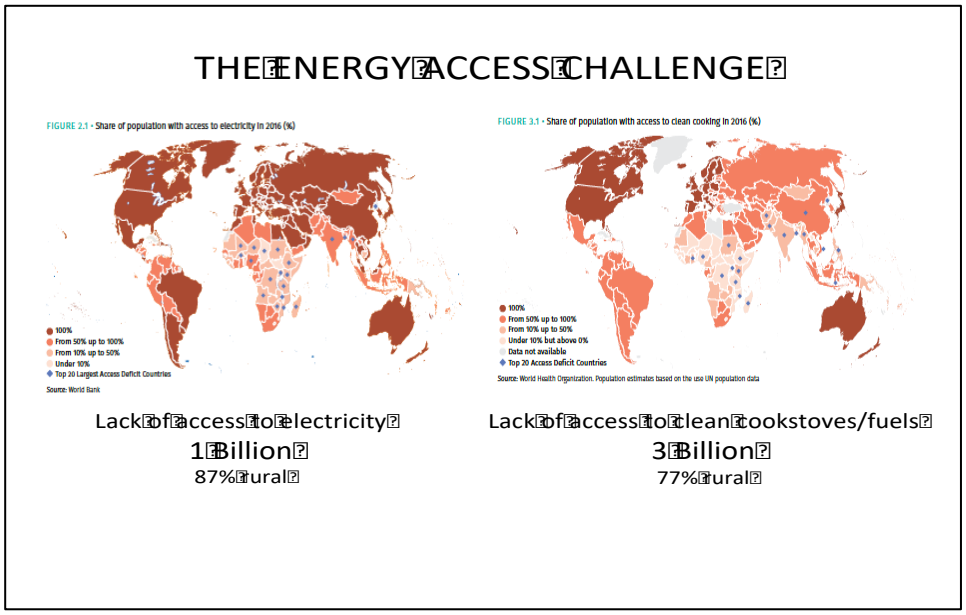
Despite these policy goals and priorities, there are limited data on the impact and contribution of women-centric approaches to expanding both access and effective use of clean energy technology and/or energy-based services (Clancy, Oparaocha, & Roehr 2004; Rewald 2017; Shankar 2015b; SE4All-PCA 2017a,b). At this time, there are no national data sets available that provide exact or even approximate numbers of women employed in informal jobs or activities related to energy such as fuelwood (as biomass) collection and charcoal production. Extrapolations from regional data sets suggest that the numbers are significant, for example, an estimated 13 million people are employed in the commercial biomass sector in sub-Saharan Africa alone (Openshaw 2010). This is important as fuelwood and charcoal represent between 50 and 90% of all energy needs in developing countries, and usage of wood for fuel and charcoal comprise 60–80% of total wood consumption (ESMAP 2012).

Since informal sector economies dominate in regions where significant deficits in energy access exist, this provides an important opportunity to advance energy access. A targeted policy and research agenda for gender and entrepreneurship is needed in the energy sector focused on an evidence-based understanding on how women's involvement in energy-based enterprises in developing nations will forward not only Sustainable Development Goal 7 (energy access for all), but also several other goals including improving health, educational outcomes, reducing inequalities, reducing poverty and creating sustainable environments.

1.1. The Energy Access Challenge

Globally, one billion individuals still lack access to modern electricity, nearly 3 billion people rely on wood, coal, charcoal or animal waste for cooking and heating (World Bank 2018) and more than one billion people living in the hottest climates are at risk of insufficient energy for cooling (SE4ALL 2018). The energy access challenge is heavily concentrated in Sub-Saharan Africa and South Asia and overwhelmingly affects individuals living in rural or poor communities (figure 1.1). Moreover, in these same settings, women and girls are primarily responsible for household tasks including gathering, managing, and providing the energy that makes this work possible. Therefore, energy poverty is a problem that has a disproportionate effect on women and girls, especially in rural areas (Oparaocha & Dutta 2011).

Figure 1.1 Distribution of energy access and deficits
(Source: SE4ALL 2018)



In recognition of the importance of this issue, in 2015, improved energy access was included in the United Nation's seventh Sustainable Development Goal (SDG) that aims to ensure access to affordable, reliable, sustainable, and modern energy for all by 2030. Driven in large part by the SDG 7 mandate, considerable global efforts are underway to address this deficit, especially for individuals in poor and rural locations. Over the last decade, many countries such as Bangladesh, Ethiopia, Kenya, India, and Tanzania have made significant headway in increasing access to electricity (World Bank 2018). Unfortunately, progress in many areas of sustainable energy falls short of what is needed to achieve energy access for all. While access to electricity is estimated to be over 85% (in 2014), the rate of expansion efforts is still low (at about 0.3% per year access since 2012) and access to clean cooking and fuels, which is at 60%, has not changed appreciably since 2012.

In order to meet this demand, the energy market is comprised of devices, and household systems such as improved cookstoves and fuels, solar lanterns and solar home systems and kits, mini-grids/utilities, and grid extension. Analysis by the International Finance Corporation (IFC) found that, using current spending patterns and leveraged monthly costs to end users, **devices and household systems represent the largest share of the energy expansion market at $31 billion, mini-grids comprise a $4 billion market, and grid extension represents a $2 billion market** (Bardouille 2012). To make significant progress towards SDG 7 will require higher levels of financing, innovative expansion efforts and the adoption of new technologies at a larger scale.

1.2. The Case for Women's Entrepreneurship as a Mechanism to Enhance Global Access to Energy

Women entrepreneurs are considered essential for private sector development in emerging markets (Grewe & Stein 2011; IFC 2017; Habtezion 2016). Women-owned enterprises account for about one-third of SMEs in emerging markets, estimated to

consist of 8-10 million businesses (Grewe & Stein 2011; Kelley et 2017; GEM 2018). Moreover, as women start businesses at a higher rate than men it is predicted that by 2018, women will have nearly 50% of new small business jobs (World Bank, 2017b). Additional evidence suggests that women-owned firms fill important gaps in local, national and international economies, as women tend to start businesses with more emphasis on social goals compared to men (Hechavarria et al 2017) and tend to start businesses in different types of industries than men (Kelley et al. 2017; GEM 2018).

Despite the tendency to operate at small scale, yet in highly competitive industries, women-owned businesses can generate significant family income, which is thought to increase investments in education and healthcare at the family level (Lamoy 2010). Structural differences in size and industry sector have contributed to the female underperformance hypothesis in the management studies literature, which states that female entrepreneurs tend to be less successful than their male counterparts in conventional economic indicators (Rosa et al 1996; Fischer 1992). However, when compared to similar male business owners within the same sector, women business owners tend to perform as well or better than their male counterparts (Du Reitz & Henrekson 2000; Zolin et al. 2013; Robb & Watson 2011), which suggests that women's entrepreneurship is a promising source of wealth creation, women's advancement, and attention to the social needs of the local community and marketplace (Kobeissi 2010). However, given the significant variation in patterns of women's entrepreneurship across industries, very few studies have addressed the exact role that women-led micro and small, medium enterprises (MSMEs) play in specific industries within the energy sector, and the contribution of women's entrepreneurship to specific Sustainable Development Goals (SDGs).

ENERGY TECHNOLOGIES THAT CAN BE USED IN ENTERPRISES (Miller Center 2018)

Biomass power
- Biodiesel
- Biogas digesters
- Biomass briquettes, charcoal
- Biomass gasification
- Efficient burning stoves

Efficient use of grid and fossil fuels

Fuel cells

Human power
- Hand cranks, pedal, treadle pumps

Hydropower

Solar power
- Fixed panels
- Portable power products

Wind power

1.3. The role of MSME's in the energy sector

Energy access and use is a key driver for economic and social development around the world. Indeed, energy access is critical to catalyse economic growth, to expand employment, and to support human development across these regions where basic infrastructure is currently lacking. From a policy standpoint, there are different ways to support rapid expansion of energy services. In developing countries today, the energy industry is focused heavily on large-scale energy infrastructure projects to support commercial development and to expand electrification to households (World Bank 2017). In fact, trillions of dollars will be spent to improve global energy systems (IEA 2014), yet these efforts are unlikely to significantly close the energy deficit gap. An alternative approach that may help fill the gap and reach energy consumers in the most remote

corners of the globe is to encourage start-up and growth of micro, small and medium enterprises in the energy sector. Sustainable energy solutions, including mini grids and biomass alternatives like solar power, liquid petroleum gas (LPG), and ethanol, and efficient cookstoves offer some promise as affordable, reliable, sustainable and modern energy for everyone, especially those in the most remote locations and those with the fewest resources. This trend is moving forward rapidly. Micro, small, and medium enterprises that distribute energy products and services are growing exponentially, especially in the renewable energy sector (IRENA 2015).

The Miller Center for Social Entrepreneurship refers to this alternate approach as an enterprise system approach to energy access. Based on calculations presented in a recent report, **Miller Center researchers concluded that from 7,000 to 20,000 local energy enterprises each growing to 25,000 customers is needed to address the energy deficit** (Miller Center 2015). We consider this estimate to be low, especially given that the number of entrepreneurs with the capacity to reach large numbers of customers is small. It may require a considerably larger number of local energy entrepreneurs producing and selling high quality products within strong markets to address the global energy deficit gap for underserved populations. While these estimates require further examination and review, they provide a numerical range upon which an enterprise system of energy entrepreneurs can be built. Work is currently underway to draft an EnergyMap (Miller Center 2018) to allow greater understanding of energy access to underserved populations.

Of increasing interest is the potential role of women's entrepreneurship as a strategy to reach these underserved populations and to extend energy access specifically to female consumers. However, women are still significantly underrepresented in the energy industry, especially in leadership roles. Although women may be playing an increasingly important role in distribution and sales of energy products, they tend not to be working in technical roles like product design and engineering that could improve uptake and usability of products. New businesses are an important source of innovation, and therefore, introducing leaders from underrepresented groups such as women are critical, not only because of their unique perspective, but also because they constitute a significant portion of consumers of energy products at the household level. There is currently insufficient attention paid to best practices for micro, small, and medium enterprises that distribute energy products and services in the energy programmatic and academic literatures to the extent that funders and policymakers have noted a lack of evidence to support investment in women's entrepreneurship and a need for better research to clarify the business case (SE4All-PCA 2017b).

1.4. Evidence to support women's energy entrepreneurship as effective development policy

Despite low representation, women constitute an important and growing minority within the energy sector, especially among energy entrepreneurs in both the informal and formal sectors. However, women as entrepreneurs, employees, and consumers face some important challenges in the energy sector. **Not only is entrepreneurship a term associated more often with men** (Ahl 2006; Brush et al 2009; Elam 2008), **but also the energy industry itself is highly male-dominated** (with some variation across sectors) (Pearl-Martinez & Stephens 2016; Ernst & Young 2015). A survey

of renewable energy companies globally found that women represented an average of 35% of the workforce, which is higher than the traditional energy sector, but lower than in the broader economy. This is due in part because women are severely underrepresented in science, technology, engineering and mathematics (STEM) fields and across the clean energy sector, with even greater disparities at the management level (IRENA 2015). Energy researchers consistently note the strong bias by policy makers in favour of industry applications of existing energy products and services with less attention given to household use of energy (Oparaocha & Dutta 2011; Clancy et al. 2004; Cecelski 2000).

To investigate the existing evidence and to identify gaps in understandings around gender and entrepreneurship in the energy sector, we undertook a systematic literature review (SLR) of policy papers, grey literature and academic peer-reviewed papers. With the resulting sample of publications and reports, we examined the quality of evidence clarifying how women's energy entrepreneurship may contribute to key SDGs, including energy access for all individuals (SDG7), gender equality (SDG5), health and well-being (SDG3), poverty alleviation (SDG1), and sustainable economic growth (SDG8). Our primary research objectives for this review were to outline key business and behavioural drivers of success of women's involvement in energy-based enterprises, to examine the role of the private sector and market-based approaches, and to identify current program innovations to strengthen women's agency and economic empowerment in order to scale energy access through business start-up and growth. Importantly, we applied a "gender system" theoretical perspective (Elam 2008; Ridgeway et al 2004; Ridgeway et al 1999) and multilevel research model to guide the literature review on women's energy entrepreneurship.

In this report, we provide a summary of our SLR findings based on the following three questions:

1) How does women's energy entrepreneurship advance energy access for all?

2) How does women's energy entrepreneurship benefit women and their families?

3) What are the best practices to support women's entrepreneurship in the energy sector?

In the following chapters, we specifically address the state of the science on women's energy entrepreneurship, contribute to theory development around the potential impact of women's entrepreneurship on energy access and benefits to families and communities, and recommend solutions that may inform policy and programming supportive of women's energy entrepreneurship.

2. UNDERSTANDING WOMEN'S ENERGY ENTREPRENEURSHIP WITHIN THE GENDER SYSTEM

2.1. Gender Systems Perspective

Gender is part of the larger system of social categorization and dominance that contribute to the reproduction and persistence of traditional patriarchies. In all societies, systems of social organization exist to regulate social behaviour, to reduce conflict, and generally to protect the advantages enjoyed by the more powerful and valued members of the social collective (Chafetz 2004; Sidanius et al. 2004). In the domain of paid work, individuals are assigned to roles, which are regulated by legitimizing norms and ideology in which gender plays a significant part. Gender ideals, norms, and expectations are expressed both consciously and unconsciously in the form of explicit bias and implicit bias. This sort of psychological programming leads to important patterns of micro-behaviours that hold women entrepreneurs back via habits of the mind and socio-cultural norms. The result of these every day habits of the mind are larger social patterns and structural barriers that ill prepare women for business start-up and growth (Elam 2008). **Unlike other social status characteristics (e.g., race/ethnicity and social class), gender operates within the household as well as across all sectors of social life.** This aspect of gender inequality is critical for understanding the persistence of gender inequality in even the most advanced societies.

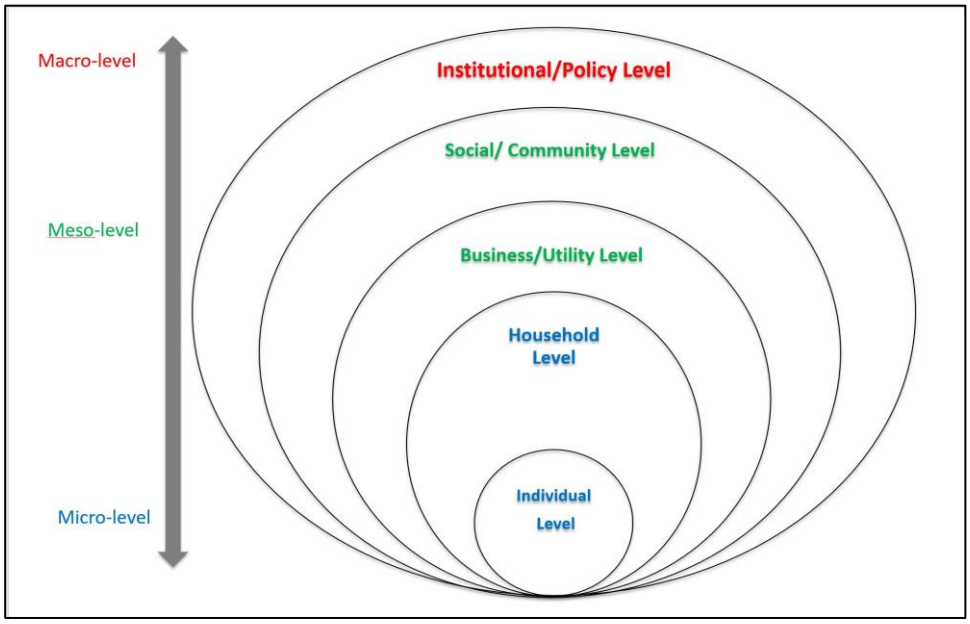
In this sense, ***the gender system is comprised of processes that both define males and females as different in socially significant ways and justify inequality on the basis of those differences***. Gendered social norms, ideals and expectations dictate the roles that men and women play, how power and resources are distributed between men and women inside and outside the household, and how gendered interactions reflect and reinforce these institutional and structural forces. Gendered interactions create experiences that confirm, or potentially undermine, hegemonic beliefs about gender differences and inequality that underlie the overall gender system and our own individual gender identities. Importantly, the cognitive processes around gender identity are reinforced by existing power and status structures, leading to the social reproduction of existing social norms, ideals and expectations and related systems of belief and individual agency (Sidanius et al. 2004; Foschi 2000). In fact, our social and personal identities are heavily influenced by gender norms and ideologies tied to specific roles or task sets (e.g., teacher, mother, entrepreneur, father, etc.) with resources and rights allocated accordingly (Ridgeway & Correll 2004; Foschi 2000; Ridgeway & Smith-Lovin 1999).

Advances in gender theory and social psychology have made clear the ways in which gender norms and ideology work through individual psychology, allocation of resources, and social regulation to keep women in their places. For example, women in non-traditional roles must work harder to prove their competence, to access resources that are not normally allocated to women in non-traditional roles, and to push back against the enforcement of traditional gender division of labour at home and in business. Using a social category, like gender, and the associated stereotypes to hold women back from male-linked task sets like business start-up and growth, is a form of what sociologist

Pierre Bourdieu (2001) called "***symbolic violence***." In the world of business, women's leadership abilities are doubted, both explicitly and implicitly, because of the traditional norms and ideology that define business as a man's world. As such, women often lack basic credibility or legitimacy as business leaders. When women are reminded of the mismatch between their gender and the work they pursue, that is symbolic violence. When women's business competence is in doubt, even after proving their worth over and over, that is symbolic violence. Symbolic violence is an important tool of social reproduction and preservation of the status quo.

Writ large, entrepreneurship is understood to be a highly gendered activity in terms of both social structure and influenced heavily by family status and social networks (Jennings & Brush 2013). There is a call for gender research that extends far beyond the simple discussion of gender as a variable and the role of gender segmentation in societies towards a focus on more rigorous theories and methodologies that examine gender within a systems approach (Henry et al. 2015; Brush et al. 2009). Entrepreneurial ecosystems have a known bias towards male entrepreneurs and business owners (Brush et al. 2018), but the processes and mechanisms are poorly understood. Importantly, findings from cross-national research on gender and entrepreneurship are highly consistent with the theoretical propositions proposed by this "gender system" perspective (Elam, 2008). Female entrepreneurs encounter barriers and enabling factors every day, driven by gendered social norms, across the multiple levels in analysis, from sense of agency at the individual level to enabling policies at the institutional level. Our aim in presenting this gender system framework is to identify key barriers to women's entrepreneurship at each of five levels of analysis with an eye towards cross-level interactions, as shown in Figure 2.1.

Figure 2.1 Gender Systems Research Model



At the individual and household levels, one's psychology, which is both historical and concurrently shaped by social norms, often puts women at a disadvantage compared to men, especially inside their households. Women's time is less valued in the household and female family roles tend to put most of the caring work and household labour on female shoulders. Male domination and gendered habits of the mind, in the context of

household power dynamics, operate in important ways at the individual level to enable or constrain women entrepreneurs, interacting with individual confidence, entrepreneurial mindset, personal agency, and alertness to business opportunities.

At the business level, women more often pursue opportunities in more competitive, low margin industries or markets and are more likely to start businesses with an emphasis on meeting social needs. This results in very different business goals, business models and outcomes than men (Hechavarria 2017; Kelley et al 2017). Specifically, women tend to start businesses with low barriers to entry and are more likely to start businesses that focus on community needs like childcare, schools, health clinics, etc. In most cases, these businesses tend to involve low prices and low profit margins. Women also encounter interpersonal dynamics at the business level that reinforce traditional gender hierarchies, male dominance, and undermine personal agency, self-confidence and professional legitimacy (Ridgeway & Smith-Lovin 1999).

At the societal and community levels, support for women's entrepreneurship can be hard to come by, not only because women are leading businesses which can challenge traditional gender norms regarding women, paid work, and leadership, but also because resources may be scarce and seen as better directed towards more legitimate and established firms, which tend to be businesses led by men. This inequality results in part because men's businesses are often located in higher margin industries and because of misguided assumptions about male leadership (Brush 2004; Manolova et al 2018).

At the policy/institutional level, considerable work has been done to ensure equality under the law in many, but not in all countries (Brush et al, 2009; Manolova et al, 2018). Unfortunately, ensuring equal access to occupations, industries and resources, may not change individual-level psychology or shifts in gender norms and ideology. Even after structural changes have taken place, it is not unusual for cultural change to lag; in other words, it can take a while for individual thought and action to adapt to new circumstances (Ogburn 1966).

Furthermore, women still face many institutional challenges related to starting and growing business such as limited access to land ownership, challenges securing loans, and mobility constraints among others. Policymaking in many countries addresses these institutional challenges but with limited success. In this sense, the persistence of barriers against women's entrepreneurship is a mindset problem for women entrepreneurs as well as for the powerful others who control allocation of resources and access to opportunities for women entrepreneurs. For example, land ownership is typically a household decision where traditional gender norms and ideals result in land titles held by a single, usually male, head of household. Similar patterns of household decision-making tend to result in higher levels of loan qualification (e.g., bank accounts, credit history) and transportation, communication, and mobility for men compared to women (Oxfam 2017). For this reason, the importance of mindset, perceptions of self and others play an increasingly important role in academic research and program interventions focused on women entrepreneurship.

2.2. Understanding the energy entrepreneurship 'system'

From a gender perspective, entrepreneurship is considered a male-dominated occupation in most countries (GEM 2018; Henry et al. 2015), thus many of the barriers

that generally affect women entrepreneurs are also likely to affect women energy entrepreneurs. The focus of much of the energy policy research to date has been on impacts and outcomes that may result from women's energy entrepreneurship. As a consequence, insufficient consideration is given to market factors, business models, customer value propositions, and other key business principles in the support of women's energy entrepreneurship. To date, there little empirical evidence to support the types of outcomes desired by policy makers, but there considerable speculation based on largely descriptive and proscriptive research. Given the early state of the research in women's energy entrepreneurship and with these key constructs in mind, we compiled a table of key factors at each level of analysis for general entrepreneurship as well as factors unique to women entrepreneurs and those unique to energy entrepreneurs (Table 2.1). Note that ***social norms play a role at every level of analysis for general entrepreneurship, women's entrepreneurship, and for energy entrepreneurship. How we think and feel about the world, our mindsets and habits of the mind, influence decision-making at every level of analysis***.

Table 2.1 Factors affecting women's energy entrepreneurship by level of analysis

Level of Analysis	Key Factors for Entrepreneurship	Unique to Women	Unique to Energy
Institutional/ Policy	entrepreneurial culture, economic conditions, capital markets, taxes and banking regulations, pricing controls/ incentives	gender culture, women's rights to property, political representation, employment incentives/ protections, childcare/ eldercare support	awareness/ priority of energy solutions, energy supply, energy access/proximity, disaster relief, energy subsidies/incentives
Social/ Community	occupational prestige for entrepreneurship, entrepreneurial role models & mentors, local markets & economies, political stability, local infrastructure (telecom, transport, banking & investment), business networks & associations, education & training programs, professional & commercial services	gender culture, security, women's unions, tolerance for domestic violence, acceptance of female leadership and business activity, women-focused mentoring/ training programs	energy awareness, STEM education & training, local energy stewardship
Business	industry/market sector (size, maturity, profitability), product/ service, innovation, business age & size, organizational goals & strategy, business models, access to growth capital, labor supply, domain expertise, business advisors, training/ mentoring, commercial & professional services	gender culture, acceptance of female leadership, social value creation, gender composition of occupation/ industry/ market, qualifications for financial access, access to social networks, women-only networks/ programming, management skills/ styles	energy awareness, energy occupational/ industry market, capital intensive industry, STEM expertise, product/ service innovation
Household	occupational prestige for entrepreneurship, household income, organizational goals & strategy, family size and support, urban/rural	gender culture, household division of labor, household income, financial control & bankability,	energy use/ awareness/ access, technology needs or wants, decision-making

	location, access to transportation, telecom, etc.	property ownership norms, domestic violence, childcare/ eldercare arrangements	
Individual	occupational prestige for entrepreneurship, education, skills, experience, gender, age, immigrant status, status within household, family role, time demands, alertness to opportunity, optimistic, fear of failure, confidence/agency (locus of control, self-efficacy)	gender culture, social dominance, access to education, care work burden, mobility, security, time poverty, perceptions, confidence, etc.	energy awareness, STEM education & experience, status awareness

Focusing first on those factors in women's energy entrepreneurship that are unique to women, we observe that, due to structural conditions and laws at the institutional level, women have fewer rights and less power overall compared to men. The gender system reinforces limited freedoms for women at the community level resulting in increased safety risks and fewer examples of women leaders to serve as community role models for younger women. Within the business, women entrepreneurs tend to experience poor access to business networks and key business advisors, limited access to finance, less prior experience and training in finance and business management, and lower credibility as business leaders which affects their ability to lead and interact with suppliers and customers. At the household level, women in these contexts tend to be the primary caregivers and therefore have significant responsibilities in managing the household and caring for children, elderly and the sick. In addition, women tend to lack decision-making power in the household and may be at risk for violence. At the individual level, women suffer disproportionately from psychological disempowerment; they tend to lack basic education, and suffer from time poverty, which exacerbates their conditions.

Factors unique to energy at the institutional or policy level are that most of the energy sector is led by large organizations focused on industrial markets and outside of the reach of most women's businesses. Even at the social/community level, there is limited understanding or awareness of energy related issues. For businesses, in many cases this is a nascent venture and therefore there is limited knowledge of technology, innovation and access to required products and services. This lack of 'energy awareness' is found at the household level, where most energy needs rely on traditional sources of lighting and fuel. Thus, at the individual level, understanding of energy issues or knowledge of science and technology is severely limited.

Business start-up and growth is an extremely difficult endeavour, especially within the context of resource scarce environments, new technology, and market creation. Entrepreneurship scholars focus on addressing the challenges that entrepreneurs face in terms of cultural barriers to new and small business activity which have shown that advanced economies, in particular, are wrestling with highly regulated market environments that are not conducive to, or supportive of, innovation. Culture matters for successful entrepreneurship because it influences outcomes at every level of analysis. Cultural ideologies live primarily in the minds of the collective; shared ideals,

values, and beliefs that influence who has priority access to resources, including legitimacy of business start-up and ownership.

Critically, research at the individual level shows that, controlling for individual context and business characteristics, ***psychological factors are the strongest predictors of business start-up*** (Arenius & Minniti 2005; Elam 2008; GEM 2017). Perceptions of self and environment are the keys to social change because change starts with individuals who believe in themselves enough to take on challenges, learn new things, and persist in the face of impossibility, lack of social support, and ultimately self-doubt. It takes an incredible amount of ingenuity and determination to successfully navigate and grow a business in any market, even more so in environments with unsupportive gendered social norms and expectations.

Just as women can face a discount in entrepreneurial legitimacy, so do people who are poor. As in any public, paid work role, poor mothers face the toughest challenges with both gender bias and household workload. As far as industry differences go, while the newer renewables sector may fit well with the social and economic values and motivations that women entrepreneurs tend to report, the sector is highly male-dominated, which suggests higher levels of gender bias and significant challenges in terms of market creation and technology adoption. No research exists to date to determine how these challenges vary for subsistence entrepreneurs, small business entrepreneurs, and high potential high growth energy entrepreneurs.

3. METHODS

To investigate the intersections of gender and energy entrepreneurship, we performed a systematic literature review (SLR) scanning a wide range of literature from across databases and employing several rounds of targeted elimination to identify the articles that were most relevant to our research questions. In addition, this review was supported by case studies and primary data collection from active intervention programs; the results of which are described in this report. Box 3.1 outlines the various types of data sources underlying the analyses in this research. The methodology to identify these sources is presented below.

3.1. Peer-review and grey literature from database search

BOX 3.1: Literature Review Data Sources

1) Peer-reviewed literature from database search
2) Grey literature from database search
3) Grey literature identified through snowballing technique
4) Fieldwork-based case studies

This systematic literature review was based on established best practices (Tsafnat et al. 2014; Tranfield et al. 2003). We placed a strong emphasis on basic principles of transparency, clarity, and the accessibility of the literature within a unified and focused scope, with attention to context-sensitive research (Thorpe et al. 2006; Tranfield et al. 2003). We searched a total of 15 databases shown in Box 3.2 and employed a list of 15 pre-defined keywords to identify articles published over the last 20 years between 1998 and 2018. Keywords were selected based on their relevance to gender/women, entrepreneurship, energy and/or clean energy research in the academic and grey literature, including energy; clean energy; entrepreneurship; policy; small and medium (enterprise OR business) OR SME; financing. A detailed description of the methods is available in Annex 2.

3.2. Grey literature collected from snowballing technique

Given the frequent absence of highly relevant grey literature from academic search databases, including Google Scholar, we also used a snowballing technique to supplement our database search. We searched out highly relevant references in footnotes and bibliographies of articles and other research documents. The process of snowballing is a continuous, recursive process of gathering, searching, scanning and aggregating references. From these documents, we searched other keywords, descriptors and themes to support or add to our existing database. In addition, we collated a list of organizations working with women entrepreneurs from several sources including ENERGIA, the Clean Cooking Alliance (previously Global Alliance for Clean Cookstoves, wPOWER, and Sustainable Energy For All – People Centred Accelerator. From this list, we conducted a brief review of programs focused specifically on women's

BOX 3.2: The selected databases included: Google Scholar; EconLit; Elsevier; JSTOR; Gender and Development; Science Direct; PubMed; Web of Science; Scopus; Research Papers in Economics (RePEc); PsycINFO; African Journals Online (AJOL); Eldis; Global Health; Psychology s Feminist Voices.

entrepreneurship and engagement in the energy sector and level of analysis of their programming, if available.

3.3. Search Results

The initial database search generated 12,474,493 results across the 15 selected databases, with heavy overlap between databases. After filtering based on our exclusionary criteria, we identified 595 articles eligible for coding and saved them in a Zotero bibliographic database. We identified 208 research articles suitable for full coding.

Research on women's energy entrepreneurship is clearly in its infancy. Today, the women's energy entrepreneurship literature primarily consists of qualitative, anecdotal, and observational studies. Very little academic research has generated empirical evidence on the role of women's entrepreneurship in facilitating access to energy for all, poverty alleviation, and economic growth through productive uses (Baruah 2017; de Groot et al. 2017). While most of the global academic research on women's entrepreneurship is focused on formal businesses in Western, industrialized economies (Yadav & Unni 2016; Kobeissi 2010), research on women's energy entrepreneurship is primarily focused on the informal sector in developing country contexts.

We noted some significant differences between the larger literature on women's entrepreneurship and the more specific literature on women's energy entrepreneurship. Notably, the women's energy entrepreneurship literature tends to focus on informal, micro-level entrepreneurship in developing economies, while the larger literature on women's entrepreneurship is dominated by studies of formal sector entrepreneurship at all levels of practice, from subsistence or necessity-based business activities to high profit, high potential entrepreneurship where job creation and other economic impacts are typically greatest.

As shown in Table 3.1, we identified five distinctions of importance. Whereas the larger women's entrepreneurship (WE) literature includes rigorous multilevel studies, a strong entrepreneurial/business ecosystem view, and a clear understanding that key business characteristics and market factors explain most of the difference in business outcomes, the women's energy entrepreneurship (WEE) literature tends to focus very little attention on market factors, technology adoption challenges, and business processes and very little attention to the local business ecosystem. Additionally, the larger WE literature pays a lot attention to the extra burden that motherhood imposes on women entrepreneurs, but the WEE literature not only addresses the motherhood burden in terms of time poverty, but also reports on the risks of domestic violence and the importance of household power dynamics for women entrepreneurs. This difference in approaches is likely explained in large part by the focus on different populations and contexts. In similar ways, both bodies of literature tend to focus interventions on supporting women as individuals with the risk of taking a "fix the women" approach to entrepreneurship support, rather than a "fix the system" approach. Importantly, the WEE literature may actually be a bit ahead of the larger WE literature given recent policy statements urging the involvement of key stakeholders and male family members. Assumptions of individualism versus the collectivism inherent in family business and poverty contexts may explain this difference. Finally, both the WE literature and the emerging WEE literature have seen highly rigorous studies (e.g. randomized controlled trials) published in recent years that support the importance and potential impact of

agency-based training as a catalyst for growth in addition to traditional business training courses.

Table 3.1 Comparison of women's energy entrepreneurship and women's entrepreneurship literature

WOMEN'S ENTREPRENEURSHIP	WOMEN'S ENERGY ENTREPRENEURSHIP
1. Strong on entrepreneurial ecosystem view; attention to multiple levels of analysis and cross-level interactions.	1. Weak on entrepreneurial ecosystem view; little/no quantitative evidence from multilevel models or cross-level linkages.
2. Evidence that market, business model and technology adoption factors similar for men and women, except women's business leadership is less accepted, especially in male-dominated industries; no research on women selling to women.	2. Little/no attention to market, business model and technology adoption factors as similar for men and women and some recognition that support from male family is critical for business leadership, especially in male-dominated industries.
3. Evidence that women, especially mothers, face discrimination in high discretion decision-making contexts; little concern with household power dynamics.	3. Reports that women's entrepreneurship may upset household power dynamics.
4. Interventions tend to focus on fixing women through education and training; trend towards women-focused venture funding.	4. Interventions tend to focus on finance, education and training; well-established trend of women-focused microfinance funding.
5. Personal-agency focused entrepreneurship education particularly impactful for women (Frese et al. 2017).	5. Personal-agency focused entrepreneurship education particularly impactful for women (Shankar et al. 2015a).

We identified some potential intersections and opportunities for powering research on women's energy entrepreneurship. For example, like the newly emerging field of research on sustainability and entrepreneurship, the strongest and most often cited evidence to date is based largely descriptive case studies. According to Muñoz and Cohen (2017), in this new area of sustainable entrepreneurship research, entrepreneurship is presented as a "solution to, rather than a cause of, environmental degradation and social inequality." Developing the intersection between sustainable entrepreneurship and women's energy entrepreneurship offers an opportunity to design studies and collect better data for more rigorous qualitative and quantitative analysis by economists and social scientists. We describe additional examples in the following chapters.

A key methodological note for this review relates to the need to distinguish evidence identified in peer-reviewed studies from that obtained in grey literature. As previously stated, an overwhelming proportion of the studies identified come from the grey literature. Grey literature is often defined as materials and research produced by organizations outside of the traditional commercial or academic publishing and distribution channels and includes reports (e.g. annual, research, technical, project, etc.), working papers, government documents, white papers and evaluations. Unlike peer-reviewed literature, there is no formal indexing system or mechanism to access them, and often don't follow standard bibliographic control. In addition, these tend to have to positive bias in reporting. Given the limited amount of peer-reviewed studies identified in this review, we have not restricted our inclusion criteria to such studies.

3.4. Limitations of this Literature Review

There are some important limitations of this literature review that should be noted. Most prominently, this review only identifies research and programs that have been published in English or articles translated into English. Therefore, there is significant under-representation of scientific work published in other languages such as French, Spanish, Chinese, Portuguese or Japanese. While the percentage of the scientific literature and programs in non-English journals is not known, this does bias the interpretation of evidence.

Moreover, in any development program activity, the outcomes and impacts can change over time. Initial program successes can wane over time due to a range of endogenous and exogenous factors. In the same vain, and related to business success, it can take several years (well beyond the initial monitoring and evaluation period) for entrepreneurial programs to demonstrate success. This is particularly true of programs designed to support high potential businesses.

Due to the paucity of scientific research conducted on entrepreneurship in developing country settings, many of our examples of large-scale systematic entrepreneurship research are gathered from developed country contexts. While this research may have parallels to developing country settings, these questions are best addressed with future studies conducted within local contexts. Furthermore, a majority of lessons related to program challenges are not readily available as failures tend not to be reported in program descriptions and more generally, due to the overall positive bias of grey literature.

4. RESEARCH QUESTION 1: HOW DOES WOMEN'S ENERGY ENTREPRENEURSHIP ADVANCE ENERGY ACCESS FOR ALL?

The role of women entrepreneurship has had a logical place in the renewable energy sector programs for decades, in part due to the place that women have played as managers of fuel-intensive informal enterprises and knowledgeable managers of household and business-related energy (Batliwala & Reddy 1996). The focus on women micro-entrepreneurs was highlighted in Cecelski's seminal review of women's role in sustainable energy development (Cecelski 2000) where she argued that women have proven themselves capable, when provided appropriate training and support, to effectively participate throughout energy value chains. This focus on intersections within the energy-poverty-gender nexus gained considerable attention in the early 2000s as part of a sustainable livelihoods framework and is supported by a number of case studies from around the world (Cecelski 2004). However, little empirical research has been done on this subject.

Overall, we found the published literature on women's energy entrepreneurship to be at a very early stage of development with a focus on informal, subsistence-level business activity in emerging economies, low levels of methodological rigor, absence of theory development, murky use of key constructs, absence of control groups for counterfactual analysis, and few significant quantitative findings outside of program impact reports. In other words, the literature is primarily comprised of prescriptive and descriptive studies and program reports, confirming the need for more rigorous research to address the lack of evidence regarding the potential impact of women's entrepreneurship on energy access for all (SE4ALL-PCA 2017a; Oparaocha & Dutta 2011; Avato & Madeira 2010; Bardouille 2012). Indeed, we were only able to identify seven peer-reviewed, published literature review articles that explicitly addressed women's energy entrepreneurship (Baruah 2017; de Groot et al. 2017; Abdullahi 2017; Glenmarec et al. 2016; Pearl-Martinez & Stephens 2016; Batliwala & Reddy 2003; Makhabene 2002), the earliest of which was an unpublished white paper. Unsurprisingly, these articles all address the lack of scientific evidence and call for more research to fill the knowledge gaps for policy-makers and program implementers.

In this chapter, we summarize the descriptive evidence linking women's entrepreneurship to access to energy for all, identify some gaps in the literature and opportunities for powering research on women's energy entrepreneurship and identify key factors at each level of analysis that deserve attention from researchers, policy makers, and program implementers. Throughout the research and programmatic literature on women's energy entrepreneurship research, there is a clear and immediate need for more explicitly defined business constructs, such as entrepreneurship, business models, supply chain, and ecosystems. A brief clarification of these terms is presented below.

Energy Access for ALL

There is a shared understanding that households using candles or kerosene lamps as a sole lighting source while cooking with firewood or charcoal are considered to be energy poor. However, there are no clear definitions of what is meant by access to energy services or technologies that address all components of energy poverty. For our purposes, using guidance from the Sustainable Development Goals, we define energy access for all as ***ensuring universal access to affordable, reliable and modern energy services for everyone, with a special focus on reaching individuals in the poorest, remotest parts of the world***. A key aspect of energy-based services is that they can change the life of the poor in a significant and sustainable way. ***Thus, all energy-based services and technologies contribute to ending energy poverty if they have a direct positive impact on basic living conditions.*** Historically, energy access has been seen as a key driver of economic development in development contexts where the focus tended to be on building out electrical grid infrastructure and providing services to commercial businesses in large urban centres. Energy access for all requires a broader set of energy products and service offerings, including off-grid technologies, like solar lighting, solar home systems and mini-grids as well as clean cooking technologies and fuels.

Entrepreneurship

We define entrepreneurship as ***a process by which individuals or a group of individuals mobilize key resources to create a business in pursuit of a commercial opportunity***; this could include bringing a new product or process to the market; substantially improving an existing good, service, or method of production, or by simply addressing an unmet need in a target market. The concept of entrepreneurship is used in many different ways by scholars and policy makers and is often confounded with concepts such as self-employment (sole proprietorships versus employer firms) and innovation. These distinctions are particularly important when it comes to research, because women entrepreneurs, as a population, tend to be quite different from male entrepreneurs in some fundamental ways.

Globally, men are about twice as likely to own/manage a business compared to women (GEM, 2018). Women are all or part owners of about one third of formal businesses globally (Kelley et al., 2017). However, their firms tend to be small and tend to be concentrated in sectors with lower profits and growth opportunities, such as retail, beauty, and food services, and less so in industries such as mining, construction, electronics, and software, leading to significant structural differences for women-owned business (Bardasi et al. 2011; Hallward-Driemeier 2013; Mel et al. 2014).

Importantly, entrepreneurship is often confounded or used synonymously with the concept of ***self-employment***. While most businesses overall in every economy are sole proprietorships and not employer firms, men are much more likely to start employer firms than women. For example, according to the US Small Business Administration (2017), while 70% of all US businesses are sole proprietorships, which effectively means self-employment, it is nearly 90% for women-owned firms compared to 60% for men-owned firms and 31% for equally-owned firms. Importantly, the employer firms that men lead tend to be concentrated in capital intensive, high profit, low competition industries, while women-owned firms tend to concentrate in highly competitive industries with low

barriers to entry and low profit margins. This distinction between sole proprietorships and employer firms is also important for developing contexts where similar gender patterns of business ownership are observed (Daymard 2015).

Business size is an important classification for research and policy work on micro, small, and medium enterprises (MSMEs). Key measures of business size include 1) number of employees; 2) total assets and 3) annual revenue (Gibson 2008; Kushnir 2010). Each of these measures can be difficult to assess at the level of the business and countries may use a variety of cut-offs for business size categories. For ease of assessment, the number of employees is used as the most common measurement device for defining business size (Kushnir 2010; Gonzales et al. 2014). ***Microenterprises are often defined as 0-9 employees, small businesses as 10-49 employees, and medium-sized businesses as 50-249 employees or large businesses with 250 employees or more*** (Gonzales et al. 2014). These definitions may vary somewhat by context.

Entrepreneurship is also often confounded heavily with the concept of ***innovation***. Most businesses are not very innovative in terms of technology, business model, or market served. This fact is often truer for women-owned businesses and for subsistence-level businesses typical of the informal sector. That said, the rates of women's new venture creation are growing in countries around the world, and most promising in high-growth, high-innovation categories where we often see the largest economic impacts and job creation, especially given that women business owners appear to be more likely to hire other women (Weber & Zulehner 2010). The role of innovation as a catalyst for energy-related businesses for women is an important one, especially at the high-growth levels. Around the globe, ***female-run businesses tend more to be focused on social benefits rather than profit***. Business data suggest that women business leaders have a strong positive impact on growth and innovation (Hoobler et al. 2018); perhaps encouraging businesses to pursue markets and offerings that better address the needs of women, households, and children.

Business Models

Funders, policymakers and program developers are increasingly incorporating key business principles into women's entrepreneurship education and program design. However, there appears to be some confusion regarding the concept of a business model. ***Both entrepreneurial support programs and the businesses owned and managed by entrepreneurs have business models.*** Business models have traditionally been a vague concept in management studies, but scholars have recently introduced some important definitions and specifications. A business model refers to key business design elements that collectively, and in relation to one another, characterize the business logic of a specific firm. ***More specifically, a business model describes the value that a company offers to its customers via the architecture of interconnected business processes from the cost structure to the revenue model, including the key activities, resources, and partners in the production, sale, and delivery of the product or service offering to the customer, in order to generate sustainable, profitable revenue streams*** (Adapted from Osterwalder et al. 2005). This definition has spurred a great deal of interest in management studies but has not resulted in any research on gender differences in business model characteristics beyond what is currently known about the different types of businesses that men and women tend to launch. This sort of modelling puts the

product/service offering and the customer value proposition at the centre of the business model and is often missing from the empirical research on energy entrepreneurship.

What are most commonly described in the literature are delivery models of energy products that include a combination of finance and business components that are attempting to address a 'social good' in an economically viable way (Kolk & Van den Buuse 2012). With respect to women energy entrepreneurs, we identify several different mechanisms of engagement in businesses, some of which include sole proprietorship. While women can also be involved as employees in each of these models, we have seen a plethora of examples in the field where women are engaged as entrepreneurs. These include:

1) **Direct sales model** which generally refers to a network of local micro-entrepreneurs that sell off grid products in communities that are often remote or hard to reach. The direct sales model works well because local community members are able to sell to their local networks (Avato & Madeira 2010) reducing the need to establish distribution channels de novo.

    a. **Micro-consignment model** utilizes a consignment financing mechanism that allows entrepreneurs to access needed start-up capital in the form of products. The products are subsequently paid for from the profits of their sales (van Kirk, 2010).

2) **Service model** where local community members are recruited and trained to install and maintain solar home systems, create cookstove liners, or other energy related products.

3) **Micro-franchise model,** which is a permutation of the traditional franchising business model, but with more of a development focus. It is defined as a contractual relationship between an individual and a franchisor (usually a larger business) where the franchisee agrees to expand the market of the franchisor. This give the franchisee an opportunity to be part of a larger business program without significant risk associated with creating one's own business (McDade et al. 2014). Micro-franchising models have gained traction in developing country settings for numerous products including off-grid energy products (Krithika and Palit, 2012).

Value Chain

A value chain is the business activities that increase the value of the product or service in the eyes of the buyer and enable the company to have a competitive advantage over competitors in its industry. Porter's (1985) widely-accepted definition of a value chain includes: (1) inbound logistics: warehousing and inventory control; (2) operations: value-creating activities that transform inputs into products/services; (3) outbound logistics: activities required to get a finished product/service to a customer; (4) marketing and sales: activities associated with getting a buyer to purchase a product/service; and (5) service: activities that maintain and enhance a product/service's value, such as customer support. This may also be referred to as a supply chain, however, a value chain is more encompassing in that it also includes design, marketing, and after-sales

service/support in addition to the traditional components of a supply chain used to create and distribute products/services.

Entrepreneurial Ecosystem

Another concept that is key to understanding the opportunities for and barriers to women's entrepreneurship is that of the "***entrepreneurial ecosystem***." This construct is central to much of the research on entrepreneurship today. As researchers observed, a gender lens has not been rigorously applied to entrepreneurial ecosystem theory and research in the mainstream business literature (Brush et al. 2009). ***Entrepreneurial ecosystem refers to a collection of interconnected elements in the local and macro-environment that work together to facilitate commercial innovation and the growth of new and small ventures, including but not limited to a supportive culture, availability and access to financing, supply and development of human capital, new/existing markets for products and services, and a range of institutional and infrastructural supports*** (Manolova et al. 2018).

The Global Entrepreneurship Monitor (GEM) research program tracks eleven framework conditions based on expert assessments that characterize entrepreneurial ecosystems at the national level, including cultural and social norms, physical infrastructure, entrepreneurial finance, government support and relevance, government taxes and regulations, government entrepreneurship programs, school-age entrepreneurship education, post-school entrepreneurship education, commercial and legal infrastructure, internal market dynamics, internal market burdens and entry regulations. Of course, these framework conditions vary locally where the impact on business is most felt and, to date, there is very little research to address differences in need/impact by gender, industry, or differences across types of businesses (subsistence, small business, and high-growth firms) or business models.

4.1. Little Empirical Evidence of the Impacts of Women's Entrepreneurship on Access to Energy for All

While there is descriptive research and programmatic summaries of approaches that have engaged female entrepreneurs in the production and distribution of energy products and services, there is little empirical research that presents a counterfactual analysis to show that engagement of female entrepreneurs leads to greater or reduced energy compared with non-engagement of women. The work by Shailaja (2000) is one of the earlier papers that outlined women's entrepreneurship in energy and sustainable development. A largely descriptive paper, it focuses on the role of rural Indian women in biomass management, where women as cookstove entrepreneurs could be one of many players disseminating more efficient biomass stoves. This focus was also emphasized by Haque (2002), in their description of an early government program started by the Government of Bangladesh, where women were trained to construct and disseminate cleaner cookstoves. The paper summarized several positive outcomes as assessed through qualitative methods, however no primary data were presented.

During the early 2000s, there was greater recognition of women's role in energy. This was highlighted in Makhabene (2002) paper, which describes two global networks,

ENERGIA and the Southern African Gender and Sustainable Energy Network (SAGEN) that have attempted to promote the role of women in sustainable energy development. The author stresses the need for implementers and enterprises to participate at all levels of political advocacy and formulation and to be clear about the specific objectives of their efforts. Ten years later, Oparaocha and Dutta (2011) present data showing that addressing gender issues within the energy sector can support overall development goals, yet, at that time, a majority of these programs were still at a pilot scale. The article highlights the efforts of ENERGIA and policy recommendations to promote sustainable livelihoods through modern energy technologies and services.

One of the early empirical studies from rural India present data on time and energy use between men and women and points to the need for energy interventions to improve the quality of women's lives. A key conclusion of this study is that energy programming should shift from thinking about women as primary beneficiaries of energy access to women as managers and entrepreneurs of energy services and products (Batliwala & Reddy, 2003). In this paper, the authors point to the successes of SEWA (Self-employed Women's Association) in India and the Grameen Bank in Bangladesh and call to the international community and policy makers to create enabling environments to support this approach. However, there are no specific data presented to elaborate this point. Unfortunately, the practice of making generalized statements without specific data is common, even within peer-reviewed literature. For example, a recent meta-analysis from Abdullahi (2017) does not present specific data or a description of the methodological process.

Looking forward, researchers stress the need to actively include women more effectively within energy value chains, lest they are left behind. Baruah (2015) argues that there is tremendous potential to create quality employment opportunities for women in the green economy, mainly in technology and infrastructure. These jobs can become available, Baruah suggests, as long as other supports for gender equality are enabled. **History has shown that without an emphasis on addressing gender inequalities, these shifts in economic empowerment are unlikely**. A similar argument is put forth by Pearl-Martinez and Stephens (2016) in their commentary on a gender diverse workforce in the renewable energy sector. Given the results of a recent critical discourse analysis, which demonstrates that energy entrepreneurial activities continue to reinforce gender power imbalances, efforts to gain gender equality in the energy sector proves to be a challenge (Marshall et al. 2017).

The need for more empirical evaluations is critical to understand the nature of energy access programs over time. An excellent example highlighting this is illustrated by Nygaard (2010) on the multifunctional platform (MFP) programs. The MFP programs have expanded in five West African countries since 1994 and have garnered significant policy and donor support. In this paper, the author presents a critical examination of this program, suggesting that several components of the program, including it multi-functionality may not be as successful as hoped. Moreover, the review suggests that single-purpose implementation and private ownership by both men and women may be a better option than multipurpose programs operated by women's groups in many cases. The authors suggest that efforts may have been better placed to support a stronger enabling environment rather than creating a new competing service (Nygaard 2010). A similar conclusion was reached of the MFP program in Mali by Sovacool (2013), highlighting both the program successes and challenges. This lack of taking a gendered

approach to energy entrepreneurship persists, as evidenced by a recent study on renewable energy businesses, that described the utility of various business models in developing country contexts, yet failed to indicate if the respondents were women or men (Gabriel & Kirkwood 2016).

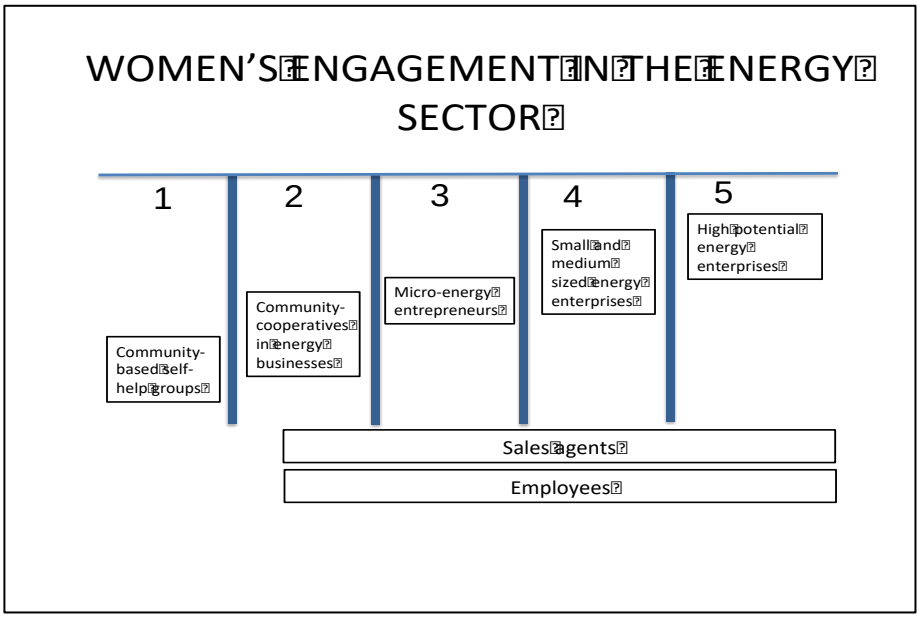
In a recent literature review of the intersections between access to energy, empowerment and women's enterprises, De Groot et al (2017) argue that informal sector enterprises have some potential to affect women's choice and agency, however, they stress that there is little empirical evidence to prove that energy access promotes women's empowerment. In the only randomized controlled trial of energy entrepreneurs identified in this review, Shankar et al (2015a) found that business training was insufficient to support new clean energy entrepreneurs in Kenya and that a focused personal agency-based empowerment training could significantly improve both sales and business retention. This study also provides initial evidence that in the case of clean cookstoves, women were able to sell at considerably higher rates than men.

4.2. Types of Entrepreneurial Engagement in the Energy Sector

Despite a call for increased 'women's energy entrepreneurship' activities, many of the available case studies describe various roles for women along the energy value chain and few that include entrepreneurship in a classical sense (i.e., starting a business). Early case studies, mainly from Africa, describe engagement of women in manufacturing roles, or in the sales of fuels, equipment or services as part of an existing program activity and not creation/expansion of formal businesses (Misana and Karlsson 2001). Globally, women are all or part owners of about one third of formal businesses (Kelley et al., 2017). However, their firms tend to be small: it is estimated that women own about one third of micro firms (less than 5 employees), around one third of small firms (5-49 employees), and only about one fifth of medium-sized firms in developing countries (50-250 employees) (IFC 2011) and women-owned businesses tend to be concentrated in sectors with lower profits and growth opportunities (Bardasi et al. 2011; Hallward-Driemeier 2013; Mel et al. 2014). While these data show that women-owned enterprises are smaller and often more informal than male-owned businesses, due to their proximity to the communities in which they work, they may be at an advantage for distributing energy.

As we consider women's engagement within the energy sector, it is important to first examine the roles women have played and investigate how these roles can be enriched or expanded to advance energy access. As women have historically been engaged in the collection and cultivation of traditional energy sources, it is a natural shift to also include them in the creation and distribution of clean energy products and services. Data from field programs suggests that much of the discussion related to women's entrepreneurship in energy is in fact referring to a range of women's engagement in the sector, from informal women's groups, micro and small businesses, high potential entrepreneurial endeavours as well as independent sales agents and employees (See Table 4.1). An examination of the nature of these engagements is detailed below.

Table 4.1 Various forms of women's engagement in the energy sector



It is important to recognize that the majority of energy distribution programs and services are not designed to create women's businesses or to strengthen the gender equality. The primary goals are, generally, to distribute energy product or services to the greatest number of people while maintaining sufficient profits to stay in business. Nonetheless, each of the mechanisms described below do support both the gender equality and entrepreneurial ecosystem for women to varying degrees.

Existing community-based self-help groups

Collective approaches such as self-help groups or cooperatives have been mentioned as effective ways to organize women and empower them to own and manage businesses. There has been an extraordinary increase in the number of women's collectives and self-help groups at the grassroots level. Self-help groups (SHG) go by different names, but generally consist of a gathering of individuals at the village level on a regular basis (e.g. weekly or monthly) as a means of aggregating resources and funds towards either individual or collective economic activities. Village savings and loan associations (VSLAs) are another form of SHGs, with a specific focus on economic advancement, and are noted to have considerable market potential for clean energy products in Kenya, Rwanda, and Tanzania (Wright 2013) and have been found to be drivers of entrepreneurship (Satyasai et al. 2014). VSLAs can be important vehicles for the distribution of clean energy, especially solar lights and portable clean cookstoves. Self-Employed Women's Association (SEWA), which is a network of over 1.8 million self-employed, informal female workers in India, started its Hariyali initiative to provide clean and sustainable solutions for urban energy issues for members. This initiative both creates an income stream for members (involved in the sales and distribution of energy products) and also increases access to energy among members.

***Why this works**:* As social units, VSLAs have money in circulation and can obtain loans to purchase clean energy products. Therefore, the ready availability of finance can lead to the ability to have inventory and execute sales. Leaders within VSLAs can be important sources of change; they are influential in the community and can promote uptake of clean energy products. Data from a program implemented by CARE in several countries in East Africa showed VSLAs were instrumental in garnering interest in clean energy technology (Wright 2013). Through this program, VSLA members worked with Village Agents (VA), who had been specifically trained on selling clean energy cooking and lighting products and were often members of the VSLAs themselves. VAs helped VSLA members sell their clean energy products in markets through selling door to door, taking up stalls in local markets and adding product inventory to their existing small shops. Suppliers have noted that women selling to women was a powerful sales strategy as women do the majority of the fuel collection and cooking and are in the best position to help the buyer understand the benefits of clean energy technology, such as improved cookstoves (Wright 2013). SEWA, the largest network of trade specific self-help groups globally, continues to be a leader in using SHGs to both increase access to energy related products for its over one million members, especially those in hard-to-reach locations (SEWA 2015).

***Challenges of the SHG approach**:* Engagement of self-help groups as a means of advancing energy access requires significant resources and commitment to the communities within which these SHGs reside. There are currently no examples of energy-related self-help group initiatives that demonstrate a significantly profitable business strategy, although significant efforts are being put forth. These SHGs function at that base of the economic pyramid and the energy related technology or services are simply one of many needs that require support in these populations. The revenue models deployed by SHGs involved in the distribution of energy reflect the desire to increase access to clean energy products and to earn subsistence level revenue, rather than an objective of increasing profits and growth. In this sense, engagement of women through SHGs does not align with traditional constructs of and or contribute to benefits from entrepreneurship (see list of prominent programs using SHGs for energy distribution Table 4.2).

Table 4.2 Organizations that use a self-help group approach to distribute energy products or services

Project or Organization NAME	Location	Products or services	Customers reached	People reached
Grameen Shakti[1]	Bangladesh	Solar home systems	973,430	4,830,000

[1]World Bank program summary: http://projects.worldbank.org/P106135/grameen-shakti-solar-homes-project?lang=en&tab=results

[2] Sovacool et al. (2012) The energy-enterprise-gender nexus: Lessons from the Multifunctional Platform (MFP) in Mali

[3] USAID program summary: http://arcfinance.org/wp-content/uploads/2017/02/REMMP_Impact_9-30-17.v2.pdf

[4] wPOWER 2018

[5] SEWA slides: https://d2oc0ihd6a5bt.cloudfront.net/wp-content/uploads/sites/837/2017/06/5_Rehana-Riyawala_SEWA-Hariyali-Clean-and-Sustainable-Solutions-for-Urban-Energy.pdf

[6] Wright 2013 . Village savings and loan associations: market potential for clean energy products in Kenya, Rwanda, and Tanzania

Mali Multifunctional Platform[2]	Mali	Multifunctional platforms		500,000
Renewable Energy Microfinance and Microenterprise program (REMMP)[3]	South Asia	Cookstoves, Solar home systems, mini-grids	367,000	1.83 million
Sustainable Community Development Services (SCODE)[4]	Kenya	Cookstoves and fuels, solar lanterns		1.53 million
Self-Employed Women's Association (SEWA)[5]	India	Cookstoves and solar lanterns	24,000	
Swayam Shikshan Prayog (SSP)[4]	India	Cookstoves and solar lanterns	145,000	5 million
TATEDO[6]	Tanzania	Cookstoves and solar dryers	2,270,520	
Upesi Rural Stoves Project[7]	Kenya	Cookstoves	24,000	130,000

Community-cooperatives specifically created for energy sector

For the purposes of our review, the term community-cooperatives refers to local energy businesses that are established at the community level and engage several members of the community together in a cooperative. A scan of field implementation programs shows that there are a number of community-based cooperatives that deal with energy-related projects, some more informal than others (see Table 4.3). Examples of this include individuals working to produce clay liners for more efficient cookstoves, selling and installing stoves and solar home products, managing village-level power systems, constructing and marketing biogas digesters, or producing biodiesel fuels from locally grown crops. For example, Technology Informatics Design Endeavour (TIDE) has successfully trained women who formerly worked for daily wages as manual labourers to build smokeless chulas [stoves] from locally available materials. Program reports indicate that this program has enabled women, who often lack basic literacy skills, to earn two or three times their previous incomes and also relieved them of more physically strenuous and unsafe work.

***Why this works**:* Women can work directly within other women in the community and directly with other female customers. One example comes from SELCO Solar, which provides commissions for connecting potential customers with bank-financed solar energy schemes. Since it was considered inappropriate for male technicians to enter the homes of customers while male family members were away, training female technicians became the most practical solution. Female technicians were also able to identify key design elements for product improvements (Baruah 2016). In Nepal, the Nepal Village Micro-Hydro Project has helped empower local women and vulnerable groups by engaging them to build, own, operate, and maintain micro-hydropower microenterprises. Training was provided to over 34,000 people overall, including 15,000 women, of whom more than two were trained in micro-hydro operation, maintenance, and management. In most of the community micro-hydro function groups established, women represented

[7] Gold Standard program summary: https://www.goldstandard.org/projects/stoves-life-energy-efficient-cook-stove-project-kakamega-kenya

at least half of the membership (Orlando et al. 2018). A similar, long-standing initiative is the Windfang cooperative which was created by women in Germany in 1991 with the specific goal of building, running, and operating wind turbines (Delfs 2000). The group continues to operate today, running eleven wind turbines and three solar plants. The cooperative not only contributes to a reduction in carbon emissions, but also enables women to earn income and serve in leadership roles in technical and strategic fields that have been traditionally dominated by men. Data from other sectors have found that when given leadership positions in the management of community resources such as sanitation, health, housing or education, women can deliver better results, with less corruption, at lower costs than men (Batliwala & Reddy 2003, SPARC 1988; GROOTS et al. 2001; Batliwala 2002).

***Challenges to the community cooperative approach**:* Of the various methods of engaging women within the energy sector, community cooperatives appear to be most challenging, especially for women. Due to the significant gender segmentation of most programs, women generally have little autonomy or decision-making power to expand their economic base. Moreover, depending on the energy technology and fluctuations in the local economy, skills may not be transferable to other sectors and the fundamentals of entrepreneurship are generally not strengthened. An illustrative example is the Grameen Shakti program in Bangladesh (USAID 2014). This five-year project was designed to expand Grameen's Renewable Energy Technology (RET) program in rural communities through training and support of 3,000 women entrepreneurs and engineers with the expectation that these women would be integrated in the RET sector. Unfortunately, this did not occur due to lack of support within the larger gender system within which Grameen Shakti operated. This included a lack of intentional integration of these women into the program from the outset and monitoring of this integration during the course of the program. In addition, the Grameen Shakti management (comprised largely of men) did not have clear gender-equity policies in place. It was also recognized that the training should be broad enough to apply to multiple outcomes and that gender segmentation in the program should have been addressed early on in order to enable women to repair other solar home components, including radios, phones, etc. It was clear from this program that training alone was insufficient to support women in this energy sector and required more targeted support directly addressing the gender dynamics at play.

Community-based cooperatives can play a significant role in expanding access to energy products and services and alleviating poverty. However, careful planning, integration and buy-in of key stakeholders to promote the enrolment of women and more effective education and training methodologies applied to a larger range of energy support services is critical. The types of innovation identified with these community cooperatives tend to mirror those used with community SHGs. Similar to women's engagement through SHGs, unless specific consideration is made around how women's engagement through community-cooperatives builds women's leadership and participation in decision-making women likely will not experience the traditional benefits of entrepreneurship such as increased agency. In addition, similar to SHGs, community-cooperatives often focus on sustainability and shared prosperity rather than increased sales/revenue and thus do not present opportunities for growth and individual economic mobility. The challenge for many of these programs is that the resources and opportunities available for women is limited unless there is clear governance and transparency in the functioning of these groups.

Table 4.3 Organizations that use a community cooperative approach to distribute energy products or services

Project or Organization NAME	Location	Products sold	Customers reached	People reached
Char Montaz[1]	Bangladesh	Lamps		1,200
International Lifeline Fund[7]	Uganda, Haiti	Cookstoves, energy kiosks for a variety of products	305,000	1.6 million
Grameen Shakti[3]	Bangladesh	Solar home systems	973,430	4,830,000
Nepal Village Micro-Hydro Project[4]	Nepal	Micro-hydropower	129,590	
Project Gaia Ethiopia[2]	Global	Clean cookstoves and fuels	9,000	40,000
SELCO Foundation[5]	India	Solar lanterns, solar home systems, mini-grids and energy centers		500,000
Technology Informatics Design Endeavour (TIDE)[6]	India	Clean cookstoves	10,000	
Windfang[7]	Germany	Wind turbines	3,140	

Case study 1: Cookstove Liner Collective, Uganda

This case describes a family that participates in a community collective in a peri-urban region of Uganda. The base product, a cookstove liner is sold to consumers, as part of the collective and a portion of the profits are shared amongst the group. In this case, these individuals are neither entrepreneurs nor employees, and they don't have the burden of

[1] World Bank summary: http://documents.worldbank.org/curated/en/716401468743376417/pdf/301730Promisin1er0august2002number1.pdf
[2] wPOWER 2018
[3] World Bank program summary: http://projects.worldbank.org/P106135/grameen-shakti-solar-homes-project?lang=en&tab=results
[4] World Bank program summary: http://documents.worldbank.org/curated/en/334991468279912984/pdf/ISR-Disclosable-P095978-06-18-2015-1434658386074.pdf
[5] SELCO Annual Report: https://selcofoundation.org/wp-content/uploads/2018/11/Annual-Report-17-18-merged.pdf
[6] TIDE Annual Report, Available at: http://tide-india.org/wp-content/uploads/2017/10/tide_annual_report_2016-17/index.html
[7] Project summary: http://womengenderclimate.org/gjc_solutions/windfang-a-womens-cooperative-that-projects-builds-and-runs-wind-turbines/

having to obtain capital to purchase supplies or identify clients. The challenges with this type of business engagement are that there is little or no opportunity to differentiate from the competition and limited opportunity to expand their business and profit. However, their engagement does allow families to participate in an informal economic activity and contribute to subsistence level earnings.

Energy micro-entrepreneurs

There is a significant need for micro-entrepreneurs, in both rural and urban areas, that can distribute and repair energy equipment on a regular basis, notwithstanding some support in the short term. Women micro-entrepreneurs can emerge from self-help groups or community cooperatives, or they can develop independently. Depending on the contexts, enterprises can be driven by necessity (to ensure survival) or are driven by opportunity. In general, opportunity-based enterprises are more profitable and better managed. Yet most development programs and policies are aimed at subsistence entrepreneurship, with the expectation that these will evolve into opportunity-based enterprises. While this upwards movement is not common, it can be improved through strengthening aspects of both gender equality and the entrepreneurial ecosystems. From the literature, there are ample examples of women's engagement in sales and after-sales service; however, the evidence is generally qualitative in nature, with few, if any, empirical studies published peer-reviewed journals. Thus, while the descriptive evidence in case studies can be compelling, there is little basis for drawing generalized conclusions on their impacts on energy distribution. Some examples of organizations that use a micro-enterprise approach are listed in Table 4.4.

A well-known program that seeks to transform the existing gender system is Barefoot College's Solar Engineers (Roy 2011). This program has trained hundreds of women (mostly grandmothers) through an extensive six-month program to fabricate, install and maintain solar powered home lighting systems in remote, poor rural villages in Asia, Africa and South America. This program has used a 'learn by doing' approach that is able overcome differences in language and culture. Working to transform aspects of the existing gender system, the Barefoot approach leverages local community contributions and participation with government, international organizations and private sector investment and financing. A key aspect of this program's success is that it is tailored to women's needs – it demystifies the technology and uses decentralized support systems. The learn by doing approach of Barefoot College works to shift mindsets, not only of the grandmothers engaged in this technology, but also of the communities' beliefs related to what type of work women can effectively do.

Another successful business model is Solar Sister in Tanzania and Nigeria that uses a woman-to-woman direct sales approach to marketing affordable solar technology. Solar Sister is unique in that it uses a sisterhood approach that focuses on strengthening interpersonal relationships, enhances confidence and fosters personal agency. Local community women are recruited, trained and mentored over time in the business. Research on impacts of Solar Sister has found significant enhancements at the individual level, household, business and community levels and its ability to reach rural last mile customers (Soria et al. 2016; CITE 2018).

Why this works: Women micro-entrepreneurs tend to be living at the base of the economic pyramid and are therefore leveraged by many international or national social

businesses as means to both distribute energy products as well as promote economic development. Since women are often the primary collectors, cultivators, managers and users of energy, they are generally aware of community members' energy needs, as well as the benefits they will experience from having enhanced energy access (Baruah 2016; Ilahi 2000). In addition to understanding customers' needs, female entrepreneurs appear to be able to better physically reach female customers and form trusting relationships (Batliwala & Reddy 1996; Sarin 1984). For example, commercial investments in electrification may not find it economical to go to rural locations that are hard to reach and where there is low demand for energy. However, female entrepreneurs are able to leverage naturally existing social connections and networks to reach customers in last mile locations (Batliwala & Reddy 2003; SE4All 2017a).

Challenges to micro-entrepreneurship: Women involved in sales and distribution of clean energy products are often required to secure credit to purchase inventory. For example, the initial cost of acquiring even 10-20 solar lanterns to sell or rent would be an impossibly high burden for the poorest households to bear. Women from such households cannot become entrepreneurs (with the potential to run a small enterprise) because the burden of entrepreneurship and the risk associated with the loan would simply be too high for them. Further, business loan terms in some countries are highly unfavourable to all entrepreneurs, perhaps more so for women who might lack necessarily collateral requirements and who face higher rates of social censure for failing at business (Oxfam 2016). On the other hand, evidence in certain settings suggests that while women experience large barriers to accessing productive credit, when they do gain access to credit, their application and use of this credit for income generation is extremely effective (Batliwala & Reddy 2003).

Engagement of women as micro-entrepreneurial sales agents of products/services assumes that these women are interested in creating and growing profitable businesses. However, in many cases, women engage in these opportunities simply as a means to gain another income-generation stream to balance economic shocks. Because of this, these sales agents may face challenges once they deplete their naturally existing social network of potential customers in that they may lack the motivation, resources, or skills to extend sales into new and harder to reach markets.

Women in developing countries and emerging economies also face mobility constraints owing to personal safety considerations, social responsibilities and the traditional division of household labour, but some do manage to find creative solutions (Baruah 2016). Micro-entrepreneurs that work as repair agents might be a good low risk (low overheads or capital) option for poor women, however, there is the risk of not being able to find sufficient work to sustain their businesses. Moreover, many entrepreneurial policies have failed to support more opportunity-based enterprises because they fail to recognize that certain policies (such as regulatory frameworks) disproportionately affect these enterprises in any given sector (Schoar 2010).

Table 4.4: Organizations that use a micro-enterprise approach to distribute energy products or services

Project or Organization NAME	Location	Products sold	Customers reached	People reached
Barefoot College[1]	Asia, Africa, South America	Solar home systems		2 million
Bidhaa Sasa[2]	Kenya	Clean cookstoves, LPG, solar lanterns, solar systems, and agricultural tools	18,000	
Empower Generation[1]	Nepal	Cookstoves, solar lanterns and solar home systems	58,580	300,000
ENERGIA's Women's Economic Empowerment program (WE)[1]	Indonesia, Kenya, Nepal, Nigeria, Senegal, Tanzania and Uganda	Cookstoves, solar lanterns and solar home systems	576,895	2.6 million
Energy4Impact[1]	Kenya, Tanzania, Senegal	Solar kiosks and phone charging stations, clean cookstoves and fuels, solar lanterns		16.5 million
Greenway Grameen[3]	India	Clean cookstoves	800,000	3,200,00
Juabar[4]	Tanzania	Solar kiosks	6,600	
Kopernik[5] ***(Wonder Woman Program)***	Indonesia	Cookstoves, water filters, solar lanterns and solar home systems	31,946	164,140
LivelyHoods[1]	Kenya	Clean cookstoves and solar lanterns	37,471	
Nuru Energy[6]	Rwanda	Solar lanterns	120,000	
Oorja[1]	India	Solar-powered mini-grids and solar pumps	520	
Pollinate Energy[1]	India, Nepal, Australia	Cookstoves, solar lanterns	98,093	530,885
Solar Sister[1]	Uganda, Tanzania, Nigeria	Cookstoves, solar lanterns, and solar home systems	267,054	1.53 million
Solarkiosk[1]	Africa	Solar-powered kiosk		5 million
Swayam Shikshan Prayog (SSP)[1]	India	Cookstoves	145,000	5 million

Small and medium energy enterprises

Small and medium sized enterprises (SMEs) are considerably different than micro-enterprises described above. On the whole, SMEs are generally registered, have functioning financial systems, have assets, are required to pay taxes and have employees. SMEs are key players in all economies, supplying at least half the jobs in the formal sector,

[1] wPOWER 2018
[2] ICRW Gender Smart Case Study
[3] Greenway Appliances website: https://www.greenwayappliances.com/
[4] Miller Center Juabar Case Study: https://www.scu-social-entrepreneurship.org/case-studies-1/2017/5/17/juabar-case-study
[5] Kopernik annual report: https://v1.kopernik.info/documents/report/1528776649300_6427.pdf
[6] Nuru Energy Website: http://www.nuruenergy.org/

are estimated to account for 60% of Gross Domestic Product (GDP) in low-income countries (ILO 2015), and are thought to have an important role to play in achieving the Sustainable Development Goals (OECD 2017). It is through SMEs that innovation can be more effectively introduced to accommodate market demands and changing technologies. This is particularly relevant to the energy sector. Results from the 2017 Paris meeting of the OECD identified SMEs as central to the efforts of achieving environmental sustainability (OECD 2017) as it is argued that the transition to green goods and services opens significant business opportunities. A short list of organizations that use a small-medium enterprise approach to distribute energy products is listed in Table 4.5.

Why this works: Within the energy sector, there have been several initiatives that have attempted to better integrate women's SMEs into the local economy (Batliwala & Reddy, 2003; Baruah 2016). There are some notable SMEs that have been started by women and focus on employing women either as sales agents, employees or as entrepreneurs. These include Solar Sister (Africa), Frontier Markets (Asia), Appropriate Energy Saving Technologies (AEST) (Africa), LivelyHoods (Africa) and Greenway (Asia). In addition, entrepreneurship, in general, is seen as a primary driver of renewable energy technologies (RET) by driving market and local economy-level changes that create incentives for their uptake. For example, as women engage in other types of entrepreneurial endeavours, it may motivate the purchase and use of clean energy technologies which save time spent on household tasks, enabling more time to be spent on entrepreneurial income-generation activities. Entrepreneurs can also serve as early adopters of RETs, as they actively promote the need for RET products and services and catalyse penetration in markets. The literature has limited examples of how energy-related businesses serve the poorest households.

Challenges with SMEs: While SMEs appear to hold significant promise to expand energy-related businesses, women-owned businesses comprise less than one third of the formal SMEs worldwide (ILO 2015; GEM 2018). With respect to growth, women face substantially greater challenges to growing their businesses as compared with men. Lack of adequate access to finance, training and mentoring support as well as women's competing responsibilities are key factors limiting growth.

Effective entrepreneurial support models for women in the energy sector at the SME level will need to directly address both societal and self-misperceptions about women's technical abilities; opportunities and constraints associated with self-employment and entrepreneurship; the pros and cons presented by part-time work and arrangements like job sharing; the limitations and opportunities women face in managing work-related travel; skill shortages in the RET sector; and public sector involvement in framing policy to enable employment equity in RET (Gabriel & Kirkwood 2016). In addition, favourable regulatory conditions that support SMEs, recognizing the needs of women-led businesses, are crucial. SMEs hold great promise in expanding energy access, however, focused efforts are necessary to effectively engage women in developing country economies.

Table 4.5: Organizations that use a small-medium enterprise approach to distribute energy products or services

Project or Organization NAME	Location	Products sold	Number of entrepreneurs reached	People reached
Frontier Markets[1]	India	Cookstoves and solar lanterns, home lighting systems, appliances	5,000	2.1 million
Greenway Grameen[3]	India	Clean cookstoves	3,128	3,200,00
Solar Sister[1]	Uganda, Tanzania, Nigeria	Cookstoves, solar lanterns, and solar home systems	3,653	1.53 million

Case study 2: Briquette manufacturer, Uganda

This case focuses on a very early stage start up small business owner that is manufacturing briquettes to be sold in the local markets. The founder is a young woman who, with strong family support, has brought in good business partners and has a strong sense of product quality and customer value proposition. In addition, she continues to broaden her social and business networks and has strong community mentors and contacts in the industry.

High-potential energy enterprises

There are currently no empirical studies that have focused on high-potential women-led energy enterprises in the women's energy entrepreneurship literature. However, with the greening of many economies, there is significant opportunity to advance high-potential energy enterprises and to engage women as employees, entrepreneurs, and industry leaders within this sector. The green economy is generally referred to as an economy that aims at reducing environmental risks and ecological scarcities, and that aims for sustainable development without degrading the environment. Over the next 20 years, it is expected that the green economy will create 60 million new jobs, mainly in technology and infrastructure (Baruah 2016). Women's perspectives and innovation in renewable energy can greatly benefit this burgeoning sector as their knowledge of various energy related needs are likely to lead to greater

[1] wPOWER 2018
[3] Greenway Appliances website: https://www.greenwayappliances.com/

enhancements and design elements. Renewable energy related employment has provided jobs, either directly or indirectly, for nearly eight million people worldwide in 2014, excluding large hydropower (IRENA 2015). This is an 18% increase from the previous year, and employment in the sector is expected to continue to grow rapidly in the future (IRENA 2015). Currently, there are limited data on the roles that women play in the renewable sector, with recent data showing that women make up only 6% of technical staff, 4% of decision-makers, and just 1% of top management in the fossil fuel-based energy sector (UN Women 2012). From our review, we did not find specific statistics on the number of high potential energy businesses that are led by women.

Why this works: Supporting high potential women-led energy businesses provides and important opportunity to mainstream gender into industry leadership and to create companies more likely to employ women workers in technical and management roles, as well as produce a new cohort of women mentors and connectors. Big industry has an important role to play in supporting and spawning new ventures through spill over effects (For example, see Qian & Acs 2013). As women learn the trade in large organizations, some number may actually start their own companies one day, based on the experience and knowledge they gain on the job. Data from our fieldwork suggest that women business owners are more likely to employ other women in their company. These women business owners can also serve a coaches and mentors to up and coming women-led businesses and serve as examples within their communities.

Challenges to high-potential enterprises: While women's engagement in energy professions has been increasing as access to science and technology education, and equal opportunity policies by institutions and governments increase, in both the fossil fuel-based and renewable energy workforce, women are still concentrated in the lowest-paid positions, engaged in the most menial and tedious tasks, and are furthest from the creative design of technology and authority of management or policy making (Baruah 2015). Overall lack of government support for renewables and entrepreneurship acts as a crippling force, trickling down to financial and other start-up support institutions. There are some examples of programs and policies to promote employment equity in the RE sector. Brazil, for example, has become a world leader in renewable energy (IEA 2013), and also succeeded in enabling women's substantial participation in science, technology and engineering fields through progressive social policies that include state funded tuition and scholarship awards at the undergraduate and graduate level (Huyer & Hafkin 2013).

Case study 3: Strauss Energy, LTD

In this example, Strauss Energy, founded by Charity Wanjiku is a five-million-dollar Kenyan business manufacturing solar roofing tiles for us in urban settings. Charity runs this business with her brother and maintains an office at Strathmore University in Nairobi. She has been able to raise millions of dollars in capital for her business and continues to build her business skills through international training programs. Charity, who also serves as head of

operations and makes a point to hire women as solar roof tile installers. These women are great employees and often encourage family and friends to consider working in solar energy.

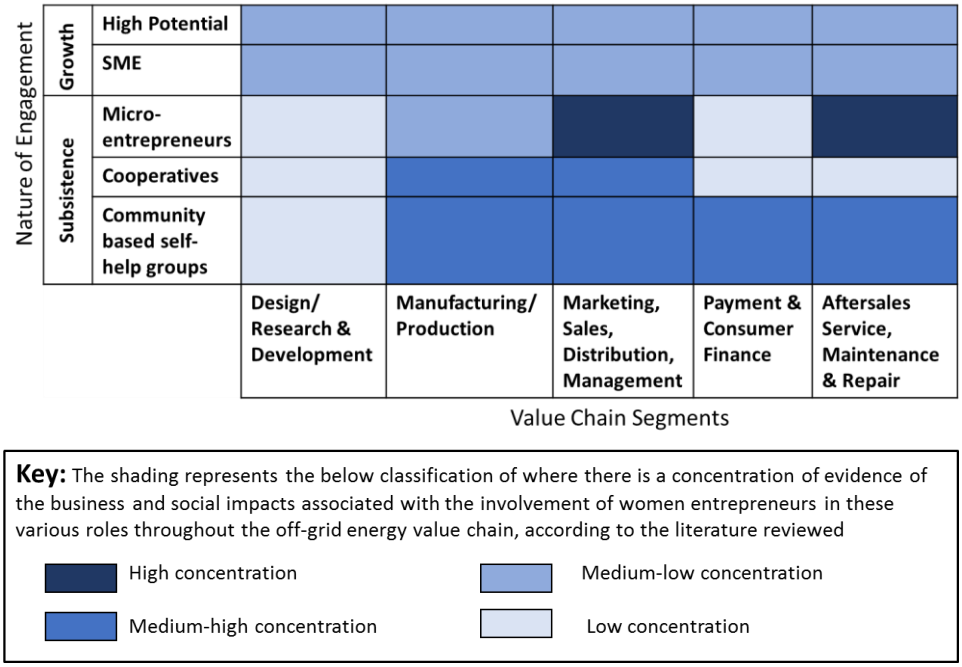
Are women energy entrepreneurs reaching their targets?

As previously mentioned in the introduction, researchers at the Miller Center for Social Entrepreneurship, suggest a reframing of the energy access problem to that of an enterprise system approach that could lead to a market of 500 million potential customers for public and private energy supplies (Miller Center 2015). As such, this team has estimated the number of energy delivery enterprises would be required to serve this market. Using a simple model, that takes into account transactions several key variables including business size, gross margins, time to growth, etc., they suggested a range of 7,000-20,000 high capacity entrepreneurs (each serving up to 25,000 customers) would be needed to address the current energy access deficit (Miller Center 2015). Based on our review of the estimated number of entrepreneurs trained and the population they can reach, it does appear that there are close to 9,000 women who are moving towards that goal. While it is clear that most of the entrepreneurs are not able to service 25,000 customers, tracking the progress on women's reach in the energy sector is an important guide as we move towards energy access for all. In addition to examining how these women are engaged from a business perspective, in the next section we explore women's roles along the value chains of energy products and services.

4.3. Women's Engagement as Energy Entrepreneurs Across the Value Chains

How and why women should be engaged throughout energy value chains differs by value chain segment and mode of engagement. Building on frameworks and findings from several studies, Figure 4.1 depicts the main roles where women entrepreneurs have been engaged in off-grid energy value chains, and below we provide more detail on what women's entrepreneurship looks like at each of these value chain segments (O'Dell et al. 2014; Misana & Karlsson 2001; Bardouille 2012; Kohlin et al. 2011; Baruah 2016; Cecelski 2000). Sales and distribution roles may be more effective for the distribution of smaller home products and women's roles as technicians may be better suited for larger solar home systems. It does appear that engagement in aftersales service, maintenance and repair may be more attractive to women from poorer households as this involves less capital risk, helps them gain technical skills that can be used in their professional and personal lives, and doesn't require the need to consistently find new customers outside of their social networks. However, these roles may need to be combined with sales and distribution in order to provide sufficient business. We provide more detail on each of these approaches in the sections below.

Figure 4.1 Integration of female entrepreneurs in off-grid energy value chains



Design/Research and Development

Women entrepreneurs have a role to play in research and development of new energy technology products and services. This can include providing input into the design of energy technologies, assisting in identifying/designing appropriate financing mechanisms to enable female customers to access products, and/or determining where to geographically lay a mini-gird in order to provide equitable access to men and women (Bardouille 2012; O'Dell et al. 2014; Cecelski 2000). Women entrepreneurs are rarely engaged only at this level, but rather may be involved in sales and distribution of an energy product or service, and also play a valuable role in providing feedback and input into the research and design aspects of the enterprise. Examples of engaging women in design/research and development include: (1) women entrepreneurs with Juabar in Tanzania who were primarily involved in operating solar powered kiosks for mobile phone charging also provided feedback into the design of the kiosks (Pailman, 2016) and (2) the Upesi Project in Kenya involved women's groups in design and field-testing of stoves (Misana & Karlsson 2001).

Manufacturing and Production

Engagement of women entrepreneurs in manufacturing and production can consist of roles involved in producing component parts or manufacturing clean energy technologies such as cookstoves and also production of fuels such as biomass briquettes and pellets (Misana & Karlsson 2001; Baruah 2016; Bardouille 2012). External entities may play a role in forming groups and often provide skills training, as well as assistance in establishing management and financing systems. In some cases, women can be engaged as entrepreneurs in manufacturing and are paid per piece produced.

Another related role where women may be engaged, although also not technically entrepreneurship, is through growing of biofuel crops (WDR, 2008). There may be

opportunities for women to be engaged in growing these crops as this is an area where men have not already established themselves (Karlsson & Banda 2009; Karlsson-Vinkhuyzen 2012). Examples of engaging women in manufacturing and production include: (1) the Upesi Project in Kenya involved women's groups in local production of stoves (Misana & Karlsson 2001); (2) a project in Char Montaz Bangladesh trained women in lamp production (Misana & Karlsson 2001; World Bank 2004); and (3) Ndirande Nkhuni Biomass Briquette Programme in Malawi engaged women in producing briquettes from wood and paper waste, agricultural residue and other biomass materials (Misana & Karlsson 2001).

Marketing, Sales, Distribution, and Management

Marketing, sales, distribution, and management of energy products and services is one of the value chain segments where we have seen the greatest proliferation of engagement of female entrepreneurs. Women can be engaged in sales and distribution through operating retail shops that sell energy products and fuels to customers or can be engaged in direct sales as mobile entrepreneurs who keep a minimum amount of stock and supply to customers upon demand (Gabriel & Kirkwood 2016, Sarkar 2012). Direct sales models use networks of local micro-entrepreneurs to sell products at the last mile to those in their immediate and broader networks (within a geographic radius). This model usually involves smaller, portable, household products such as solar lanterns, lighting systems, and clean and/or efficient cookstoves. Women can provide a unique value in sales and distribution because they are able to leverage existing social networks, as well as form trusting relationships with potential customers (Karlsson- 2012). This enables companies to tap into local distribution networks and to overcome challenges of reaching last mile customers (Pailman 2016). For example, Envirofit, who employs women from poor urban and rural communities in India to demonstrate the use of energy technologies and pays a commission for each unit sold, finds that "because women are typically responsible for cooking for their families, they do have a comparative advantage in reaching out to other end-users of cookstoves" (Baruah 2016).

Examples of engaging women in marketing, sales, distribution, and management include: (1) the Mali multifunctional platform (MFP) trained women in operating and managing the MFP (Misana & Karlsson 2001); (2) in Tanzania and Nigeria, Solar Sister uses a woman-to-woman direct sales approach to marketing affordable solar technology; (3) African Renewable Energy Distributor (ARED) works with entrepreneurs in Rwanda to manage solar powered mobile kiosk (Pailman, 2016); and (4) Nuru engages entrepreneurs in Rwanda to sell Nuru lights and provide a recharging service for the LED lights and mobile phones (Pailman, 2016).

Payment and Consumer Finance

Through their roles in sales and distribution of energy products and services, women may be engaged in payment and consumer finance. This can entail roles related to bill collection for energy services, and formal or informal microfinance mechanisms for the purchase of energy products (Gabriel & Kirkwood 2016; SustainAbility 2014; UNEP 2012; O'Dell et al. 2014). Formally, companies may have systems wherein customers pay for products on instalments and entrepreneurs are responsible for collecting these payments. Informally, entrepreneurs may decide to sell products partially on credit and collect the remaining payments overtime. Apart from designing financing mechanisms as

discussed earlier, women may be at an advantage in payment collection as well. For example, a project in Char Montaz Bangladesh that engaged women in the production and distribution of direct current (DC) lamps found that female sales agents were very effective in collecting payments on time; staff reflected that this could be due to the fact that all of the purchasers were known to the women in the project and thus may have been more motivated to repay their loans on time (Khan 2001). An example of engaging women in payment and consumer finance includes: the project in Char Montaz, Bangladesh involved women in collection of loan payments (Misana & Karlsson 2001; World Bank 2004).

Aftersales Service, Maintenance, and Repair

Another key role for female entrepreneurs is in aftersales service, maintenance and repair. Several initiatives have trained women in technical skills and now they are able to service and repair various types of energy technologies (Baruah 2016; Cecelski 2000; Sarkar 2012; O'Dell et al. 2014) suggest that this might be a particularly effective role for poor women in that it involves low capital risk and helps them gain technical skills that will be valuable for both personal and profession use. Women may be able to overcome geographic and cultural barriers associated with providing services and repairing products and systems for last mile customers (Baruah 2016). As the primary users of energy products and services, involvement of women in maintenance and repair may ensure that these systems are better taken care of as women understand the value of and benefits derived from these products and systems (Cecelski 2000). While women's engagement in direct sales may be more suitable for smaller home products, women's engagement as technicians may be better suited for larger solar home systems where photovoltaic panels are mounted on roofs and battery systems are installed in homes (Pailman 2016). Women can be engaged as technician both as employees, paid a fixed wage for performing installations and repairs, or as entrepreneurs who earn a commission from each repair performed (Pailman 2016). In many cases it is the same entrepreneur who is involved in sales and distribution, who then provides maintenance and customer service support.

Examples of engaging women in aftersales service, maintenance, and repair include: (1) in addition to sales and distribution, both Solar Sister entrepreneurs (in Tanzania and Nigeria) and Nuru entrepreneurs (in Rwanda) provide after-sales service to customers, such as exchanging products (Pailman 2016); (2) Grameen Shakti trains women in Bangladesh to repair and maintain solar home systems and other renewable energy technologies (USAID, 2014); and (3) in India and Africa, Barefoot College trains poor, illiterate women to be solar engineers, enabling them to install and repair solar equipment (Misana & Karlsson 2001).

Senior Management and C-Level (Chief) Leadership

While the literature provides examples of involvement of women in roles across the clean energy value chain, there is still a dearth of engagement of women in top management and decision-making positions within the clean energy sector. Women are missing from involvement in bigger utility systems, in both the Global North and South and even with off-grid energy, women are often not in the positions to make decisions related to how and where an energy service or product will be distributed (Baruah 2016). Even when women are in these positions, they often do not address the gender

constraints that make it difficult for other women to reach these same opportunities (Sarkar 2012). This leads to a significant lack of gender mainstreaming in energy policies and programs. High potential women's entrepreneurship offers a key opportunity to increase the number of women in energy industry leadership. It is often easier for women to build their own industry-leading companies than to scale the ranks within large companies.

4.4. Conclusion

Based on the available grey literature, there are multiple ways that women can effectively engage within the energy sector to advance access of energy for all. However, there is no substantive evidence that the current efforts have significantly increased household access to energy in a sustained way. While there have been thousands of women entrepreneurs supported through many of these programs, the bulk of these women are micro-entrepreneurs and building their businesses beyond necessity towards more growth-oriented opportunity-based businesses is a challenge. This is due in part to the transient nature of clean energy technology products and the need to continue to maintain and update products to continually serve household energy needs. Given the numerous challenges women face at all levels of engagement and along the value chains, it is unlikely that these programs will significantly scale without concurrently strengthening the gender ecosystem.

There are advantages of engaging women in particular roles throughout the energy value chain. In addition, the nature of women's engagement – whether through self-help groups, cooperatives, as micro-entrepreneurs, SME owners, or leaders of high potential firms – affects the enterprise's ability to reach new customers, the initiative's commercial viability, and the benefits experienced by the women. In order for women to be successful in this sector, it is necessary to transform the gender system to support such advances. It is also likely that these shifts will need to be informed and in large part, crafted by women. Due to women's conflicting household responsibilities, it is important for any energy sector engagement to take into account women's schedules and mobility constraints. Women may require targeted support, through education and training in business planning, accounting, and marketing skills, that is oriented towards women's enterprises as well as behavioural trainings and coaching/mentoring focused on strengthening personal agency, voice and confidence. Finally, access to affordable financing and credit facilities, and potentially subsidies and investment programs targeted towards women's businesses, are essential to help support and grow these women led-businesses. However, a change of mindset is required on the part of energy planners and activists: they must promote the notion of women as managers and entrepreneurs, not just beneficiaries, of improved energy services. To reemphasize, unlike other social status characteristics, gender operates within the household as well as across all levels of engagement. Therefore, shifting mindsets at all levels (especially with the household as change begins at home) will be a critical force in moving gender norms to greater equality.

Considerable programmatic and policy interest and growth in women's energy entrepreneurship activities has emerged in recent decades as a mechanism of providing energy technologies and services. As a prime example, ENERGIA, the international network on gender and sustainable energy has supported over 4,000 micro and small women's enterprises through its partners, Solar Sister in Nigeria, Tanzania and Uganda;

Practical Action East Africa and Sustainable Community Development Services (SCODE) in Kenya; Kopernik in Indonesia; Energy4Impact in Senegal and Centre for Research and Technology (CRT) Nepal (SE4ALL, 2017b). A recent effort by the European Union, entitled 'Women and Sustainable Energy in Developing Countries' is supporting three multi-layered initiatives primarily in Sub-Saharan Africa countries to increase the number of women in the sustainable energy sector, support women's entrepreneurship and improve access to finance. Included in these programs is Barefoot Solar Engineers working in Sierra Leone, Uganda and Kenya; Christian Aid's program in Ethiopia, Honduras, Burkina Faso and Malawi; and Fundación Plan International Spain working in Senegal, Mali and Niger. In addition, there are numerous networks that have been created to continue to expand and support women energy entrepreneurs, such as the Clean Cooking Alliance (previously Global Alliance for Clean Cookstoves), wPOWER and the Shine Campaign (SE4ALL 2018). It is hoped that these efforts continue to strengthen women's entrepreneurship in the energy sector and also strengthen the gender ecosystem toward greater equality.

5. RESEARCH QUESTION 2: HOW DOES WOMEN'S ENERGY ENTREPRENEURSHIP BENEFIT WOMEN AND THEIR FAMILIES?

5.1. Introduction

Women's participation in energy entrepreneurship has the potential to address several of the Sustainable Development Goals (SDGs) through the direct empowerment of women, through women's investments in their families and communities, and through benefits associated with access to energy. Women's participation in income-generation, and as ambassadors of new energy technology products or services can contribute to: increasing decent work and economic growth (SDG8) by providing women with a sustainable income generation opportunity, reducing poverty through women's increased incomes (SDG1), and improving gender equality (SDG5) as women are able to not only financially contribute to the family, but are also able to communicate, negotiate, and participate in household and community level decision making.

Through increasing access to and benefits from clean energy products and services among rural, hard to reach last mile households, women's energy entrepreneurship can contribute to: increasing access to affordable and clean energy (SDG7), improving health and well-being (SDG3) through reduced exposure to harmful emissions, improving educational outcomes (SDG4) due to having access to light to study with, enhancing gender equality (SDG5) through reducing women's unpaid care burden, reducing inequalities (SDG10) by enabling both poor and wealthy households to experience the benefits of energy access, and creating more sustainable communities and cities (SDG11).

The majority of literature identified in the literature review focused on connections between gender and use of energy products and services (see: Cecelski 2000; Parikh 1995; Clancy 2009; Karlsson 2013; Barnett et al. 2002; Rath 2005; Clancy, 2003; Annecke, 2000) For example, rather than focusing on the benefits that a woman and her family experience from her role as a solar lantern sales agent, the literature primarily examined the benefits that women and their families experienced due to access to electricity (e.g., keeping store open later at night or increased mobility). It is clear that the intersection between participation in clean energy value chains and the benefits experienced through the use of clean energy products and services are inextricably linked and often mutually reinforcing.

This review describes the **unique bi-directional relationship between participation in energy entrepreneurship opportunities and the use of time saving energy products and services**. The presence of income generating opportunities can increase the value of women's time thus motivating the purchase and use of energy products/services, and the use of energy products/services can free time (for example reduced cooking times with clean cookstoves) to be redirected to income-generating activities. Therefore, we are suggesting that women energy entrepreneurship is distinct from other forms of business activity because of the valued added through access to

energy products and/or services. Moreover, these added benefits could be fully realized, we suggest, if other supports to both the gender ecosystem and the business exist. We outline some of these best practices, as observed from both empirical literature and programs in the next chapter.

It was in Batliwala and Reddy's (2003) review of the gender-energy nexus, that they convincingly argue that energy interventions can improve the lives of women. Through detailed time-task assessments, they documented how women used their own energy to perform longer more arduous tasks on a daily basis as compared with men. In addition, women faced the negative health impacts of the labour as well as harmful emissions from biomass cooking fuels. Access to time saving devices, cleaner cooking technologies and fuels as well as regular sources of light were recognized as targeted solutions to health challenges women faced. However, women and men use energy products and services differently. In a case study in Nepal (Mahat 2011), access to energy showed both negative and positive benefits to men and women. Women had less work on arduous tasks such as firewood collection or extensive cooking routines, but had to work longer hours on other household tasks due to more light. Men, on the other hand, gained from productive uses of energy and gained greater knowledge from the TV, while young boys were more likely to take leisure to watch the TV, rather than work (Mahat 2011).

While the benefits of energy access are clearer, the impacts of women's entrepreneurship within these same, energy poor households are not. As with any disruptive shift in household tasks and dynamics, there are often unintended consequences. More research is needed to further parse out this relationship to understand if particular forms of women's energy entrepreneurship have greater benefits for the household, especially related to impacts on increasing the value of women's labour and shifting gender norms.

5.2. Program impacts show that energy entrepreneurship may be key in unlocking women's economic potential

Women's participation in **energy entrepreneurship has the potential to influence the relationship between women's income-generation, the value of women's labour, and women's unpaid care work**. Anecdotal evidence from programs have indicated that the presence of income-generation opportunities is one of the key motivators for uptake of clean energy products and fuels. While there is a body of literature that explores how productive uses of energy products influence energy choices, here we are referring to the income-generation opportunities associated with being an entrepreneur within a clean energy value chain- as a manufacturer, sales agents, or in aftersales services for example. In many of the rural locations where energy enterprises operate, there are very limited income generation opportunities available for women. Rather, women spend most of their time on unpaid agricultural and household activities, causing their labour to not be seen as financially valuable (Misana & Karlsson 2001). However, once an energy enterprise provides opportunities for entrepreneurship and income generation, a shift in how women's labour is valued may occur. The presence of these businesses creates an opportunity cost for women's time spent on unpaid work. This in turn can motivate families to use strategies to reduce or redistribute women's unpaid care work so that women can spend more time participating in these income generation activities. In the

case of productive use of energy products, women's income generation through use of energy products can increase the value that households place on both energy access and on women's labour.

The use of the clean energy products has been associated with reduced time poverty for women. In some cases, the combination of an income-generation opportunity, and a technology that reduces the amount of time needed to complete household tasks is what enabled women to participate in energy value chains, earning an income and becoming empowered. For example, women who participated in the Ndirande Nkhuni Biomass Briquette Programme in Malawi found that when they no longer had to travel long distances to collect fuel, they were able to socialize with their friends more freely, and also had more time to dedicate to income generating activities (Mabona 2001). In addition, studies have found that with electricity access, women become newly engaged in small-scale, entrepreneurship activities and micro-enterprises and their productivity in these activities rises (Grogan & Sadanand 2013).

More research is needed to explore this nexus. Several studies suggest that women, who save time on household tasks through the use of energy efficient technologies, may in fact simply spend that time on other household tasks (Clancy et al. 2011). Further exploration is needed to assess if and how the presence of an energy entrepreneurship opportunity results in greater likelihood of spending newly available time on income generation and ultimately shifting the value that families and communities place on women's time and labour. Similarly, more research is needed to understand if and how a woman's participation in energy entrepreneurship changes how her family values her time and labour and whether this therefore motivates families to purchase time-saving energy-efficient products or services.

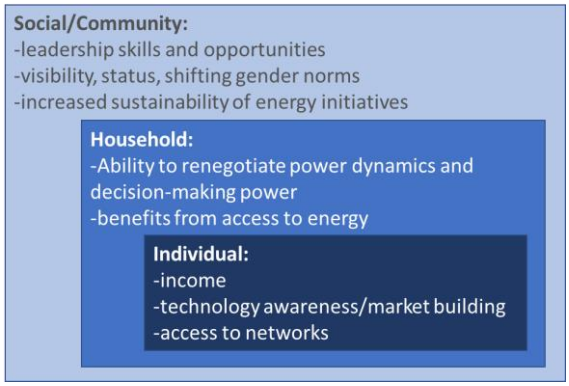
5.3. Benefits for entrepreneurs and their families and communities

When women are engaged as energy entrepreneurs throughout energy value chains, there are multitude of benefits produced for women, their families, and their communities. *Figure 5.1* outlines the benefits at each level. At the individual level, women experience increased access to skills and resources such as income, technical and business skills, and access to networks that are beneficial for both business and personal purposes. At the family or household level, social norms may begin to shift as women are able to contribute to household earnings and, due to increased communication skills and self-confidence, are also able to negotiate with their partners and participate in household decision making. In addition to the benefits associated with women's participation in energy entrepreneurship, households benefit from the use of the energy products and services that the entrepreneurs create, distribute, and manage. These benefits are related to improved educational, health and safety outcomes among household members.

Some programs have reported that at the community level, as women are engaged in energy entrepreneurship their status improves, they serve in leadership roles, and gender norms may begin to shift as women are seen as being capable of more diverse roles. The engagement of female entrepreneurs may also make the energy initiatives themselves more sustainable. Finally, through the productive use of energy – created, distributed, and managed by women energy entrepreneurs – communities experience

broader economic development. While changes at the individual level can happen almost immediately as entrepreneurs gain new skills through a training or earn income through selling products, change take increasingly more time as we move along the ecological model, with changes at the community, social norm, and institutional levels taking years to occur.

Figure 5.1 Benefits associated with women's energy entrepreneurship



Individual Level

Income

The most direct impact on female entrepreneurs who are engaged in energy value chains is increased income. In settings where women often have few opportunities for income-generation clean energy production and distribution initiatives can create a host of opportunities. In their case study review, Misana & Karlsson (2001) note that when "local people can actually make money from manufacturing or selling new energy technologies and services, an entrepreneurial dynamic is unleashed." Engaging women as energy entrepreneurs, rather than simply as beneficiaries of energy access, can expand their economic activities, diversity products, and create new sources of wealth and income to support investments in family education and health. In places where women have limited options for income generation, women's ability to earn consistent incomes and control innovative technology equipment can begin to transform social and gender dynamics (Misana & Karlsson 2001).

Women may gain access to credit through participation with energy enterprises (World Bank 2004; Iyiola & Azuh 2014; Sigalla & Carney 2012). This access can be immediately helpful in enabling them to secure inventory or needed supplies/resources, and also help to build entrepreneurs credit history and financial literacy so that they are able to more easily access other forms of credit in the future (Misana & Karlsson 2001). For many women involved through cooperatives or as micro-entrepreneurs, engagement in clean energy value chains comprises a supplementary income stream (Pailman 2016). Many entrepreneurs use this income to supplement agricultural earnings and may be more active in some seasons compared to others. Especially for micro-entrepreneurs engaged in sales and distribution, because their income is dependent on finding new customers, and thus is inconsistent, they use this income to augment other sources of revenue. Pailman (2016) found that entrepreneurs who were involved in selling an energy service, such operating a solar-powered mobile phone charging kiosk were more likely to use this role as their primary source of income, compared to those who were engaged in

the sales of durable clean energy products and thus relied on the number of sales they were able to execute.

Technology awareness/market building

Women engaged as clean energy entrepreneurs gain both business and technical skills. Women learn technical skills through involvement in various value chain segments – women involved in manufacturing and producing energy products learn technical, craftsmanship skills, while women involved in sales and distribution gain an understanding of how to operate the energy products/services, and women engaged as technicians gain skills related to the repair and maintenance of energy technologies (World Bank 2004).

Gaining science, technology, engineering and mathematical (STEM) skills represents a unique opportunity for individuals in rural areas, especially women. These skills help women to make a shift from traditional, informal income generation to skilled labour in more formalized positions. These entrepreneurs also gain key business skills such as price setting, record-keeping, financial literacy, and keeping household and business expenses separate, as well as communications and customer service skills. Technical skills can translate into use of the energy products/services themselves, and the business and communications skills gained can translate to improvements in other aspects of their lives. Marketing skills have enabled women to become more successful sales agents and to better negotiate in other aspects of their lives (Misana & Karlsson 2001). Most enterprises have some form of formal training that they provide to women engaged as entrepreneurs – the skills gained through these trainings enable women to become more effective energy entrepreneurs and also to apply these skills to other entrepreneurial activities they are engaged in, as well as to their domestic lives. Enterprises have actually found that training related to the environmental benefits of clean energy products and services has limited effectiveness as this is not a core motivator for why customers are interested in purchasing these products (Misana & Karlsson 2001).

Access to Networks

Women engaged as energy entrepreneurs often gain access to social networks either directly through the enterprise structure, or through forming their own groups to share knowledge and best practices. Some enterprises leverage existing women's groups or organize women into self-help groups or cooperatives to produce and distribute clean energy products and services. Even enterprises that work with female micro-entrepreneurs may organize them into groups for sharing learnings, leveraging each other's networks and to provide on-going support. Solar Sister engages entrepreneurs who sell solar lanterns and clean cookstoves in regularly scheduled "sisterhood" meetings to enhance business skills, build networks, and share learnings among entrepreneurs. In a qualitative assessment, Solar Sister entrepreneurs mentioned that these sessions have created social and economic impacts in their lives – they exchange best practices with other sales agents, work together to support each other in sales (supplying products to fellow entrepreneurs when they are short on inventory), refer customers, and form strong friendships (Soria et al. 2016). Women entrepreneurs often independently form their own groups to share best practices and optimize their performance (Baruah, 2016). Not only do these groups provide women with social, business, and emotional support, but they can also promote collective empowerment as women have increased control

over important community assets and community members come to see women as capable of mastering new tasks and responsibilities.

Household Level

Ability to renegotiate power dynamics and decision-making power

When women gain income and are engaged in roles where they are physically moving throughout the community and interacting with diverse community members, it can cause a shift in household power dynamics and relationships. Sigalla & Carney (2012) explained "in the course of challenges [women] face in business, women enter new relationships and social worlds with customers, creditors, and development agencies, and renegotiate deeply structured relations within marriage, families, and community." Specifically related to entrepreneurship, Sigalla & Carney (2012) convey one women's experience in Tanzania: "a change in the subjective condition of her life created via entrepreneurship enabled her to reflect on her marriage and its power dynamic." Having roles that break with cultural stereotypes and gender norms, cause women, and their family members, to begin to question and challenge other gender norms.

In particular, as women earn income and contribute to household earnings, it can shift household power dynamics as they are given a larger role in household decision-making, particularly around how the money they earn is spent. One participant in Sigalla & Carneys' (2012) study with female entrepreneurs in Tanzania reflected that previously her husband would have the right to "just take be me back to my parents, but now that option is gone: Now he needs me more than ever before. I am economically viable."

An extensive literature review conducted by ENERGIA found many examples where women's empowerment increased as a result of participation in energy projects (ENERGIA 2006). A study conducted amongst entrepreneurs in the informal sector in the Dominican Republic found that while only about half of the female micro-entrepreneurs who earned more than 50% of their household income claimed to be the head of the household, nearly two-thirds claimed to be the predominant decision-maker (72.4% of women) (Espinal & Grasmuck 1997). Thus, while social structures may inhibit female entrepreneurs to feel like they are the head of the household, they do feel that they now play a larger role in household decision- making.

Benefits from access to energy

In addition to the benefits associated with having a female family member who is an energy entrepreneur, households benefit from the use of the energy products and services with which the entrepreneur works. Numerous studies throughout the world have found that access to electricity, through connection to mini-grids or solar lanterns, is associated with better school outcomes as students are able to study later into the night (Van de Walle et al. 2013; Khander et al. 2009; Cecelski et al. 2005). For example, a World Bank study in Bangladesh found that when villages are electrified, boys complete 0.23 more years of schooling and girls complete 0.47 more years, compared to those in non-electrified villages. When households themselves are electrified, the benefits are even greater. In villages that were electrified, boys who live in households that also have electricity complete an average of 1.13 more years of schooling, while girls average 1.07 more years of schooling, compared to those in non-electrified villages (Khander et al.

2009). Historical research from the United States in the 20th century similarly suggests that electrification first increases school enrolment rates of girls, which subsequently leads to better employment rates later on (O'Dell et al. 2014; Lewis 2014).

Access to clean cooking and lighting products and fuels can greatly reduce household air pollution and provide positive health benefits to women and children, those who are most acutely affected by respiratory illnesses associated with high exposure to harmful emissions from cooking over an open flame (Haves 2012; IEA 2013; UNIDO & UN Women 2014). The WHO reports that household air pollution is responsible for 4 million premature deaths across the globe, 60% of which are women and children (Bruce et al. 2002). More specifically, cooking with biomass is associated with increased risk of pneumonia by a factor of 1.8 among young children (Dherani et al. 2008). Therefore, energy products, services, and fuels that aim to reduce exposure to harmful emissions can reduce incidence of these health issues and prevent premature deaths among women and children.

Access to energy for lighting and improving labour-intensive tasks can create improvements in women's safety. When homes and communities lack access to energy, and lighting in particular, it leaves women and girls more vulnerable to gender-based violence. Around the world, women and girls generally bear the burden of household chores and can be exposed to various forms of violence while performing these tasks. Without access to electricity or gas for cooking, they often travel long distances to collect biomass fuel, at which time they may become the targets of physical or sexual assault (CRGGE 2006; UNIDO & UN WOMEN 2014). Electricity availability in public spaces, however, increases women's access to those public spaces and allows them to more safely complete household chores outside the home (O'Dell et al. 2014). In addition, products and services that make household tasks more efficient, such as efficient cookstoves, may decrease women's exposure to harmful situations.

Social/Community Level

Leadership skills and opportunities

Increased visibility in the community and enhanced communications and self-confidence often enable women to rise to supervisory or management roles and also to serve in leadership roles in local community groups and committees. Khan (2001), describes how women who participated in the project in Char Montaz Bangladesh were able to not only gain technical skills, but also serve in supervisory positions through their experience and training in business. Njenga (2001) describes how women who participated in design, production, distribution, and installation of stoves in the Upesi Project in Kenya were able to leverage their increased confidence and status to serve on community development committees.

Visibility, status and shifting gender norms

As women participate in roles that give them exposure to the community and also engage in the management and distribution of an important resource, their sense of status in the community often improves. When women are engaged as sales and repair agents, their visibility and reputation spreads throughout their community – a project in Rajasthan implemented by TERI described how lower-caste Gujjar women experienced

increased visibility and increased recognition of their socio-economic and political empowerment through their role as solar entrepreneurs (Baruah 2016). Social norms may also begin to shift as community members see women in roles that they previously did not think they were capable of, such is the case with older women trained as solar technicians with Barefoot College in India (Karlsson 2012).

Furthermore, as women enter and prove their competence in a field that is typically male dominated, it may begin to shift social norms related to what roles are appropriate for women and what women are capable of. A recent qualitative assessment with Solar Sister found that entrepreneurs engaged in selling solar lanterns and cookstoves experienced a heightened sense of status as they brought new, innovative technology products to their communities (Soria et al. 2016). In addition, other women in the community may be motivated to participate in entrepreneurial endeavours when they see female energy entrepreneurs in their community. Baruah (2016) find that "the demonstration effect of women with limited education and social privilege earning a living by constructing stoves for a fee frequently motivates other women to pursue the training."

Increased sustainability of energy initiatives

Some researchers have argued that engaging women as entrepreneurs in energy initiatives can increase the sustainability of these initiatives. Transferring skills to women at the local level, who are already engaged in energy collection, cultivation, and management is a natural method of creating a cadre of energy entrepreneurs with an invested interest in increasing access to energy efficient products and services. With growing decentralization, privatization, and democratization of energy services, in addition to corruption and bureaucracy associated with government-provided services, engaging private, local entrepreneurs may represent a more efficient method of distributing needed energy products and services (Shailaja 2000). This localization promotes the use of local materials and skills development leading to community-based control over quality and distribution systems that are best fit for local needs. Table 5.1 collates the results from several case studies obtained in the grey literature that support a range of benefits at the individual, households and community levels. Since these data, in large part, represent self-reports of programs, they are not definitive impacts, however, they do show a range of possible benefits to women energy entrepreneurs.

5.4. Limits of women's energy entrepreneurship

Not the best option for poor women

While there are many economic and social benefits of participation in energy entrepreneurship, as outlined above, it should be noted that entrepreneurship, particularly micro-entrepreneurship may not be the best way to engage women from the poorest tiers of society. Baruah (2016) suggest that low-income women, from both developed and developing countries often do not become entrepreneurs because the level of risk associated with taking loans and having an unpredictable income is too high. Rather, these women are more interested in wage employment that offers stable hours and income (Baruah 2015). In addition, while the clean energy sector presents new and innovative ideas, poorer women may be hesitant to take risks on products and services that have not already been proven in the market. These women would prefer

opportunities in the energy sector where they can earn an income without becoming indebted and do not have to depend on convincing potential customers to purchase a new, unknown product or service (Baruah 2016).

Table 5.1 Reported program outcomes for women energy entrepreneurs

Programs	Income	Time saved	Tech aware	Individual energy usage	Personal agency	Access to networks	Decision making	Household energy benefits	Societal leadership	Environment benefits	Challenges
African Renewable Energy Distributor (ARED), Rwanda^	X		X		X	X		X			Limited access to women, modified program to increase access
Center for Rural Technology in Nepal,'Promoting Women-led Enterprises for Energy Access and Local Production' (WEE-Nepal Project)&	X		X		X	X	X	X			Financial availability and accessibility
Developing Energy Enterprises Programme (DEEP) East Africa<	X		X	X	X	X	X				Financial availability and accessibility
Energy for Sustainable Women's Livelihoods: Gender Responsive Energy Systems Development and Application: Ghana*	X		X								Challenges with engaging men and leaders
Greenway Grameen		X		X	X	X	X	X		X	Expansion into new geographies even within India is expensive and needs financial/organizational support
International Lifeline Fund	X	X		X						X	High costs of last mile distribution, low market awareness, price sensitive target market
Energy4Impact, Energy Opportunities for Women in Senegal (EOWS) project&	X	X	X	X	X	X	X	X			Costs of business support activities and access to finance
Juabar solar powered mobile kiosk, Tanzania^	X		X			X					Women were not able to easily access this franchise opportunity
Kopernik Solutions, Wonder Women programme, Indonesia&	X	X	X	X		X	X	X		X	Training is crucial to support entrepreneurs, discriminatory social norms, existing family and community obligations and limited mobility
Livelyhoods	X	X			X		X	X		X	Attrition of sales agents and resource intensive daily contact time
Multifunctional Platform for Village Power, Mali*	X	X	X			X	X	X			Labour intensive program
Ndirande Nkhuni Biomass Briquette Programme, Malawi*	X	X	X			X	X			X	Not all women improved income significantly, transport was an issue
Nuru Energy, Rwanda^	X		X	X				X			Challenges in costing structure for consumers, variable markets

Opportunity for Women in Renewable Energy Technology Utilization in Bangladesh, Char Montaz*	X		X	X	X		X	X	X		Significant financial resources required
Practical Action/SCODE Women in Energy Enterprises, Kenya (WEEK) programme&	X	X	X	X	X	X		X			Challenges to reach remote areas, mobilizing finance
Rural Micro-hydro development Programme, Nepal*	X	X	X	X				X	X	X	Careful planning required as well as government and regulatory frameworks
Solar Sister, Uganda, Tanzania and Nigeria (WEE Programme)^#&	X	X	X	X	X	X	X	X	X	X	Need to diversify revenues streams/role of blended financing Need to expand organizational capability to collect customer-level data Need to provide further business growth opportunities for entrepreneurs
Uganda Photovoltaic Project for Rural Electrification, Uganda*		X	X	X				X			Poor financial mechanism and requirement of collateral
Upsei Rural Stoves Project, Kenya*	X	X	X			X		X		X	Transport a challenge as well as quality control

*Misana and Karlsson, 2001

^Pailman 2016

#Soria, Farley and Glinski 2016

&Dutta, 2019

<Kariuki and Balla 2010

Women's energy entrepreneurship is not, on its own, the solution to gender inequity

Due to structural and cultural systems, energy entrepreneurship on its own will not create gender equity. Rather, it may just reinforce the existing inequitable systems and structures. For example, female entrepreneurs with less access to financing, restricted mobility, and limited access to business and technical skills will likely remain in more subsistence forms for entrepreneurship while male entrepreneurs are able to progress to more high growth enterprises. Gender roles shape individuals' identity by prescribing how they are expected to think and behave and interact with those of the opposite gender (Clancy 2000). The "gender system" perspective suggests that all interactions happen between men and women both within and outside of the household as a result of pervasive institutional forces (Sidanius et al. 2004; Ridgeway & Correlll 2004; Fowler 2003). Therefore, female entrepreneurs face unique barriers to equal participation and achieved benefits, which are driven by gendered social norms across the ecological framework – from agency at the individual level to enabling policies at the institutional level.

If initiatives and policies do not proactively try to change these gender dynamics, it is unlikely to be able to empower women through engagement in entrepreneurship. Baruah (2015, 2016) contends that "in the absence of appropriately targeted training, education, apprenticeships, employment placement, financial tools and supportive polices, transitioning to renewables may exacerbate existing gender inequities, as well as hinder broader human development goals." Baruah (2016) adds the warning that "if issues of gender equity are not addressed proactively and systematically, the opportunities for women in the renewable energy sector green economy may do what the green revolution did in the 1970s – boost economic productivity by putting capital and technology in the hands of wealthier, predominantly male, farmers while marginalizing and making women in the agricultural sector even more invisible and vulnerable to poverty than they already were." There are factors, outside of the energy sector, which may limit women's abilities to leverage opportunities in the clean energy sector such as lower levels of literacy, property rights and land tenure, and lack of access to credit; it is therefore important that we look to change some of these structural policies in addition to providing more individualistic entrepreneurship opportunities (Baruah 2016).

Geographic and infrastructure conditions may limit the capacity of female entrepreneurs. Entrepreneurial roles related to sales and distribution of energy products/services, payment and consumer finance, and aftersales service, maintenance, and repair may require entrepreneurs to work awkward hours, travel long distances in the absence of public transportation, interact with strangers, and travel in areas without electricity and water access (Sigalla & Carney 2012; Bathge 2010). In particular, in order to reach new markets, women may have to travel to areas that are completely unknown to them. These situations can present potential for physical and sexual violence. Any considerations that companies can make to minimize these risks, such as providing bicycles, portable solar powered lights, cell phones and/or airtime, and regular check-points with managers and mentors can help female entrepreneurs.

In addition to policies, there needs to be a cultural shift around what are acceptable roles for women – this may in fact happen gradually as women are engaged in income-generation, their self-reliance and self-worth, and their ability to negotiate,

communicate, and defend their rights may help to transform unequal power dynamics (James, 1998). James (1998) suggests that the investment in human capacity to take control over the development process and contribute to social transformations is necessary but cannot be automatically delivered through a rural electrification program. However, he does contend that with targeted investment, participatory approaches can and do build this human capacity for transcending behaviour. He also suggests that it is essential to look at broader community gender dynamics in order to develop an approach that will create opportunities that are both feasible for women, and also will gradually challenge gender norms.

Women entrepreneurs experience with microcredit through a project in Tanzania provides an example of the challenge women face in pursuing entrepreneurial success, while balancing traditional roles (Sigalla & Carney 2012). Women discussed the challenges of fulfilling the role of an independent, self-determined, empowered entrepreneur, with that of a nurturing caregiver. Specifically, the "practice of negotiating spaces for pursuing both the values build into the position of the independent, self-determined entrepreneurial citizen and those connected to the traditional discourse of service and subservience are thus extremely complex" (Sigalla & Carney 2012). The study suggests that women must construct definitions of entrepreneurship that enable them to balance traditional gender norms, providing for their family while at the same time investing in growing their business.

While empowerment and gender equity are not market objectives (Clancy 2000), it is important for initiatives to think about how where there is a market advantage of engaging women as energy entrepreneurs – where women have a unique advantage in designing, marketing, distributing, or repairing products and services – and how policies and procedures that promote gender equity and empowerment programming may make women even more effective in these roles. While gender equity is not the ultimate objective of energy distribution companies, it may be a means to increase the reach, use, and impact of their energy products and services.

5.5. Conclusions

While more research is needed to better understand which business models and roles for female entrepreneurs produce the greatest impacts for women and their families, through this research some initial findings and patterns have emerged. Through their increased income, as well as their public role as an ambassador of a new technology, women gain income and skills that can translate into shifting gender norms at the household level and greater participation in community decision-making and leadership. In addition to the benefits associated with women's participation in energy entrepreneurship, households benefit from the use of the energy products and services that the entrepreneurs create, distribute, and manage such as improvements in health, education, safety, and broader economic development.

There is some research that supports the suggestion that women's energy entrepreneurship may play a unique role in bridging women's income-generation, the value of women's labour, and women's unpaid care work, however, few, if any, well designed research exists. Program case studies suggest that women's energy entrepreneurship shifts the value that households place on women's labour and subsequently increases the uptake of energy products and services (Misana & Karlsson

2001; World Bank 2004; Sonne 2016). In addition, these case reports suggest that the uptake of energy products and services reduces women's unpaid care burden and frees time to be spent on women's participation in energy entrepreneurship (Misana & Karlsson 2001; Grogan & Sadanand 2013). More systematic research is needed to explore these connections and specifically to compare the impacts on the value of women's labour and reductions in time poverty related to women's participation in energy entrepreneurship compared to other forms of entrepreneurship.

Finally, this research suggests that unless initiatives and policies proactively seek to change gender dynamics, they won't necessarily empower women and enhance gender equity through women's engagement in energy entrepreneurship. Rather, several structural enabling/inhibiting factors need to be considered in order to create an enabling environment for female energy entrepreneurs to start and grow successful energy businesses. This includes energy and entrepreneurship policies, as well as shifts in mindsets at the individual and household level to promote shifts in gender norms related to decision-making and what roles are viewed as acceptable for women.

6. RESEARCH QUESTION 3: WHAT ARE THE BEST PRACTICES TO SUPPORT WOMEN'S ENTREPRENUERSHIP IN THE ENERGY SECTOR?

To address the question of best practices for women's energy entrepreneurship, we draw significantly from the existing entrepreneurship literature and the numerous field programs working with women's energy-related businesses. From the empirical literature, we find four types of supports identified that vastly enhance women's economic growth. These include at the individual level: a) business education and skill development and b) training to foster personal agency and initiative; and at the business level: c) access to finance and capital and d) access to coaches, mentors and networks (Glemarec et al. 2016; Henry & Lewis, 2018; Pittaway & Cope, 2007; McKenzie & Woodruff 2013; Chitsike 2000; Buvinic, et al. 2016; Campos et al. 2017; Shankar et al. 2015a). In this chapter, we present an overview of the evidence for each of these entrepreneurial supports, review field programs in the energy sector using these strategies (Table 6.2) and recommend best practices for organizations and programs working to expand women's energy entrepreneurship.

6.1. Best practices to support the individual

Business education and skill development

Basic businesses skills and financial literacy are necessary to build strong women's businesses. Although there may be considerable variation in business education content, these programs tend to include accounting, financial planning, pricing and costing, marketing and inventory management (McKenzie & Woodruff 2013). The length of training also varies substantially; from a few days to a few weeks with rising upfront costs the longer the trainings last. Despite the clear necessity for business training, there have been a number of randomized experiments recently showing fairly strong evidence that business skills training alone are not sufficient for entrepreneurial success (McKenzie & Woodruff 2013; Buvinic 2016). While almost all the studies reviewed find a positive impact of business training on business practices, this is likely due to very low levels of business practices in the populations observed (McKenzie & Woodruff 2013). A few extensive business-training programs have shown more promise for micro-entrepreneurs. A six week fully subsidized training in Mexico found increased earnings for women's businesses (Calderone et al. 2013) and similar positive impacts were seen with a three-month intensive training delivered by professional in Peru (Valdivia 2015). For any training program, constraints faced by women, such as travel and time, must be taken into consideration otherwise as it will likely to lead to lower retention rates. In addition, trainings that reduce travel costs and provide accommodation for childcare (or organizing the training to adjust for household obligations) are more likely to be successful.

Training to foster personal agency and initiative

Many university-based entrepreneurship training programs now incorporate training on "entrepreneurial mindsets" and growth mindsets, like Babson College's Entrepreneurial Thought and Action training methodology to support traditional business skills and planning. However, few of these novel programs have published scientific evidence that these entrepreneurship training approaches actually enhance business performance. Two exceptions are found in data from a series of randomized experiments of entrepreneurial training program efficacy for women entrepreneurs that have produced consistent results across different developing country contexts. These data are based on studies of two approaches to personal empowerment training in entrepreneurship that can be further strengthened and expanded with supportive coaching and mentoring. One is a targeted action-regulation training approach focused on enhancing personal initiative (Campos et al. 2017; Frese et al. 2016; Glaub et al. 2014; Koop et all. 2000). This training combines knowledge acquisition and mental tools with direct actions, actively practicing and repeating actions towards their goals. The second is a personal agency approach that recognizes the integrated nature of various aspects of an entrepreneur's life and uses a cognitive-behavioural approach that considers how an individual's thoughts, feelings, and actions can lead to meaningful action when examined within one's specific sociocultural and situational context (Shankar et al 2018; Shankar et al. 2015a).

In the personal initiative approach, tested in several locations in Africa, training activities are designed to encourage entrepreneurial action. In Uganda, results of a personal initiative-based training program were evaluated with a one-year study based on a randomized pre-test/post-test control-group design and showed a high degree of effectiveness where the training increased participants' personal initiative behaviour, which the researchers believe was also responsible for higher business success after the training (Glaub et al. 2014). Sales for training participants rose 27% and the training led to a 35% increase in number of employees hired by training participants, compared to a decrease in the control group. Similar results were obtained in Togo, where personal initiative training increased firm profits by 30% compared with a statistically insignificant 11% for traditional training (Campos et al. 2017). Based on these results, Campos et al. argue that psychological mindset training may lead to both improved entrepreneurial success and increased innovation practices. Finally, the researchers note that the training for the personal initiative program was cost-effective and paid for itself within one year. Further research from Ethiopia found similar results and argue that spousal support is critical for entrepreneurial success and that participation in the personal initiative training also resulted in an increase in spousal support.

In research related to energy entrepreneurs using a personal agency approach, Shankar et al. (2015a) compare sales performance of newly trained male and female cookstove entrepreneurs following a personal agency-based empowerment training. In this study, entrepreneurs were either enrolled in 4-day traditional business training or a 4-day personal agency-based empowerment intervention group. All groups were mixed-gender. Here, participants were led through relevant and meaningful exercises that emphasized locus of control remaining firmly with the individual and were instructed in cognitive re-framing and self-reflection processes to assess goal progression. Entrepreneurs from each group were followed for the subsequent eight months. Intervention group participants were found to be significantly more likely to demonstrate

business commitment over time, and nearly three times more likely to be higher sellers (those selling above the mean) compared with the business-trained control group (relative risk = 2.7, 95% CI [1.4, 5.4] controlling for both gender and rural/urban locale. Furthermore, women were found to outsell men by a margin of 3:1 and were more likely to persevere in pursuing leads despite limited sales. The results of this study demonstrate that women can successfully serve as improved cookstove entrepreneurs in both urban and rural settings, with empowerment training serving to equip these entrepreneurs with a sense of personal agency, confidence, and social solidarity with their fellow women entrepreneurs.

As a result of this recent study and subsequent research, the Empowered Entrepreneur Training Handbook (Smith & Shankar 2015) was developed as an open-source document with support by the Global Alliance for Clean Cookstoves (GACC). This personal agency-centered training was deployed through a trainer certification program that reached over 600 energy entrepreneurs via 67 trainers at 20+ organizations in Kenya, Tanzania, Uganda, Nigeria, India, Bangladesh, Nepal and Indonesia. The post-training monitoring showed increased sales volumes and numbers of high sellers among those trained. A return on investment (ROI) study conducted under real-life conditions found an ROI of 115.9% and a significant (10.6%) increase in monthly sales after the training program (Shankar et al. 2017).

6.2. Best practices to support the business

Access to finance and capital

Access to capital (as monetary services or goods) is one of the largest barriers faced by female entrepreneurs attempting to start and expand energy enterprises (IFC 2011; Bardasi 2011; Ellwell et al. 2014; Sigalla & Carney 2012; Clancy 2000; Baruah 2016; Amatucci & Crawley 2010; Pachauri & Rao 2013). There are numerous reasons why women face challenges when accessing credit: gender inequalities in land tenure and access make it difficult to demonstrate collateral needed to obtain a loan; cultural norms, such the requirement to have a male signatory on loans taken by women; and other gender discriminatory banking practices that discourage women's use of banking services and in particular, access to credit (IFC 2011; Bardasi 2011).

Women entrepreneurs are not a homogeneous group. The type of capital needed varies by entrepreneurial type. For example, community collectives, micro-entrepreneurs or SMEs come to the financial sector with different requirements, level of capital needed, and knowledge and skills. The stage of the business growth is also a critical consideration, whether it is a start-up, or working towards proof of market, or for business growth.

The primary mechanisms for accessing finance include commercial banks, equity funds, micro-finance or micro-credit lending organizations, and private investors. **Start-up capital** for female micro-entrepreneurs engaged in sales/distribution of energy products and services is critical to purchase initial inventory (such as cookstoves or solar lanterns) or energy provision equipment (such as a solar kiosk). In some cases, energy related programs working with micro-entrepreneurs can help entrepreneurs access **micro-credit** by negotiate for low interest loans with longer payback periods and can underwrite risk for micro-entrepreneurs by serving as the collateral when linking with financial institutions. Alternatively, enterprises can provide inventory through a **micro-**

consignment model wherein the entrepreneur pays back the inventory after making a first round of sales (Dutt 2012). This micro-consignment model puts the financial risk on the energy program or larger enterprise, rather than the entrepreneur and it allows the entrepreneur to test the product and their sales ability without making a large upfront investment. Social enterprises focused on energy distribution such as Solar Sister, have found that taking on the financial risk through micro-consignment was not an effective model to support business growth. Solar Sister initially provided products on micro-consignment but after high attrition rates, presumably due to limited commitment from the women, now require entrepreneurs to purchase stock upfront (Pailman 2016). While the micro-consignment model might be attractive to entrepreneurs of all backgrounds, the micro-credit model may only be attractive to those who already have experience taking and paying back loans. In fact, some studies have found that women from wealthier families were more likely to take the financial risk of taking out a microloan to support an entrepreneurial venture (Baruah 2016).

Case studies reviewed by Pailman (2016) demonstrate some of the diversity in methods and the need for energy programs to adjust their financing approach to both attract and ensure the sustainability of their entrepreneurs: For example, Nuru Energy requires a $60 commitment fee and then entrepreneurs finance solar lighting products through upfront orders; the African Renewable Energy Distributor (ARED) program requires entrepreneurs who want to run their solar powered mobile phone charging kiosks to pay 20% of the first lease payment (for the kiosk) up front; Juabar, who works with entrepreneurs in rural Tanzania who manage solar powered mobile phone charging kiosks, switched from an upfront payment to a deferred initial payment after one month of operations.

Angel investment, grant funding, or venture capital are important for small and medium enterprises when these businesses are testing and refining their business model, creating customer awareness, and generating demand for their product/service (Pailman 2016; Bardouille 2012; Van Leeuwen & Erboy Ruff 2014). While angel investing can be more flexible, these investors often expect higher rates of return. A study by Omidyar Network and the Monitor Group (2013) found that angel investment and venture capital comprised only 4 and 5% respectively of funding sources for African enterprises, and it can be assumed that these numbers would be even lower for women-owned enterprises. Grants, on the other hand, are generally tied to developing market solutions for specific social needs.

The case for gender equality in business, including entrepreneurship is strong, yet is remarkably underutilized (IFC 2017). Investors in businesses that have greater gender diversity have better returns and are able to adapt during times of economic volatility (IFC 2017). Moreover, there is growing evidence that when compared with to similar male business owners, women business owners tend to perform as well or better than their male counterparts (Du Reitz & Henrekson, 2000; Zolin et al., 2013; Robb and Watson, 2011; Shankar et al, 2015a). The same appears true of the banking sector, as the Global Banking Alliance (GBA) analysis of women-led businesses found they tend to have a lower risk profile and are more profitable for banks (GBA 2018). Yet, based on GBA's review of various government and private sector financing models, there few examples of programs geared specifically to increase access for women-owned MSMEs (IFC 2011). Box 6.1 outlines some key considerations for lending institutions to consider as they develop targeted financial solutions to better suit women's needs.

Box 6.1. Key considerations for financial services to support women led MSME

1. Understand that women may limit their own access to credit/fiancé (e.g. due to limited understanding of financial services, lack of collateral, informality of their businesses or inadequate documentation or record keeping).
2. Recognize there is a strong business case for lending to women (in general, their risk profile is lower, loans to women are more profitable than that of men, and women tend to have more robust savings accounts)
3. Customized offerings for the local context and markets (e.g. for new products or informal economic sectors)
4. Create paths for women to establish credit history, become bankable (e.g. bank accounts for individuals, rather than only males or household heads)
5. Modify the approval and delivery process for loans in areas where cultural norms may limit women's movement, travel, or interactions with others (e.g. use of mobile money)
6. Provide training and education for female entrepreneurs associated with financial literacy
7. Provide training and education of staff at financial institutions to more effectively engage with women entrepreneurs
8. Provide non-financial supports and advice for women on new products and markets including information on various financial services

Mentors and Networks

A large body of literature supports the need for on-going support and mentoring to provide female entrepreneurs with the training and support they need to excel (IUCN 2014; Pailman 2016; Amatucci & Crawley 2010; O'Dell et al. 2014). Coaching and mentoring are types of personal support provided to individual entrepreneurs. While definitions vary, enterprise mentoring generally refers to a one-to-one relationship, usually over a set period of time, in which an established businessperson (mentor) provides consistent support, guidance and practical help to a less experienced person (mentee) (Lowbridge 2011). Creating on-going touch points for mentoring and networking can help female entrepreneurs feel that they have a support network, to address business challenges as they arise and learn best practices from other entrepreneurs, and to expand their networks and reach. It tends to be a two-part process in which the mentor shares his/her personal skills, knowledge and experience with the mentee to enable him/her to explore his/her personal and professional situation, and in which the mentor and mentee work together to achieve predetermined goals and objectives. In the case of energy entrepreneurs, mentors with two types of skill are required, one to support business development and another to support the technological components of the energy product.

Depending on the available resources, meetings can be done face-to-face, and either one-on-one or with groups of entrepreneurs. The group mentoring, a popular form of enterprise mentoring, is often delivered as action learning sets where business owners comes together to discuss their challenges and issues. If regular face-to-face meetings are not possible, telephone mentoring, used in tandem with face-to-face mentoring allows more flexibility in deployment. Less frequently used for energy entrepreneurs in developing country settings is e-mentoring, where a mobile device is used to convey information. Interactive voice recording (IVR) that has been used in resource poor settings

where in-person mentors were not feasible. Table 6.1 provides some examples of the types of support reported by organizations for women's energy entrepreneurship.

Table 6.1 Examples of women's energy entrepreneurship organizations/programs and support provided

Programs	Business skills training	Personal agency training	Access to financial services	Coaching and mentoring
AEST	X	X	X	
Center for Rural Technology in Nepal, 'Promoting Women-led Enterprises for Energy Access and Local Production' (WEE-Nepal Project)&	X	X	X	X
Energy4Impact, Energy Opportunities for Women in Senegal (EOWS) project&	X	X	X	X
Juabar solar powered mobile kiosk, Tanzania^	X		X	
Kopernik Solutions, Wonder Women programme, Indonesia&	X	X	X	X
Frontier Markets	X		X	
Greenway Grameen	X			
Nuru Energy, Rwanda^	X		X	X
Livelyhoods	X	X	X	X
Practical Action/SCODE Women in Energy Enterprises, Kenya (WEEK) programme&	X	X	X	X
Solar Sister, Uganda, Tanzania and Nigeria (WEE Programme)^#&	X	X	X	X
Swayam Shikshan Prayog (SSP), India	X	X	X	X

^Pailman 2016
#Soria et al. 2016
&Dutta, 2019
<Kariuki and Balla 2010

6.3. Best practices for organizations or programs to support women energy entrepreneurs

Identify the right people

Requiring prior entrepreneurial experience or access to credit may limit who is able to participate in an enterprise's entrepreneurial opportunities, and often will be particularly limiting for women (Clancy 2000). While it is reasonable that enterprises might want to set criteria for their entrepreneurs, such as prior sales experience, owning of a shop, access to credit to purchase inventory, or energy technology knowledge, this will likely automatically reduce the number of women who are eligible for these opportunities. For example, a project in Zambia that was engaging entrepreneurs in the installation and maintenance of solar home systems required that all candidates have knowledge of electricity and electrical systems (Munyeme 1999). This requirement ruled out most female candidates, and without providing any training to give women these skills and knowledge, there was no way for women to overcome this barrier. Clancy (2000) points out that this overlooks the possibility that a woman could run the business while employing people with the required skills.

However, not everyone is suited to being an entrepreneur. Those individuals with some level of motivation and that are willing to learn are more likely to succeed (Dutta, 2019). While setting these criteria requirements can limit who is eligible for an entrepreneurial position, providing training specifically related to the skills the enterprise requires can help both male and female candidates to overcome these challenges. Moreover, specific trainings designed to enhance personal agency are critical (Shankar et al. 2015a; Campos et al. 2017).

Have the right product - Ensure quality assurance and quality standards

In many markets throughout the developing world, companies have struggled with convincing customers of the value and quality of clean energy products. Initially it can be difficult to convince someone to use a new clean energy product that seems entirely foreign. However, what is even more difficult is trying to win back their trust after they have purchased and used a clean energy product that they felt was of poor quality or quickly broke down. This is how many customers feel in rural markets and they are often hesitant to buy clean energy products out of fear of "fake" products. In order to overcome this challenge, it is important that there is a consistent system of quality assurance through standards and certification that helps establish trust in clean energy products (Pailman 2016).

Leverage and expand business networks

Business networks, especially for women, become an important source of new information, and means of obtaining social support with other entrepreneurs. Through improved social networks, women feel a greater solidarity with peers, appear to demonstrate greater financial independence and can gain greater respect in their communities (Brody et al. 2015). Existing networks can be used to recruit entrepreneurs. Enterprises that work with women's self-help groups and/or cooperatives build off of these existing structures and leverage their management systems as well as their trusting relationships. Engaging women through self-help groups and/or cooperatives may also help to overcome some of the challenges related to access to finance in that they are able to pool funds or may have already established a system of savings and loans within the group (Pachauri & Rao 2013). Other enterprises that recruit micro-entrepreneurs sometimes use existing women's groups as a resource to find women who might be interested in participating in their endeavour. For example, Solar Sister uses the community-based organization *Mothers Union* to identify its initial round of entrepreneurs to sell solar lanterns and clean cookstoves and Barefoot Power used groups such as BRAC Uganda and Uganda Micro-finance to identify individuals interested in serving as micro-entrepreneurs to sell their pico-solar lighting products and solar home systems (Pailman 2016). This presents a particular leverage point for either imbedding energy enterprises within these groups or using these groups to recruit micro-entrepreneurs.

Bundle services and provide targeted support

While each of the supports described above show significant value to women entrepreneurs, any of them alone is likely not to be sufficient to support long-term growth for energy businesses. There is compelling evidence that bundled services, such as the provision of a capital transfer (as cash or in kind), business training and on-going

supervision can be an effective support (Banerjee et al. 2015a). An excellent example of such a program in the non-energy sector is the graduation program designed to support the ultra-poor in Bangladesh and India that bundled intensive training, access to savings, capital in kind and as cash. A recent systematic review of several randomized impact evaluations of this program demonstrated significant benefits even two years after the intervention (Banerjee et al. 2015a). This is in contrast to a systematic review of randomized impact evaluations for micro-credit alone, which showed no impacts on poverty reduction over time (Banerjee et al. 2015b).

Within the energy sector, ENERGIA Women's Economic Empowerment (WEE) programme supported five implementing partners in Africa and Asia and used an integrated support package that included skills development on technical, business and personal empowerment, continued mentoring and financial advice on business planning and capital access as well as supported networks and partnerships between various actors in the energy sector. The WEE program supported over 4000 energy entrepreneurs that have resulted in significant economic empowerment for these women and access to energy products to more than 2.5 million people in 2017 (Dutta, 2019).

Use Digital Technologies

Box 6.3 Role of ICTs to advance women-led enterprises

1. Access to financing – mobile money enables users to send and receive money through a phone
2. Reduces need for women's physical mobility – mobile phones allow easy communication and reduce the need to travel
3. Reduces time constraints – because women can communicate with customers while staying at home and completing household chores
4. Improves access to information, education and training – and women who may otherwise be illiterate have the opportunity to learn to read
5. Diversified learning and data collection – with the range of ICTs and increasing access to the internet, ICTs can become a central conduit for supporting entrepreneurial growth
6. Increasing links to markets and expanded supply chains
7. Rapid communications related to changing environmental conditions

Digital technology is likely the most important innovation for scaling small and medium sized entrepreneurs to emerge in recent decades (UNCTAD 2014; Martinez & Nguyen 2014). Information and communication technologies (ICTs) have been changing the global landscape of entrepreneurship, especially in resource poor settings by facilitating how people communicate, what type of information they have access to and simplifying of the exchange of money. ICTs can directly address barriers that affect women and catalyse the growth of their enterprises. Box 6.3 outlines the primary ways ICTs can support women. In addition to the traditional methods of increasing communications, new forms of ICTs can enhance learning opportunities, mentoring and coaching support, linkages to markets and rapid feedback on community or environmental concerns. Increasing women's access to the latest technological advances in ICTs through reduced costs will be critical to build SMEs in energy-related businesses.

There have also been significant advances in behavioural trainings focused on addressing women's confidence and personal agency for micro and SMEs (Campos 2017), and specifically targeting clean cookstove entrepreneurs (Shankar et al. 2015a). Both of these randomized controlled trials of psychological approaches to business education are

consistent with best practices in the entrepreneurship literature (Neck & Green 2011), are designed to cultivate entrepreneurial and growth mindsets, and have shown significant improvements in sales growth, program retention, and innovation.

Engage men in women's programs

There is growing evidence that engaging men in programs targeted towards women can greatly improve the impacts of those programs for women and the family. This is due, in part, to the fact that gender norms at the household level are directly examined and addressed through their participation. This is important as women in developing countries experience time poverty through longer working days compared to men (Wodon and Blackden, 2006; OECD 2013). This large unpaid work burden is one of the biggest challenges to achieving gender-equitable economic development today: women are not able to fully participate in the economy and gain the benefits that would result from such participation due to the large amounts of time they are required to spend on household responsibilities such as cleaning, collecting water and fuel, cooking, and caregiving. Specifically, these unpaid care burdens limit the amount of time and effort that women can dedicate to entrepreneurial endeavours. A study among business owners in the Dominican Republic found that "almost half of the women owners report that household responsibilities frequently or occasionally impede them from dedicating sufficient time to their businesses compared to only 12% of the men. In contrast, male owners are more likely to report that help from family members is essential to the success of their businesses than are women, 54.1% compared to 42.6%, respectively" (Espinal & Grasmuck 1997). Similarly, the Upesi Stove project in Kenya – which involved women entrepreneurs in the distribution of stoves – found that a primary barrier to women's participation was that they didn't have enough time and could not be away from home for such long periods of time due to domestic and community responsibilities (Njenga 2001).

In addition to time, gender norms around investment in family may also influence how women entrepreneurs are able to grow their businesses. In the Dominican Republic, despite the fact that men entrepreneurs were earning about 20% more than women entrepreneurs, they were contributing roughly the same amount to their households (Espinal & Grasmuck 1997). This means that women were contributing a larger percentage of their income to their family compared to men. While this pattern of women's income contribution to for household needs differs by context, this can influence how much women are able to reinvest their earnings in the business, enabling it to grow.

A recent ILO-WED brief highlights the importance of engaging men at all levels - at the household, community and policy levels- in women's entrepreneurship. While existing interventions are increasing, most seek to engage men as either "gatekeepers" to gender equality or as potential agents of change in challenging established gender norms. Effective strategies towards this goal include providing capacity-building activities encouraging men to adopt positive masculinities, engaging them in trainings targeting women and identifying and supporting gender champions (ILO 2014).

Improve alignment of business model and market development with entrepreneur assets and community needs

Different types of business models may be more or less conducive to engagement of female energy entrepreneurs in different contexts. Sireau (2011) suggests that many micro-entrepreneurs in rural communities who run informal businesses don't have access to appropriate skills training, working capital, and the support needed to grow and expand their businesses. However, when they are linked in with a larger company through a micro-franchise model in which the company provides training, products, access to markets, and a standardized business model, this minimizes the risk for the micro-entrepreneur and enables him/her to succeed (Sireau 2011).

For micro-entrepreneurs engaged in selling and distributing energy products and services, their success may depend on what type of energy product/service they are selling. Thesis research conducted by Pailman (2016) found that micro-entrepreneurs were primarily engaged in the sales and distribution of energy products (such as Solar Sister who distributes solar lanterns and clean cookstoves) or energy services (such as Juabar and ARED who engage micro-entrepreneurs in managing solar kiosks for mobile phone charging). A key difference between these two models is that when selling products, sales agents need to find a new customer for each sale, however with energy services, there is a recurring revenue stream, as customers need to repeatedly use the service. Fuel sales could also be considered in this same category as there is an automatic creation of repeat purchases, as customers need to consistently purchase fuel as they deplete their supply through household and productive use. With the sale of energy products, female entrepreneurs may exhaust their network or the market can become saturated, however with energy services and fuels, there is a need for recurring purchases from established customers. In addition, clean energy products often have a slow turn-around time because customers consider it a long-term purchase – they may need a long time to consider the purchase and likely will not come back within a short period of time to purchase another, similar product (Pailman 2016).

In addition, due to the fact that women entrepreneurs engaged in sales and distribution often quickly exhaust their customer base after selling to relatives, family, friends, and other acquaintances, this can cause high levels of attrition among sales agents who, after selling to their immediate social circles, are not interested in taking their business to the next level of really learning how to become a marketer and saleswoman. Enterprises should consider the market dynamics before engaging women as sales entrepreneurs and companies should establish models that account for a significant proportion of attrition, knowing the social and structural obstacles that women face to participating as entrepreneurs. Engaging women in the sales of energy services or fuels may help to overcome this challenge through recurring purchases from existing customers.

In order for an entrepreneur to effectively sell energy products and services, there needs to be awareness among potential customers of the function and benefits of these products and services. It may be necessary for enterprises to be engaged in market building in order to generate demand for their products and services (Bardouille 2012). Beyond the normal product branding and marketing, there is a need for broader awareness raising and demand generation around the category of product offered, for example in addition to marketing a specific brand of solar lantern, the enterprise may

need to engage in efforts to generate demand around the need for solar lanterns more broadly and the benefits they bring to families (Pailman 2016).

In addition, an understanding of how these energy products and services are connected to climate change mitigation can both help these women be more effective sales agents, and also enable them to see the connections between their daily activities and a broader social and environmental goal (Bathge 2010). For example, India is currently implementing the Pradhan Mantri Ujjwala Yojana scheme, which aims to increase connections to clean cooking gas among rural households. Female entrepreneurs could explore how their work could fit under this scheme and contribute to the expansion of energy connections, or at a minimum, understand how the clean energy products they promote have some of the same ultimate goals as this government scheme. This is an area that needs further research, to understand what types of marketing and behaviour change communication, and education efforts can effectively increase purchase and adoption of clean energy products and services. More research is needed to explore quantitative differences in income potential and retention of entrepreneurs engaged in selling energy services and fuels versus those selling energy products. This research would be valuable in identifying the most effective business models for leveraging the contributions of female entrepreneurs while also ensuring that they are gaining a sustainable livelihood through this engagement.

Leverage trends in decentralization, privatization, and democratization as opportunities for women's engagement in clean energy value chains

In many places, governments are addressing geographic and logistical challenges related to energy expansion by decentralizing energy distribution. Policies that support decentralization of energy are essential for providing opportunities for women to become engaged in energy value chains and also to expand local economic activities through the productive use of energy (Misana & Karlsson 2001). However, it should be noted that these local actors may need capacity building in order to effectively serve in energy value chains. In order to create sustainable energy distribution systems, governments need to consider transferring technical capacity to the local level to ensure that people understand how to operate and repair energy systems (such as mini-grids) and can teach end users how to use energy products and services (Pailman 2016). Engaging women who are energy entrepreneurs to participate in local energy committees can start to shift other inequitable policies and structures within the community (IUCN 2014).

Across the developing world, we are seeing trends towards privatization and democratization of the energy sector (Kessides 2012; Estrin & Pelletier 2016). There is a trend towards neo-liberal economics in which governments reduce state subsidies and privatize the provision of basic services (Batliwala & Reddy 2003). While this can have a negative impact in that the government is passing off key responsibilities, it can open opportunities for private, market-based companies to come in with innovative, sustainable solutions– a process known as privatization, and also opens the door for non-governmental, non-profit, community organizations to provide these same services in a more equitable manner that is not necessarily based on one's ability to pay – a process known as democratization. It is important to recognize the different motivations and objectives of entities working to provide energy services from the private sector (e.g., maximizing profits) and from the non-profit sector (e.g., create equitable access to key resource). Although some entities do sit at a unique nexus in that they aim to apply a

market-based approach to provide energy services to last mile customers. Researchers have found that while non-profit groups might struggle with raising capital for larger scale service provision, they often succeed in providing lower-cost, equitable, and affordable services (Batliwala & Reddy 2003; McLeod 2001; GROOTS 2001).

At the same time that there is a shift towards privatizing and democratizing energy provision, there has been a proliferation of women's groups around the developing world, particularly in rural areas. These groups have the unique opportunity to capitalize on the democratization of energy service provision through well-established relationships in rural communities and a deep understanding of the local context. Furthermore, as bilateral and international development agencies such as the World Bank, IADB, and ADB have become frustrated with the slow pace and high levels of corruption associated with government-run poverty alleviation and service provision programs, they often shift towards supporting local, women-centred micro-credit and micro-enterprise groups in developing countries (Batliwala & Reddy 2003). While opportunities exist for local women's groups, micro-entrepreneurs, and SMEs to access this investment, there needs to be a more efficient system to link these interested donors with the local groups who have the ability to effectively execute energy distribution. And at the same time that local women's groups and the private sector can fill gaps in energy provision, efforts should continue to be made to advocate for more effective, equitable energy provision by governments themselves.

6.4. Conclusions

As women are increasingly engaged in clean energy value chains, it is crucial to understand what business models, practices, and enabling conditions are most effective for both scaling energy access and empowering women. The two roles where female micro-entrepreneurs seem to have been most effectively engaged in energy value chains is in the sales and distribution of energy products/services and in aftersales service, maintenance and repair. Sales and distribution roles may be more effective for the distribution of smaller home products and women's roles as technicians may be better suited for larger solar home systems (Pailman 2016). Engagement in aftersales service, maintenance and repair may be more attractive to women for poorer households as this involves less capital risk, helps them to gain technical skills that can be used in their professional and personal lives, and doesn't require that they consistently find new customers outside of their social networks (Baruah 2016; Cecelski 2000; O'Dell et al. 2014). For example, in addition to sales and distribution, entrepreneurs working with Solar Sister and Nuru, are trained to provide after-sales service to customers (Pailman 2016), Grameen Shakti trains women in Bangladesh to repair and maintain solar home systems and other renewable energy technologies (USAID, 2014); and in India and Africa, Barefoot College trains poor, illiterate women to be solar engineers, enabling them to install and repair solar equipment (Misana & Karlsson 2001). However, as evidenced by Solar Sister and Nuru's business models, these roles may need to be combined with sales and distribution to ensure sufficient business. Furthermore, emerging evidence suggests that women's engagement in selling energy services and fuels may be a more effective role, than selling energy products, by ensuring that women are able to earn a sufficient and consistent income through their energy business. However more research is needed to explore and compare the income potential and retention of female energy

entrepreneurs involved in selling energy services and fuels, versus those selling energy products, versus those involved in aftersales services, maintenance, and repair.

From the research it is clear that access to financing is one of the largest barriers that female entrepreneurs face in starting and growing energy businesses. More research is needed to better understand they types of financing mechanisms are most effective in supporting female entrepreneurs through different forms of engagement (e.g., collectives, micro-entrepreneurs, SMEs) and growth stage. For example, some studies have found that micro-consignment models may be more effective for micro-entrepreneurs in that they do not have to take on the financial risk of purchasing inventory and it enables them to avoid the potential challenge of mixing household and business expenses (Dutt 2012; IUCN 2014). However, other initiatives have found that entrepreneurs do not have enough buy-in to commit to the engagement with the company without some sort of upfront investment. Clearly there is a need for de-risking the entrepreneur's investment and engagement, but more research in needed to understand which financing models are most appropriate for particular business models, and a in variety of contexts.

In general, there has been a shift towards decentralized and democratized systems for energy distribution, with players from both the for-profit and non-profit sectors filling in energy access gaps. This supports the rationale for engaging women as micro-entrepreneurs and through women's groups. These women are able to reach last-mile customers, they understand customers' needs, as they live in a similar setting, and they are able to leverage existing social networks and form trusting relationships with customers. As the quantity of women's groups increases throughout the developing world, this also presents a platform to leverage for identification and engagement of female entrepreneurs (Batliwala & Reddy 2003).

7. KEY MESSAGES FOR WOMEN'S ENERGY ENTREPRENEURSHIP, POLICY, PRACTICE AND RESEARCH

While more research is needed, this review suggests that energy entrepreneurship may provide a unique combination of inputs for transforming women's lives through the provision of an income-generation opportunity and also a time-saving technology that has the potential to both reduce women's unpaid care work and increase the value of women's labour. This comparative systematic literature review set out to answer key questions related to the existing evidence to support women's entrepreneurship as a viable means of advancing energy access for all and its potential to contribute to numerous other Sustainable Development Goals. Due to the scant literature available on women's energy entrepreneurship, it is clear that there is not sufficient data available to strongly support these assertions.

However, there are numerous programs and projects worldwide that are actively engaging with women along the energy value chain, ranging from informal to formal businesses, as individual entrepreneurs or are part of collective. Many of these projects have shown significant progress. Unfortunately, the methods of engagement to support women energy entrepreneurs are not sufficiently robust to catalyse small, medium and high potential women's businesses in the energy sector. Moreover, programs generally fail to understand the cultural gender system and the specific entrepreneurial ecosystem with sufficient depth and foresight to manage barriers and roadblocks. Within the context of energy related business, a clear understanding of the customer's journey with new technological products is necessary to prevent loss of market share or income due to fluctuating revenues.

What is clear is that experts, academics, policy makers and program managers from multiple disciplines and fields should participate in working towards solutions. Perspectives from business, health and gender provide new insights ways to examine the intersections within the gender system. In addition, integrated interventions require rigorous testing prior to deployment and scale up.

While there was very little rigorous evidence that used quasi-experimental or quasi-experimental methods, this review identified intersections, key considerations, and opportunities for women's energy entrepreneurship. There are clear program and policy messages as well as research recommendations to be drawn from this literature review. On the programmatic and policy side, we propose the following messages are important to communicate and integrate into clean energy interventions and enterprises:

1. Women's energy entrepreneurship has great potential to benefit women, their families and to distribute energy products and services to their communities.

2. These benefits can be enhanced if there are sufficient supports to these women and their businesses.

3. Expanding women's engagement in energy businesses should not be considered a strategy for poverty alleviation and has potential risks unless there are sufficient supports in place.

4. Proven effective strategies for entrepreneurship support that should be adopted by programs included bundled business services, personal agency and initiative training, coaching/mentoring, use of information technologies support, and engagement of men both at home and in the community.

These programmatic and policy recommendations are drawn from the understanding that:

- Women engage with energy-related services and products in numerous ways, not only as classical entrepreneurs and as such policies should reflect these differences

- Engaging women as micro-entrepreneurs in energy-related businesses may not be the best option for poor women who are not able to take on the financial risks associated with entrepreneurship. Initiatives that want to target the poorest women, should consider business models that reduce risks for individual entrepreneurs and leverage social capital

- Women should be better integrated throughout the energy value chain in order to influence energy technology products and services through design and production, shape who gains access to these products and services, and impact how they are used

- Engagement of women in sales and distribution of energy products/services and in aftersales service, maintenance, and repair seem to have the most effective engagement and sustainable earning potential for female entrepreneurs

- Business models that engage women in selling fuels, energy services, or a variety of energy products or in aftersales service may be more sustainable than business that only sell one product in that women entrepreneurs are able to secure repeat purchases from the same customers

- Greater experimentation should be done to determine effective programs to increase access to adequate financing for entrepreneurs engaged throughout energy value chains (e.g., design, production, sales, or aftersales), in different modes of engagement (e.g., through self-help groups, as micro-entrepreneurs, or as owners of small/medium businesses) and in different growth stages (e.g., subsistence, small/medium businesses, high-growth businesses)

- Information and communication technologies (ICTs) are important components of supports for women's energy businesses and should be expanded

- Targeted coaching and mentoring is critical to strengthening women-led businesses and should include role models and mechanisms to broaden social networks

- Personal agency-based empowerment training should be central to all educational training for women in energy businesses in order to address confidence and personal initiative

- Involvement of men in women's entrepreneurship programming to challenge existing gender norms and legitimizing ideologies, can enable women to spend more time on their entrepreneurial endeavour and to determine how to invest their own earnings

- Energy entrepreneurship may lead to shifts in perceptions of women's capabilities in non-traditional sectors, thus influencing gender norms, but is not on its own, a solution to gender inequality

- Interventions that target only one aspect of the gender system are unlikely to succeed, and a broader systems approach is required

- In order to actually contribute to gender equity, enterprises and programs need to be aware of and aim to influence social and institutional structures that create barriers for female energy entrepreneurs; this includes training at the individual level, community mobilization, and policy advocacy

- Integrated interventions that include several inter-linked components are more likely to support women's growth and businesses

- Interventions should use a gender-aware approach in their development so that offerings directly address the specific challenges that women face

This review suggests that there is a need more for rigorous experimental and quasi-experimental research to explore connections between women's energy entrepreneurship and access to energy, benefits for women and their families, and the types of training that are most effective. Here we outline a few key questions identified for further research:

- **What are the pros and cons of different types of women's energy engagement/entrepreneurship and how are they effective at expanding energy access**? This review presents a few studies that show that women energy entrepreneurs are able to effectively expand energy access for rural communities. However, more experimental and quasi-experimental research is needed to understand where within the value chain (e.g., design, production, sales, or aftersales) and in which mode of engagement (e.g., through self-help groups, as micro-entrepreneurs, or as owners of small/medium businesses) the skills and contributions of women entrepreneurs have the greatest potential to expand energy access. Studies should specifically compare the contributions of female and male entrepreneurs.

- **Which types of energy entrepreneurship provide the most sustainable income-generation options for women?** In order to understand which types of energy entrepreneurship opportunities create the most sustainable income-generation opportunities for women (such as consistent and sufficient earnings, formal contracts and job security, and social protections including insurance, leave, and other benefits), more systematic research is needed to compare the different

roles that women entrepreneurs play throughout energy value chains, as well as in mode of engagement within and across resource-poor contexts. This research should look at the benefits associated with women's engagement in selling energy products versus fuels or energy services that require repeat purchases. Moreover, research to compare energy entrepreneurship with entrepreneurship in other sectors such as retail, food services, business services, software/technology, and manufacturing is needed. Understanding which types of financing models are best suited for different types and stages of entrepreneurship is key as well as research to address product/service offerings, the customer value propositions, customer journeys—all factors at the centre of the business model—and how and why gender might matter for the sales process. In addition, due to the fact that financing is context-specific, research could explore the key factors that enterprises needs to look at in order to determine which financing method will work best for them. It will be important to understand differences in business model characteristics of the types of businesses started by men and women. This is a nascent area of research within the business management research more broadly, but could also be specifically explored for small, medium, and high-growth energy businesses. This research should put the product/service offering and the customer value proposition at the centre of the business model and seek to understand how this is done differently by men and women and how this impacts the success of the business. More specifically, this research should explore the potential of cooperative business models, which seem to be on the rise in developing countries.

- **What are the connections between women's energy entrepreneurship, the value of women's time and labour, and the use of time-saving energy technologies?** More research is needed to understand whether a woman's participation in energy entrepreneurship changes how her family values her time and labour and whether this therefore motivates families to purchase time-saving energy products or services (e.g., cleaner cookstoves and fuels, electric ovens, washing machines, etc.). Similarly, further exploration is needed to assess whether the presence of an energy entrepreneurship opportunity results in greater likelihood of spending time saved through the use of an energy-efficient energy technology on income generation and ultimately shifting the value that families and communities place on women's time and labour. As part of this question, understanding whether community norm change interventions can help unleash opportunities for female energy entrepreneurs would be critical. This literature review showed that one of the barriers that hold women back from energy entrepreneurship are the gender norms associated with the "gender system." While individual agency-based training can help women to overcome some of these barriers, research should explore the impacts of community norm change programming, such as working with male partners of female entrepreneurs and doing community awareness raising related to women's participation in income-generation, and on women's ability to participate and excel in energy entrepreneurship.

- **What are the differences in gender barriers faced women energy entrepreneurs engaged at the subsistence level, in small and medium businesses, and in high-potential, high-growth businesses**: While the business models and types of challenges encountered at these different levels of

entrepreneurship vary greatly, little to no research has looked at the different gendered barriers that women energy entrepreneurs face at each level. More research is needed to explore these gendered barriers so that enterprises, enterprise development programs such as NGOs, incubators, and accelerators, and government policies can appropriately target and support women energy entrepreneurs at each level. Understanding that coaching and mentoring is key for all stages of entrepreneurship, understanding how to most effectively support and meet the specific needs of each type of entrepreneur to start and grow businesses is important. While it is clear that personal initiative and agency-based empowerment training has the potential to increase women's ability to be effective energy entrepreneurs, more research is needed to understand how to adapt these training methods to different types of entrepreneurs and different enterprise business models. In addition, more research is needed to explore how innovative ICTs can be used to expand the reach and frequency of contact for coaching and mentoring programs.

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ANNEX 2 : METHODOLOGY

In total, 15 separate search terms were used: 1) (gender OR women) AND energy entrepreneurship; (gender OR women) AND energy; 2) (gender OR women) AND entrepreneurship; 3) (gender OR women) AND clean energy; 4) (gender OR women) AND clean energy entrepreneurship; 5) (gender OR women) AND entrepreneurship policy; 6) (gender OR women) AND entrepreneurship policy; 7) (gender OR women) AND energy policy; 8) (gender OR women) AND clean energy policy; 9) (gender OR women) AND (small and medium (enterprise OR business) OR SME); 10) (gender OR women) AND (small and medium (enterprise OR business) OR SME) AND energy; 11) (gender OR women) AND (small and medium (enterprise OR business) OR SME) AND clean energy; 12) (gender OR women) AND entrepreneurship AND financing; 13) (gender OR women) AND energy entrepreneurship AND financing; 14) (gender OR women) AND clean energy entrepreneurship AND financing; 15) (gender OR women) AND (small and medium (enterprise OR business) OR SME) AND energy AND financing.

During the initial search, database searches were replicated by a second researcher to ensure validity and thoroughness of the methodology. Exclusion criteria were applied to filter the searches to the most relevant topics and included terms such as “pregnant,” “overweight,” “consumption,” and “diet.” Utilizing such a wide scope allowed us to gather and code articles across a wide range of relevant fields, e.g., entrepreneurship, sociology, economics, environmental sciences, gender studies, etc., adding depth and complexity to our systematic literature review. Newspaper articles, blog posts, legislation, interviews, and magazine articles were excluded from the analysis. The remaining articles were downloaded and saved in a Zotero database.

Article abstracts were then reviewed for those that explicitly investigated gender and entrepreneurship in the energy sector and that made reference, directly or indirectly, to the presence of women pursing entrepreneurial opportunities within the energy sector. The final sample of articles were systematically coded by bibliographic information (including country of origin and type of publication); methodology and sample population; level of analysis (individual, household, business, social/community, or institutional/policy), sample description, key findings, and fit with our key research questions. Due to the potential diverse representation of primary sources, reports were also coded based on the methodological or theoretical rigor and data relevance.

Fieldwork based case studies: The fieldwork had two primary goals. The first was to identify case studies of women entrepreneurs currently working within the energy sector and the second was to collect primary data on the contribution of energy entrepreneurship to several Sustainable Development Goals (SDGs), specifically the potential impact on energy access for all individuals (SDG7) and associated goals including overall gender equality for both the entrepreneur and the consumer (SDG5), promotion of health and well-being (SDG3), poverty alleviation (SDG1), and sustainable economic growth (SDG8). The fieldwork took place in three countries of East Africa – Kenya, Uganda and Rwanda. The fieldwork consisted of country visits by two members of the US-based research team and nine students from the InnoEnergy Masters MSc SELECT program. Fieldwork was organized by Dr. May Sengendo (Makerere University) in Uganda and by Energy 4 Impact in Kenya. The student team included Agata Mucha (MSc SELECT), Laura Broleri (MSc SELECT), Markus Schwenk (MSc SELECT), Rudolph Santarromana (MSc

SELECT), Akila Fernando (MSc SELECT), Lalitha Srilal (MSc SELECT), Sachintha Rathnayake (MSc SELECT), Mihirani Kethumalika (MSc SELECT), and Muhammad Awais (MSc SELECT).

The research team completed 154 interviews during fieldwork in Uganda and Kenya. Several in-depth interviews were conducted with a range of female entrepreneurs in both Uganda and Kenya to provide more detailed understanding of the challenges of energy businesses. In addition, in-depth interviews were done with three female entrepreneurs selected during the fieldwork activities and reported here as case studies. The case studies selection was based on the following scenarios:

1) A member of a community cooperative that makes clay cookstoves liners, a common type of entrepreneur encountered in Kampala, Uganda;

2) An early stage briquette entrepreneur woman in Uganda involved in sales and distribution; and finally

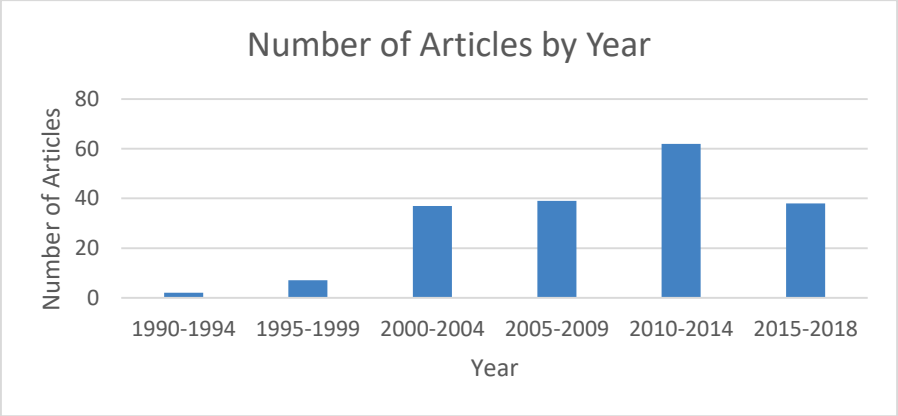
3) A high potential solar roofing entrepreneur working in Kenya to describe a success story of a businesswoman in the corporate world.

Literature review citation numbers

Search Returns	Number
Initial Search	12,474,493
Filtered	595
Coded	208
Q1	75
Q2	45
Q3	108

In our in initial analysis of the search results, we looked at publication patterns, including years, publication types, geographic regions, and relevance to our key research questions. While the literature covered the period from 1998 to 2018, however, the number of relevant articles increased significantly between 2000-2004, and again from 2010-2014. We identified 14 types of publications from 141 unique publishing bodies, including 55 different journals. The majority of articles were peer-reviewed journal articles, reports, or case studies.

Categorization of articles by year of publication



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