

GENDER AND ENERGY: OPPORTUNITIES FOR ALL



IDS Bulletin

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Gender and Energy: Opportunities for All

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Introduction: Gender and Energy – Opportunities for All*

Ana Pueyo¹

Abstract The global drive to provide universal access to sustainable and modern energy by 2030 is creating numerous opportunities for energy users and suppliers. However, men and women do not benefit equally from these opportunities. As users, they have different energy needs linked to their different gender roles. Gender blindness in the sector has led to women's needs often being ignored. As suppliers, the energy sector has traditionally been male dominated. Despite stark gender differences in the energy sector, there has been a lack of evidence to inform more equitable policymaking. This issue of the *IDS Bulletin* aims to fill some of these evidence gaps through five original papers, part of ENERGI'A's Gender and Energy Research Programme. The issue pays particular attention to women's involvement in the supply chain as energy entrepreneurs, an emerging area of research in the gender and energy space.

Keywords: gender, energy, development, entrepreneurship.

1 Introduction

Achieving the global goal to provide universal access to sustainable modern energy by 2030 (Sustainable Development Goal 7 – SDG 7) will require huge effort and great creativity. At the same time, universal access cannot be achieved without ensuring gender equality (SDG 5). The transformative insights of the last 20 years show that women's and men's energy needs differ, particularly for marginalised people in low-income countries. Furthermore, women's contribution to energy planning, supply, and policymaking is marginal, as the energy sector is heavily dominated by men. Universal energy access cannot be achieved without women being able to use the modern energy services they need. However, energy supply interventions have traditionally been gender blind. That is, they assume that the provision of modern energy services will automatically benefit both men and women. This error is compounded by the lack of gender-differentiated data on energy supply and demand.

This issue of the *IDS Bulletin* compiles a selection of articles on gender and energy, contributing to filling the evidence gap. The articles result



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from the Gender and Energy Research Programme, managed by ENERGIA and financed by the UK Department for International Development. ENERGIA is the International Network on Gender and Sustainable Energy, founded in 1996, with the goal of providing energy sector stakeholders with evidence and advocacy to improve the gender equality of their projects, programmes, and policies.

The Gender and Energy Research Programme ran for five years (2014–19), involving nine research teams, with 26 partners carrying out research in 12 countries in Africa and Asia. The aim of the programme was to create and analyse empirical evidence of the benefits of taking a gender approach in energy access interventions, and to translate this evidence into recommendations for energy policy and practice. The research programme delivered nine studies on the gender and energy nexus under the following thematic areas: electrification, productive use of energy, energy sector policy dynamics, energy subsidy reform, the role of the private sector in scaling up energy access, gender mainstreaming approaches, and global trends in gender and energy. The findings of all research projects are synthesised in a final report (ENERGIA 2019), as well as in final project reports which can be found on the ENERGIA website.²

2 Providing universal access to modern energy can bring opportunities for all

An overview of the literature on the gender and energy nexus shows that the initial aim was to make the case for a gender-differentiated approach to energy provision. It focused on the demand side, proving that women suffer disproportionately from the effects of energy poverty in their role as carers within the household (Parikh 1995). Cooking, for example, is a key topic in the literature about the gender–energy links because women have the responsibility to prepare family meals in virtually all countries in the world. They are also responsible for sourcing the energy required for the task, predominantly firewood or charcoal when modern energy is not available. As a result, they endure the drudgery of fuel collection and inefficient cooking and the health effects of indoor air pollution, thereby causing and perpetuating gender inequalities (Foell *et al.* 2011). But women's energy needs go far beyond cooking, as many other household tasks are gendered, such as water collection, pounding grain, washing clothes, and cleaning (Cecelski 2006). Researchers have also been very interested in analysing the effect of households' access to electricity on women's labour supply, concluding that women's labour time and income increase as electricity reduces household drudgery and improved lighting increases the length of the day, hence making more time available for other productive tasks (Pueyo and Maestre 2019).

The gendered dimension of energy supply and policymaking have until recently remained unexplored in the literature. This is despite the evidence that the energy sector is clearly dominated by men. For example, in the USA only 15 per cent of employees in oil and gas are women, and that number shrinks further for higher-paying

technical jobs (Mehnert 2019). IRENA (2019) estimates that women's participation in the renewable energy sector is higher than in the energy sector as a whole, employing about 32 per cent women, compared to 22 per cent in the energy sector overall. Still, it remains significantly smaller than men's participation and even smaller in jobs related to science, technology, engineering, and mathematics (STEM).

The exponential growth in renewable energy investment and the global drive towards universal access to modern energy are bringing enormous opportunities for workers and entrepreneurs in this sector. An estimated annual investment of US\$4.4bn is required to provide clean cooking solutions to the 2.9 billion people yet without access. Universal electricity access requires an annual investment of US\$51bn to reach the 840 million without coverage (SEforALL 2019). It is therefore imperative that research and practice in gender and energy move beyond men's and women's roles as users to look at their roles as policymakers and in the energy services supply chain, so that they equally shape and benefit from future energy systems.

While the existing literature on women's energy entrepreneurship is limited, it is growing, with a preponderance of grey literature informing policy and programmes (Dutta 2018). This issue of the *IDS Bulletin* aims at mitigating the lack of evidence on energy and gender in general and on gender and energy entrepreneurship in particular. The issue starts with an article setting the scene for the gender and energy nexus within global trends influencing progress and recession in global access. Three articles on gender and entrepreneurship constitute the core of the issue. The final article discusses doing research for influencing policy, drawing on ENERGIA's experience with the Gender and Energy Research Programme.

3 Contributions to this issue

The first article, by Rebecca Pearl-Martinez (this *IDS Bulletin*), sets the scene, identifying six global trends that could catalyse the closing of energy access gaps around the world and showing how these trends relate to gender inequality. Some of the trends positively support attaining universal access, namely: decentralisation of energy generation and distribution; rapidly declining renewable energy technology costs; proliferation of mobile connectivity; and increase of women's business ownership. Two other trends put universal access at risk: the increasing population in urban informal settlements and in humanitarian settlements.

The positive trend of women's entrepreneurship offers a particular opportunity to expand energy access by empowering women to reach those at the last mile. Expansion of decentralised energy supply could become a major source of income generation for women, especially at the base of the energy ladder but also further up the value chain. The article reflects on women's unique relationship with and understanding of female energy consumers, who are often the primary managers of

household energy. Some additional benefits of targeting women are that they are often a lower risk and repay loans more frequently than men, and that they reinvest more of their income than men in their families and communities. However, women face more constraints than men when creating and growing their businesses. The article hence makes the case that women's entrepreneurship requires support beyond the business realm for women's empowerment more generally.

The second article, by Anita Shankar, Amanda B. Elam, and Allie Gliniski (this *IDS Bulletin*), takes forward this theme by carrying out a thorough literature review to gain a better understanding of how to support the larger ecosystem in which women's energy entrepreneurship resides. Drawing from recent theories of gender and entrepreneurship, the article concludes that as a result of traditional gender beliefs, women entrepreneurs face barriers in access to and mobilisation of five forms of capital: economic, social, time, cultural, and symbolic. It then makes the case for bundled services, targeting several of those constraints at once, such as access to finance and capital; access to coaches, mentors, and business networks; business education and skill development; training to foster personal agency, personal initiative, and entrepreneurial mindsets; and the inclusion of men within women's energy entrepreneurship programming. These diverse types of programme support can break the myth of female underperformance and address all forms of capital, including the legitimacy of women entrepreneurs.

The third article, by Manuel Barron, Rowan Philip Clarke, Amanda B. Elam, Rebecca A. Klege, Anita Shankar, and Martine Visser (this *IDS Bulletin*), delves deeper into the myth of female business underperformance, a crucial point of debate within the field of management studies. The article is an exploratory pilot for a wider randomised controlled trial in 272 villages in Rwanda comparing the business performance of women and men entrepreneurs selling solar lights. It challenges the underperformance hypothesis with empirical evidence showing that women outperform men in the sale of solar lights to the ultra-poor. The argument that women's engagement in the energy sector improves access and distribution of energy for those most underserved is therefore reinforced. Barron *et al.* provide a key contribution to the field, as no studies to date have compared the performance of female-led and male-led firms in a controlled research design where men and women sell the same products under the same terms and in the same cultural context. The findings are encouraging news for empowerment programmes aimed at promoting female entrepreneurship, showing that recruiting women is actually good for business. Nevertheless, and echoing the previous article by Shankar, Elam and Gliniski (this *IDS Bulletin*), the authors recommend involving men in the process to avoid pushbacks from the village patriarchy.

The fourth article, by Soma Dutta (this *IDS Bulletin*), provides a case study of an intervention to develop women's enterprises in the

clean energy sector. ENERGIA's Women's Economic Empowerment (WEE) programme, running since 2014, has supported more than 4,000 women in the clean energy business, delivering energy products and services to 2.9 million customers. Like the trial in the previous article, the WEE experience challenges the female underperformance hypothesis, showing that women entrepreneurs are effective in last-mile distribution of modern energy solutions through their social networks. Echoing Shankar, Elam, and Gliniski (this *IDS Bulletin*), WEE shows the value of bundled services supporting women entrepreneurs, such as technology and business skills upgrading, empowerment and agency building, sustained mentorship support and trust-based one-to-one selling approaches. However, the article argues that an approach focusing only on the individual entrepreneur is insufficient for women to thrive. An ecosystem approach that places equal emphasis on the enabling environment and the entrepreneur is more likely to deliver sustainable results. The programme's outcomes were visible for both entrepreneurs and users. Entrepreneurs showed consistent growth in profit margins, repayment of loans, feelings of empowerment, and higher involvement in major household or business purchase decisions. Furthermore, users in communities where women were supported with the WEE programme showed more trust in the products and suppliers, and a higher willingness to pay for solar lamps or improved cookstoves.

The final article, by Annemarije Kooijman-van Dijk (this *IDS Bulletin*), highlights wider findings and policy implications from the nine research projects of ENERGIA's Gender and Energy Research Programme. One such finding is that energy demands are not necessarily met equitably for men and women, even when energy supply is physically available. These gendered differences are evident not only in households, but also in income generation in agriculture and in non-farm activities. The article also reflects on aspects of research design for influencing policy, concluding that, in the ENERGIA Gender and Energy Research Programme, multimethod and multidisciplinary approaches have been essential in developing insights into mechanisms and factors at play and that the perspective of local women and men is needed to reflect the dynamic local reality of power relations and norms.

This *IDS Bulletin* allows us to better understand the gender and energy nexus and to go one step ahead of the existing literature on the topic, stressing the role of women in the supply chain. The issue aims at an audience of international policymakers working for the SDGs, national governments, departments of energy, gender or economic development, energy supply businesses, non-governmental organisations (NGOs,) advocacy organisations, civil society organisations, and academic audiences. The issue, however, shows only a glimpse of the extensive research that took place as part of the Gender and Energy Research Programme. We invite our readers to further explore the rich evidence that was gathered and to engage with the ENERGIA network of research and practice.

Notes

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2 www.energia.org/research/gender-energy-research-programme/

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Global Trends Impacting Gender Equality in Energy Access^{*†}

Rebecca Pearl-Martinez¹

Abstract Achieving a just and equitable transition to a sustainable energy system will rest on efforts to address gender inequality. Women in developing countries are impacted by energy poverty in far greater numbers than men, and they do not have the same opportunities as men to take advantage of emerging opportunities that can help deliver energy access for marginalised populations. This article, geared to policymakers, brings attention to six global trends – decentralisation of energy services, affordability, mobile payments, women’s entrepreneurship, urbanisation, and humanitarian settings. Achieving energy access for all, as called for under Sustainable Development Goal 7, will require attention to the ways in which these trends drive or hamper gender equality in energy access.

Keywords: energy access, energy poverty, gender equality, decentralisation of energy services, affordability, mobile payments, women’s entrepreneurship, urbanisation, humanitarian settings, Sustainable Development Goals.

1 Introduction

Energy systems are undergoing rapid, significant, and disruptive change. A number of major trends² are under way that could catalyse the closing of energy access gaps around the world. Positive trends include the decentralisation of energy generation and distribution to reach remote areas, rapidly declining technology costs, the proliferation of mobile connectivity for communication and finance, and the increase of women’s business ownership in some developing countries. Trends that are problematic for energy access include the increasing populations in urban informal settlements and in humanitarian settings.

However, gender inequality impedes the leveraging of these trends to expand energy access to those who need it most. Women in developing countries are impacted by energy poverty in greater numbers than men, and they do not have the same opportunities as men to take advantage of emerging opportunities that can help deliver energy access for marginalised populations (ENERGIA 2019). Fewer women than men

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Table 1 Trends carrying gender implications in energy access

Trend	Implications for gender equality
Decentralisation Energy services are increasingly decentralised	The expansion under way of off-grid and mini-grid energy access solutions presents new opportunities to close gender gaps by reaching those not served by the grid
Affordability Energy services are increasingly affordable	With improving technology and increasing scale, energy services are becoming less expensive and consumer financing packages help to put connections within reach
Mobile payments Access to mobile payments is expanding	Mobile money and other digital innovations can be leveraged to propel women's access to off-grid and clean cooking solutions, as well as their entrepreneurship
Entrepreneurship Women's business ownership is on the rise in many countries	The upward trend in women's entrepreneurship is an opportunity to expand energy access by empowering women to help close the access gap at the last mile, reaching those who would not be reached by business-as-usual approaches
Urbanisation The world's population is increasingly urban	Securing reliable electricity and clean cooking access for women and men living in slums and peri-urban areas enables livelihoods, as well as the legitimacy and economic contribution of urban settlements
Humanitarian settings More people live in humanitarian aid settings	Humanitarian agencies should shift away from diesel-generated power towards renewable-powered electricity and provide clean cooking solutions to pre-empt the need for residents to collect firewood

Source Author's own.

own mobile phones (Intel 2013), gain access to financing (World Bank 2017b), or even have a voice in household decision making on energy matters. These realities hinder the potential for achieving universal access to sustainable energy by 2030, as called for under Sustainable Development Goal 7 (SDG 7). Delivering sustainable energy to all women and men and their children requires a greater focus on gender equality in both the delivery of and the beneficiaries of sustainable energy services.

This article brings attention to the ways in which key global trends drive – or hamper – gender equality in delivering sustainable energy solutions. The research was carried out during 2017–18 for the development of the *Levers of Change* report, which was published by Sustainable Energy for All (SEforALL) and ENERGIA, International Network on Gender and Sustainable Energy, and funded by the UK Department for International Development (DFID) (SEforALL 2018). The primary audience of that report, and thus this article, is policymakers and practitioners.

The six selected trends are: (1) decentralisation of energy services, (2) affordability, (3) mobile payments, (4) women's entrepreneurship, (5) urbanisation, and (6) humanitarian settings (see Table 1 for a summary of gender implications). The criteria used to select trends were: global significance and magnitude of the trend, including any evidence of the trend's urgency; availability of evidence to demonstrate correlation to gendered and inclusive access to electricity and clean cooking; balance of trends that are economic, social, or technological in nature; readiness of interventions that could be pursued by policymakers and, secondarily, other actors in the external audience; and potential alignment with the mandates of project partners SEforALL and ENERGIA.

The article first reviews why gender equality is important in energy access. Section 3 follows with a summary of how each trend impacts gender equality in energy access, and Section 4 concludes with suggested policy implications.

2 Why gender equality matters in energy access

Achieving a just and equitable transition to a sustainable energy system will rest on efforts to address gender inequality (ENERGIA 2019). To close the global energy access gap, governments and other actors need to reach the 1.06 billion people worldwide who do not have electricity and the 3.04 billion people who do not have clean cooking solutions (IEA and World Bank 2017).

2.1 The global energy access gap is gendered

Women in developing countries – who make up the majority of those living in extreme poverty – are those most affected by energy deficits. Equally important, or perhaps more important, women are key agents in tackling energy poverty. Women are the primary energy managers in households and are economic actors positioned to drive economic growth (ENERGIA 2019). They are uniquely networked with energy consumers in poor households, a particularly critical role at the 'last mile' where centralised grids are out of reach (Glemarec, Bayat-Renoux and Weissbein 2016; Gray, Boyle and Yu 2016). Yet women face tremendous barriers in accessing land tenure and financial services (World Bank 2017b), and they are more vulnerable to climate-induced weather events. Without access to clean cooking solutions, millions of women and children face significant illness and premature death from indoor air pollution. In addition to the devastating impact on quality of life and wellbeing, women and girls are forced to divert multiple hours per day collecting biomass for cooking, time that could be spent on educational and productive activities (Duflo, Greenstone and Hanna 2008).

2.2 The potential of policy frameworks, and the challenge of implementing them

The global policy frameworks on sustainable development and climate change, which intend to support those most affected by energy poverty, have made headway over time in integrating a gendered response in

policy language. However, the implementation of these goals and plans remains a challenge.

Through the 2030 Agenda for Sustainable Development, governments committed to leave no one behind and to prioritise those furthest behind in achieving the SDGs. Linkages between the SDGs give light to an overall agenda committed to addressing gender inequalities in energy access. Universal access to affordable, reliable, sustainable, and modern energy, SDG 7, is a fundamental component of achieving SDG 1, ending poverty in all its forms everywhere. Both of these goals are linked to SDG 5 on women's rights to economic and natural resources, the enhanced use of enabling technology, and the prevention of violence against women and girls. Other important linkages include SDG 13 on climate change action and the Paris Agreement, which recognised the intersection of climate change and gender equality.

While significant activity is already under way at the intersection of these SDGs, addressing gender equality is not always at the forefront in their implementation. In voluntary reviews of how the SDGs are being implemented, governments report on developing renewable energy sources and connecting households to the energy grid in rural areas, but they encounter challenges in the high upfront cost of modern energy and addressing energy deficits in remote areas. Governments have pointed to legal and institutional mechanisms that exist to support women's rights, and the need to integrate a gender perspective in policy and budgeting, but report that such efforts are stymied by the low level of women in decision-making in the public and private spheres and prevailing social norms that perpetuate gender inequality (UN DESA 2017).

Implementation of the global climate change policy framework (United Nations Framework Convention on Climate Change) also struggles to put women at the centre of access to renewable energy. Following the Paris Agreement, countries outlined post-2020 actions to reduce emissions, many of which charted complementary efforts to enhance energy access. While more than half of the Nationally Determined Contributions (NDCs) submitted by sub-Saharan African countries recognise the importance of affordable and reliable energy access to development, only 40 per cent of the NDC submissions reference gender equality or women. And among these countries only a few highlight the participation of women in energy decision making and in sustainable energy programmes and training (UNDP 2016).

2.3 Leveraging global trends could catalyse action

The context of our rapidly changing world is highly relevant to tackling energy poverty, and in the case of gender equality it may be possible to leverage the trends described in this article. Knowledge of these global trends could influence decisions on how energy is delivered and financed, and the contributions of and impacts on women and men. Changes over time in the global and national context could significantly alter the pathway towards achievement of energy access for all and the

SDGs by 2030. Employing a gender lens helps identify populations that are most in need of targeted support to meet these goals. Policymakers could propel energy access strategies from the perspective of how they would be best designed and deployed to reach both women and men. The trends described herein point to risks that might throw off policy and planning, as well as options for accelerating opportunities and leapfrogging ahead of existing timelines.

2.4 Background of this article

The research was undertaken as part of a scoping study commissioned by SEforALL and ENERGIA and funded by DFID (SEforALL 2018). The intention was to explore and bring visibility among policymakers to the role that select global trends play in achieving gender equality in energy access. While evidence abounds on the ways in which energy access drives economic growth, alleviates poverty, and delivers other socioeconomic benefits, less is known about how trends are impacting gendered energy access. An improved understanding of the gender aspects of these trends could support policymakers in shaping policy and finance decisions to enhance the delivery of the 2030 goals.

Owing to the broad landscape of the six trends studied, the research was designed as a scoping study capturing available evidence on each of the trends. The methodology consisted of: (1) a literature review spanning regions and sub-regions with energy access gaps for electricity and clean cooking, including Africa, Asia, and the Pacific, and Latin America and the Caribbean; (2) interviews with 33 representatives of institutions engaged in research and policy work in this arena; and (3) input and peer review from a Steering Committee.

3 Global trends

It is unlikely that achieving universal energy access will come to fruition using business-as-usual approaches. The strategies employed by governments and organisations to expand energy access will need to keep pace with significant change under way in the energy sector, in national economies, and in local communities. Six global trends affecting the modes by which energy is delivered are presented below, along with implications for gender equality.

3.1 Decentralisation of energy services

The expansion under way of off-grid and mini-grid energy access solutions presents new opportunities to close gender gaps by reaching those not served by the grid.

3.1.1 Trend overview

The way that energy is distributed is changing from centralised grids to a mix of on-grid and off-grid solutions. Off-grid energy service companies, marketing household solar electricity systems that can support varying bundles of light-emitting diode (LED) lights, mobile phone chargers, radios, fans, and/or super-efficient televisions, have emerged as a disruptive force. For households without any access,

these new services can mean additional hours of running a business or studying. But higher levels of electricity supply capacity are also important, as they enable broader use of appliances and other equipment for productive activities (SEforALL and Power for All 2017). Commercially viable mini-grid business models that can supply those levels of electricity have proven more elusive, but enthusiasm for that prospect remains. Mini-grids can provide a higher, more sophisticated level of electricity, supporting income-generating activities such as water pumping or grain milling and threshing for agriculture, or cold storage to keep dairy, meat, fish, and other products chilled and free from spoiling for a longer duration. Mobile communication technology is helping to propel the reach of these decentralised energy systems, as mobile banking and mobile payments unlock new business models. About 634 million people without electricity, or 53 per cent of the global unelectrified population, are already covered by mobile networks (Nique and Smertnik 2015), driving demand for accessible, affordable power-charging facilities – such as those supported by decentralised renewable energy (DRE) systems. Decentralised systems have been shown to increase the possibility of reaching remote populations (Practical Action 2017) and these solutions are expected to provide the majority of new access connections by 2030. Achieving energy for all will require off-grid solar photovoltaic (PV) or mini-grid connections for an estimated 72 per cent of those gaining new access (IEA 2017a).

3.1.2 Gender implications

Growing evidence suggests that decentralised systems can drive women's use of energy for income-generating purposes and, therefore, economic empowerment. Decentralised technologies extend the benefits of modern energy services – including reduced drudgery, time savings, and health and safety – to women and families who live beyond the reach of the central grid. Examples abound of decentralised technologies impacting women's health and wellbeing in remote areas. In Africa, electrifying clinics for lighting and medicine refrigeration has been found to improve maternal health (World Bank 2017a). In Indonesia and India, there is evidence linking television access to reduced family size, less domestic violence, and increased autonomy for women, owing to new norms presented in the media (Grimm, Sparrow and Tasciotti 2015; Jensen and Oster 2009). And the presence of public lighting delivered by stand-alone mini-grid systems has critical benefits for the safety of women and girls (World Bank 2017a). While there are some limitations and unexpected consequences of expanded electricity access, such as non-productive activities being pushed aside (Winther 2008), and it is not clear how access impacts gender relations, there is substantial evidence of a positive impact on women's welfare (Winther *et al.* 2017).

Employment and entrepreneurship in decentralised energy has the potential to become a major source of income generation for women, throughout the energy value chain (Pearl-Martinez 2014). Although there is currently an imbalance in women's representation in the renewables industry, this is slowly changing, and the number of jobs

in solar, bioenergy, hydropower, and wind is growing rapidly, with the potential to reach 15–24 million jobs by 2030. The off-grid sector could create 4.5 million jobs by 2030, particularly in solar PV, and additional indirect jobs will emerge through entrepreneurship (IRENA 2017b). As outlined further in Section 3.4, tapping into women's income-generating opportunities made possible by decentralised power systems (where the alternative would be no power at all) could be a win-win both for access to energy and for gender equality. As women become engaged as sales agents for clean cooking solutions and off-grid service connections, they are also empowered economically. However, the existing barriers that need to be overcome to facilitate women accessing such opportunities cannot be ignored. In rural Kenya, women were found to have less control over decision making about appliances and lighting – regardless of whether electricity came from the grid, mini-grid, or solar home system – because men paid subscription fees and registered as the customer (Winther, Ulsrud and Saini 2018).

3.2 Affordability of energy services

With improving technology and increasing scale, energy services are becoming less expensive and consumer financing packages help to put connections within reach.

3.2.1 Trend overview

Affordability of decentralised options is a key determinant in electrification at the last mile. The least-cost solution for providing energy access to three-quarters of those in sub-Saharan Africa is through decentralised options, particularly solar off-grid and mini-grid systems (Glemarec *et al.* 2016). For those without access to the grid, spending on lighting and mobile phone charging with kerosene, candles, battery flashlights, and similar technologies amounts to US\$27bn per year (Lighting Global and GOGLA 2016). The cost of appliances has an impact on women's economic empowerment and agency. Solar-powered home electricity systems are frequently bundled together with highly efficient appliances by off-grid energy service companies, and consumer financing is available via monthly instalments for the whole package. Affordability is one of the drivers of the expansion of pico-solar. Consisting of a solar panel and battery supplying LED lamps and a mobile phone charging port, and providing up to 15 watts, pico-solar accounted for 94 per cent of all off-grid solar sales in 2016, mostly in South Asia and sub-Saharan Africa. The overall cost of pico-solar units has decreased significantly in recent years, resulting in 59 per cent of all pico-solar units in sub-Saharan Africa priced below US\$20 (Nygaard, Hansen and Larsen 2016).

The uptake of clean cooking technologies is also influenced significantly by cost. The upfront cost of improved cooking appliances, as well as alternative fuels such as liquefied petroleum gas (LPG), has been a major barrier. Clean cooking technologies are not expensive enough to be a cost-effective offering of microfinance institutions or banks (GACC 2015a). Although it is a fossil fuel with environmental drawbacks and not without safety hazards, LPG is a step forward from biomass cooking

for health and climate change outcomes (Rosenthal *et al.* 2018). In urban areas, LPG use has been increasing and its expansion in developing Asia is expected to make up the majority of global expansion through 2030, despite the 2.3 billion people worldwide projected to remain without access (IEA 2017a). In rural areas, poor infrastructure and infrequent delivery of LPG cylinders are part of the equation of low supply and, on the demand side, the prohibitive cost and distribution challenges are compounded by limited awareness at the household level of the benefits of alternative fuels (Cecelski and Matinga 2014).

3.2.2 Gender implications

It is more expensive to provide access to rural areas than to urban areas owing to the need for lengthy transmission infrastructure and technical losses along the way, and rural populations usually have less disposable income than those in urban areas. For remote communities, mini-grid and off-grid systems are often a more cost-effective avenue than grid extension because, in the absence of substantial public subsidies, the connection cost is prohibitively high. In a study of clean cookstoves, the impact on household expenses and attention to the needs of end users was found to be as important as the cost of the cookstove itself (Riley 2014).

The upfront costs of solar home systems have also remained a barrier, but these systems have demonstrated benefits to women through savings on kerosene, better quality light, enhanced child welfare, and increased self-respect and empowerment (Winther *et al.* 2017). For poor energy consumers, affordability is determined by whether there are consumer finance options available, such as pay-as-you-go or lease-to-own. These options, typically financed by the energy service company, spread out repayment of the upfront capital cost over time (SEforALL and Power for All 2017). For many poor women, however, access to consumer finance is constrained by the additional hurdle of being outside the formal financial system, lack of access to mobile payments, and not having control over household decision making (Demirguc-Kunt *et al.* 2014). Pico-solar provides only a basic level of energy services, but it is beneficial to those without access as it displaces kerosene, which produces harmful smoke; enables financial savings once the investment cost has been recouped by what daily outlays to purchase kerosene would have been; and provides a higher quality of light that enhances study time (SEforALL and Power for All 2017).

3.3 Mobile payments

Mobile money and other digital innovations can be leveraged to propel women's access to off-grid and clean cooking solutions, as well as their entrepreneurship.

3.3.1 Trend overview

The energy sector is increasingly digitalised. Appliances, buildings, vehicles and transportation systems, and industry value chains are becoming *smarter* and there is greater connectivity between people and between devices, particularly through the internet and mobile phones (IEA 2017b). The emerging network of devices embedded

with the ability to connect and exchange data is improving efficiency and extending technologies and services to new spheres. For example, cloud-based metering and software platforms can be paired with mini-grids and telecom towers, which require electricity. Together, these digital solutions serve as anchor loads to provide the consistent demand that mini-grids need to operate, and they can support further investment in expanding electricity supply to remote communities. The digital revolution is propelling new modes of financing solar home systems, especially in geographic areas that are too difficult or costly for the grid to reach. When mini-grid and off-grid electricity providers have access to the internet and communications, this can accelerate expansion of energy access, especially as a tool for cashless payments that reduce the cost of many small-scale transactions and improve customers' repayment rates (Modi and Figueroa 2015). Despite these possibilities, digital connectivity is not a panacea, as access to mobile and internet technologies is irrelevant if electricity is not available.

3.3.2 Gender implications

There is emerging evidence that digital connectivity may have a leapfrogging effect in relation to poverty reduction. Between 2008 and 2014, Kenya's mobile payments system lifted 200,000 families out of poverty, equal to about 2 per cent of the country's households. The impact of access to mobile payments was more pronounced for women, whose access to mobile money prompted a switch to business or retail occupations over farming (Suri and Jack 2016). Access to mobile technology by women and those in remote locations is also a key determinant in the expansion of new financial models. Mobile finance can help women access energy products and services, as well as support services for agriculture. For women entrepreneurs in developing economies, digital commerce and other technologies can overcome limited access to finance, time constraints, mobility, and skills and training (UNCTAD 2017). Access to mobile finance also enables women to invest in businesses and pay for their families' education and health needs (Lewis, Villasenor and West 2016). New digital approaches are being used to improve adoption of clean cookstoves, such as in India, where women are paid through a system of climate credits to use stoves and fix them when they break (Ramanathan *et al.* 2017). Other aspects of digitalisation may also be beneficial to women. The declining costs of solar PV and batteries means that greater amounts of energy can be stored 'behind' the household electricity meter (IEA 2017b), which is an opening for women as household energy managers to assume more control.

However, women may remain excluded from the benefits of mobile payments unless the gender divide in access to digital and energy technologies and services is addressed. Women in developing countries have significantly lower rates of digital literacy than men. A study by Intel found that 25 per cent fewer women than men across developing countries had internet access, largely due to the high cost of a connection (Intel 2013). While global access to mobile phones is

increasing, a substantial gender gap remains in low-income and middle-income countries. Women in these countries are 10 per cent less likely than men to own a mobile phone, or 184 million fewer women than men, due to women's lower levels of education and income (GSMA 2018). Social norms are also at play in many communities, as the use of mobile phones is sometimes deemed inappropriate for women and girls.

3.4 Entrepreneurship

The upward trend in women's entrepreneurship is an opportunity to expand energy access by empowering women to help close the access gap at the last mile, reaching those who would not be reached by business-as-usual approaches.

3.4.1 Trend overview

Globally, the number of women engaged in entrepreneurial activities is growing steadily, although some regions are not seeing this increase. The 2018 Mastercard Index of Women Entrepreneurs concludes that, while there is much room for improvement, women's advancement as entrepreneurs is 'adequately healthy' in the majority of regions. While Ghana and Uganda have high proportions of women business owners, sub-Saharan Africa and the Middle East are lagging behind other regions (Mastercard 2018). Similarly, the 2014 Gender Global Entrepreneurship and Development Index finds a high level of 'female entrepreneurial drive' in certain African countries – Ghana, Nigeria, South Africa, and Uganda – but, as a whole, sub-Saharan Africa has fewer female entrepreneurs (GEDI 2014). In developing countries, women's business leadership is more prevalent in smaller firms – just under 40 per cent of small companies compared to half that for medium-sized companies (IFC 2011).

The increase in the rate of women's entrepreneurship parallels a surge in international dialogue and investment in women's economic potential. This is signalled by the establishment of the High-Level Panel on Women's Economic Empowerment by the United Nations (UN) Secretary-General in 2016 (UNHLP 2016), new global investment mechanisms such as the Calvert Foundation's Women Investing in Women Initiative and Goldman Sachs' 10,000 Women initiative, and numerous leadership and award programmes to catalyse women's leadership in business, science, technology, engineering, and mathematics (Stengel 2016). This new wave of support for investing in women draws on analyses correlating gender equality with global economic growth (Mastercard 2017; GEM 2017).

3.4.2 Gender implications

The expansion of sustainable energy, especially to remote areas, may depend on women's engagement as entrepreneurs, owing to the unique relationship they have with female energy consumers. Women's household decisions about energy afford them a nuanced understanding of their customer base and supply chain, which can translate into a minimal business cost in identifying and securing customers. Women entrepreneurs demonstrate an advantage in managing supply

chains and reaching customers in rural areas (Glemarec *et al.* 2016; Gray *et al.* 2016) and there are examples of women outperforming men in selling energy products, including solar lanterns and cookstoves. In these studies, women's success is attributed to their ability to influence members of their community, the broad networks within which they have relationships, and their understanding of women's particular energy needs (Soria, Farley and Glinski 2016; GACC 2015b). Supporting women's businesses may bring greater return on investment, as studies confirm women are a lower credit risk and repay loans more frequently than men (Zelizer 2011). Women's business success also translates into reinvestment in families and communities, as women entrepreneurs are more likely to spend earnings on children's education and health, compared to male entrepreneurs (Pazarbasioglu 2017).

Yet in developing countries, 70 per cent of women with small and medium-sized businesses are not accessing financing, amounting to nearly US\$300bn per year (World Bank 2017b). Women face more bottlenecks to building businesses than men. Existing evidence catalogues the significant and wide-ranging barriers restricting women's business ownership, including lack of access to capital, regulatory restrictions, isolation from business networks and intermediaries, lack of access to market data and information, discriminatory cultural and gender norms, lower levels of education and business experience, limited female role models and mentors, and competing demands of household and family responsibilities without access to childcare (GEM 2017). Studies also show that expansion of women's entrepreneurship requires support beyond the business realm. Tackling broader gender barriers – for example, addressing improvements in health and education, gender-based violence, childcare, land and property rights, and rural electrification – are equally important (Buvinic and O'Donnell 2016). Women were found to be less likely to develop into independent entrepreneurs in the renewable energy sector in the absence of broader skills development, support for entering established renewable energy supply chains, and changes in social norms that designated the installation of solar home systems as a male domain (Glemarec *et al.* 2016).

3.5 Urbanisation

Securing reliable electricity and clean cooking access for women and men living in slums and peri-urban areas enables livelihoods, as well as the legitimacy and economic contribution of urban settlements.

3.5.1 Trend overview

By 2050, about 68 per cent of the world's population will live in cities (UN DESA 2018), and currently one in eight people globally live in slum conditions (UN-Habitat 2016). In the fastest growing cities, electricity generation does not always keep pace with demand, leading to voltage fluctuations, brownouts and blackouts, and unreliable service. Electricity supply often prioritises large-scale commercial and industrial needs, rather than the smaller enterprises of the urban poor. The result is that the urban poor are forced to rely on polluting fuels for cooking,

to the detriment of city air quality, or to install diesel generators to have access to reliable (although dirty and expensive) electricity. In urban areas, grid connections are expected to be the most cost-effective means of expanding electricity access by 2030. However, shifting to cleaner cooking fuels, such as LPG, is also central to expanding energy access and would lead to the most dramatic reduction in both indoor and outdoor air pollution (Westphal *et al.* 2017). LPG is projected to provide access to 90 per cent of those in urban areas gaining access to clean cooking by 2030. While there are success stories in urban areas of China and Indonesia of fuel switching from traditional biomass to LPG, at a global scale, 2.3 billion people are projected to remain without access to clean cooking by 2030 (IEA 2017a).

3.5.2 Gender implications

Urban environments provide economic opportunities and facilitate proximity to energy supplies, yet women and men living in informal urban settlements have a harder time accessing energy. About half of those living in slums depend on unpaid connections to electricity, leaving utilities without revenue (Danielsen 2012). Those without a formal electricity connection may resort to illegal means of connection or use expensive and unsafe fuels, sometimes being charged higher prices by illegal intermediaries. There is some evidence pointing to insecure property tenure preventing female-headed households from accessing energy (Heinrich Boll Stiftung 2016). In urban areas without street lighting, gender-based crime is a major problem, particularly because sanitation facilities are located at a distance from households. Electrification efforts are obstructed by the lack of coordination between housing and energy initiatives, and public subsidies are not sufficient to make energy access adequately affordable. The realities of poor urban households are also missing in national energy policy. Informal settlements in cities may not be recognised by authorities and fall in the gap between national energy ministries, urban energy companies, and rural electrification agencies (Danielsen 2012).

3.6 Humanitarian settings

Humanitarian agencies should shift away from diesel-generated power towards renewable-powered electricity and provide clean cooking solutions to pre-empt the need for residents to collect firewood.

3.6.1 Trend overview

The number of people who are forcibly displaced has nearly doubled in the past two decades – up to 65.6 million people as of 2016, half of which are women (UNHCR 2016). Of these, 8.7 million people live in refugee camps with minimal access to electricity, relying on collected fuelwood for cooking (Lahn and Grafham 2015). The vast majority of refugees are hosted by developing countries, where governments often have less surplus capacity to provide additional energy services (Morales 2017). While many displaced people are housed in camps hosted by countries other than their own, many more are internally displaced and similarly lack modern energy provisions. Humanitarian

relief settlements can range in size from large towns to small cities and while the residents are there – in theory, only temporarily – they require energy for household cooking and lighting and community services such as power to operate schools and health centres, refrigerate medication, pump water, and support administration staff functions.

Decentralised renewable energy options such as solar-powered mini-grids with diesel or batteries for backup, are recognised as options by these humanitarian agencies, but are not yet the go-to solution. When electricity is available, it is typically delivered through diesel generators, at great operational cost due to the expense of fuel deliveries. Humanitarian agencies are short on energy expertise and on systematic long-term energy planning and management. While financing is needed for energy supply solutions that span both emergency and recovery periods, humanitarian funding is often short term and politically oriented, in quick response to emergencies that soon fall off the radar (Lahn and Grafham 2015). In addition, a challenge for humanitarian agencies is that installing more durable energy supply infrastructure in humanitarian settings can signal the potential permanence of these settlements to wary host governments (Morales 2017). Governments grapple with tensions between refugees and host communities caused by competition for fuelwood, as almost 65,000 acres of forest are burned for fuel each year by people living in refugee camps (Lahn and Grafham 2015).

3.6.2 Gender implications

Access to non-traditional energy sources, particularly in humanitarian settings, is a matter of protecting women's and girls' lives. Firewood collection for household energy is often a dangerous task. Reports abound from Chad to Sudan of women experiencing physical aggression, theft of property, or rape during trips outside camps to collect firewood. Women are discouraged from reporting sexual assaults owing to cultural expectations or because firewood collection outside camps is illegal in many countries (Lahn and Grafham 2015). This is compounded by the insecure legal status of people living in camps (Morales 2017). The health impact of cooking with traditional fuels is substantial, especially for women and girls, as an estimated 20,000 forcibly displaced people face premature death from indoor pollution each year (Lahn and Grafham 2015). Not having to collect firewood also facilitates time available for women's economic and educational activities in these camps (UNHCR 2012). The availability of electricity for street lighting can also keep shops and public spaces open later and generally improve the lives of those in humanitarian settings, especially women. In one example from the Goudoubo refugee camp in Burkina Faso, only 3 per cent of those who leave the house after dark are women, due to the lack of public lighting (Vianello 2016).

4 Policy implications

As introduced at the outset of this article, the national roll-out of the international agreements on sustainable development and climate change demonstrate that more attention needs to be directed towards

gender equality. Bridging the gender gap in access to sustainable and modern energy is not primarily a question of technology. Instead it is a question of organising energy delivery in a way that navigates existing inequalities and responds to the central roles played by women as energy managers and consumers. The prevailing investment approach to energy access is not organised to address these realities and thus perpetuates gender inequalities (Ngum 2016). The results of this are palpable – countries experiencing higher levels of gender inequality also have lower levels of electricity access (O'Dell, Peters and Wharton 2014). This article concludes with an overview of policy implications for each of the six trends discussed above.

4.1 Expanding decentralised energy services based on gender gaps

Government decision-making on energy rarely reflects gendered realities, partly because ministries do not collect adequate data on household and income-generating energy usage and needs. Globally, sex-disaggregated and gender-relevant data and evidence is very limited, including on access to and use of energy, decision making, household division of labour, productive uses of energy, and entrepreneurship (SEforALL 2017).³ Greater policy coherence between gender policy and renewable energy planning, as well as gender-disaggregated data collection, would help ensure that decentralised energy services are expanded in a manner that delivers specific benefits to women.

4.2 Leveraging affordability to expand services to women

Policymakers should assess what women and men can afford in specific contexts and address cost barriers, taking advantage of dramatic reductions in technology costs and the integration of technologies and new business models. Targeted mobile phone surveys and other 'lean data' approaches enable vastly better data collection than was previously possible (Acumen 2017). Achieving universal energy access will require policies that address not just the energy sector but also banking, financial, and infrastructure policies that lower the cost of grid and off-grid electricity and clean cooking solutions (Pachauri *et al.* 2013). Improving women's technology choices could be enhanced through access to credit and the collection of data that monitor how they use energy (UNIDO 2015).

4.3 Bridging the digital gender divide

Expanding women's access to mobile finance has the potential to expand local markets and reach more of those without access to electricity and clean cooking solutions (IEA 2017a). First and foremost, mobile money has to be expanded, especially in less-developed countries where a lack of these services persists. Attention should be focused on the gender digital divide when making decisions about how to expand mobile money; for example, by considering the needs of female-headed households. Global technology companies moving to connect rural areas in developing countries to their services should consider women's and men's needs, including energy needs that could benefit from solar home systems and mini-grids, as well as the application of

pay-as-you-go models to finance irrigation pumps, LPG canisters, and biogas systems (GSMA 2017).

4.4 Creating a business and regulatory environment supporting women's entrepreneurship

Given that legal and regulatory structures protect women's business activities as well as men's, countries with stronger rule of law and greater women's political empowerment also have higher rates of women's entrepreneurial activity (Goltz, Buche and Pathak 2015). To propel energy access, policymakers need to create a business and regulatory environment that supports women-owned small and medium-sized enterprises, as well as other aspects of their wellbeing. While financing targeted to the needs of women-led businesses is key, support beyond financing is critical to women's economic empowerment. Employment and entrepreneurship in decentralised energy could become a major source of income generation for women, especially at the base of the energy ladder but also further up the value chain (Pearl-Martinez and Stephens 2016; Glemarec *et al.* 2016). The number of global renewable energy jobs (direct and indirect) could reach 15–24 million by 2030 (IRENA 2017a). The off-grid sector could create 4.5 million jobs by 2030, particularly in solar PV, and additional indirect jobs will emerge through entrepreneurship (IRENA 2013).

4.5 Formalising energy access in informal urban settlements

Policymakers need to circumvent tenure and payment barriers for women and men living in slums and peri-urban areas. Municipalities, national energy ministries, and other agencies responsible for energy supply should be sensitised to the needs of women in informal settlements, collect data on those populations, and address the unique barriers faced by women and men in securing access to energy in these environments. Given the reliance of poor households on cooking fuels that cause indoor (and outdoor) air pollution, solutions should include clean cooking technologies and fuels, in addition to electricity and solar home systems. Subsidised tariffs must be designed to ensure true affordability for those most in need, particularly female-headed households. Alternative payment arrangements to alleviate upfront costs can include monthly instalments and prepaid connections. To facilitate legal connections to electricity and LPG for those without proof of land or property ownership, agencies should accept alternative forms of proof of address.

4.6 Regularising energy services in humanitarian settings

Equitable access to sustainable energy should become a formal – and central – component of humanitarian aid. Sustainable technologies and clean fuels should be prioritised in humanitarian settings, and replacing diesel generators with DRE systems can reduce long-term fuel and other operational costs (UNHCR 2012). To start, international policy frameworks, humanitarian organisations, and national governments need to adopt coordinated energy access goals and guidelines for displaced people, ensuring that women's needs are assessed and clearly

articulated. To deliver on these policies there is a need for increased capacity and funding; coordination among government, UN agencies, and non-governmental organisations that are offering their own divergent solutions in camps; standardised methods for energy-related data collection in camps that reflect the needs of both women and men; and consideration of granting displaced peoples the right to work and access land, which could provide the means for them to pay for energy services, supporting energy delivery solutions (Lahn and Grafham 2015). Both host communities and displaced populations benefit when sustainable energy services are delivered at lower cost and facilitate an integration of these populations (Morales 2017). Host country officials appreciate the benefit of saving scarce natural resources from fuelwood collection. Ideally, refugees entering a humanitarian camp would receive a suitable cookstove and fuel, and a solar lantern, as well as training on any new technology (UNHCR 2012).

Notes

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- 1 Rebecca Pearl-Martinez, Department of Geography, Durham University, UK.
 - 2 The Oxford Dictionary definition of *trend* is 'A general direction in which something is developing or changing', <https://en.oxforddictionaries.com/definition/trend>.
 - 3 For more information on gender data, see SEforALL (2017).

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Strengthening the Women's Entrepreneurship Ecosystem within the Energy Sector*

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Abstract As women are increasingly engaged in clean energy value chains globally, it is crucial to understand what business models, practices, and enabling conditions can support the dual goals of scaling energy access and empowering women. To understand gaps in the women's energy entrepreneurship ecosystem, we draw from recent theories of gender and entrepreneurship and both peer-reviewed and grey literature sources on entrepreneurship and development. Key challenges in women's energy entrepreneurship and potential programme supports to the women's energy entrepreneurship ecosystem are identified from a resource-based perspective, focused on five primary sources of capital – economic, social, time, cultural, and symbolic. Examples of programme supports include: (a) access to finance and capital; (b) access to coaches, mentors, and business networks; (c) business education and skill development; (d) training to foster personal agency, personal initiative, and entrepreneurial mindsets; and (e) inclusion of men within women's energy entrepreneurship programming.

Keywords: gender, economic empowerment, micro-enterprise, emerging markets, women's empowerment, business development, clean energy.

1 Introduction

Access to energy is considered essential to promote economic development globally. With only a decade to reach the Sustainable Development Goal (SDG 7) that seeks to ensure access to affordable, reliable, sustainable, and modern energy for all by 2030, significant efforts are under way to fast track countries towards this goal. Advancements in renewable energy technologies, declining costs, and decentralised energy solutions are seen as important pathways for growth in these emerging markets. These efforts include increasing access to energy devices and household systems such as improved cookstoves and fuels, solar lanterns and solar home systems and kits, mini-grids/utilities, and grid extensions.

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In the international development community, the role of women is considered central to fueling growth in the energy sector, in large part because they are often the primary managers of household energy and the most heavily impacted by lack of clean energy access (Batliwala and Reddy 2003; Cecelski 2000; UN Women 2013). Engaging women at all levels of energy value chains is thought not only to have positive business outcomes, but also to economically empower women and support their families (ENERGIA 2019a; 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 and more easily adopted by female customers, especially those in hard-to-reach locations, which, in turn, will increase women's access to energy (Reiss 2015; ECOWAS 2014; MIT-CITE 2018; ENERGIA 2019a). Indeed, the role of women's entrepreneurship has a logical place in renewable energy sector programmes owing to the roles that women have historically played in fuel-intensive informal enterprises and as knowledgeable managers of small business-related energy (Batliwala and Reddy 1996; Glemarec, Bayat-Renoux and Waissbein 2016).

From an economic perspective, women entrepreneurs are considered essential for private sector development in emerging markets (Grewe and Stein 2011; IFC 2017; Habtezion 2016). Women-owned enterprises account for almost half of small and medium-sized enterprises (SMEs) in emerging markets, estimated to consist of 8–10 million businesses (Grewe and Stein 2011; Kelley *et al.* 2017). 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 (Hechavarría *et al.* 2017) and in different types of industries compared with men (Kelley *et al.* 2017; Amin 2014).

However, the challenges of energy access are significant. Globally, one billion individuals still lack access to modern electricity, nearly three 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 (SEforALL 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. Therefore, it is unlikely that the SDG 7 targets for 2030 will be reached unless women are intentionally and effectively integrated in energy businesses, programming, and policies.

Despite the increasing interest in the potential role of women's entrepreneurship as a strategy to reach these underserved populations and to extend energy access specifically to female consumers, there are significant gaps in understanding how best to support the larger ecosystem within which women's energy entrepreneurship resides. The existing literature on women's energy entrepreneurship is limited, but growing (ENERGIA 2019b). Still, there is a preponderance of grey literature informing policy and programmes (Elwell, Mershon and Aguilar 2014;

SEforALL-PCA 2017; Dutta 2019). What is clear is that populations facing a lack of energy access, where efforts for increasing women's economic engagement are most common, are also facing significant gender inequity, which, in turn, comes from prevailing gender ideologies and allocation of roles and resources. In this article, we draw from recent theories of gender and entrepreneurship and from existing literature and programme efforts in the energy sector. It is through this gender theory lens that we attempt to address the question of critical supports for the women's energy entrepreneurship ecosystem.

2 Theory and methodology

Gender inequity is a product of the reciprocal relationship between ideologies of gender and the resulting allocation of roles and resources in a given society (Sidanius and Pratto 2012; Dillabough 2004). For example, cultural beliefs about gender influence who gets a bank account and when, who handles the money in a family, and who becomes involved in what types of work inside and outside the home. Gender beliefs influence the types of occupations individuals pursue, in which industries, and the ways in which individuals prepare themselves for these roles and how they are supported by others around them. Beliefs about gender further influence the types and character of the social connections individuals cultivate, the resulting power of social networks for business and family demands, the education and experience obtained, and the credibility that individuals face when starting and growing a business. The structural patterns that result from gender norms, ideals, and expectations tend to be reproduced by reinforcing the governing gender ideology. To break the cycle of gender inequity, gender policy and programmes must address both gender ideology and the limits that women face in access to and mobilisation of key business resources.

Worldwide, entrepreneurship is generally considered a masculine-type activity, especially in certain industries and at the highest levels of growth (Jennings and Brush 2013; Ahl 2006). As a result, men and women entrepreneurs tend to face very different realities when it comes to accessing and mobilising the types of resources required for starting and growing a business (Terjesen and Elam 2009; Elam 2008; Bruni, Gherardi and Poggio 2004). In an effort to better explain variations in gender patterns of business start-ups around the world, Elam (2008) proposed a *practice theory* view of gender and entrepreneurship. Practice theory is concerned with the ways in which individuals create and re-create the social world around them (Ortner 2006; Bourdieu 1977). This process of social (re)production results from the interplay of individual action and social structure, such that action is situated, negotiated, and largely based on habits of the mind (*habitus*). Drawing on Pierre Bourdieu's theory of capital ([1986] 2011), Elam (2008) argued that, as a result of traditional gender beliefs, women entrepreneurs face barriers in access to and mobilisation of four key forms of capital: economic, social, cultural, and symbolic capital. Notably, one additional resource, or form of capital, missing from this theoretical framework is 'time', which we also consider in this article.

Definitions of these forms of capital are as follows:

- *Economic capital*: Cash and other financial assets that enable one to purchase or trade for resources needed for business creation and growth.
- *Time capital*: The availability of time to put into business related activities.
- *Social capital*: A durable network of established social ties through which one can access or mobilise resources needed for business creation and growth.
- *Cultural capital*: Expertise, education and training credentials, knowledge, and habitus (i.e. mindsets, mental schemas, and ways of thinking, feeling, and doing), which influence access and mobilisation of resources needed for business creation and growth.
- *Symbolic capital*: Legitimacy (related to prestige, social status, and credibility) as defined and enforced in specific cultural contexts, limiting or enhancing individual access to, and mobilisation of, resources needed for business creation and growth.

Importantly, these forms of capital are convertible at a culturally defined exchange rate. For example, high levels of financial capital, knowing the right people, and having the right education or expertise convert into high levels of status and legitimacy in most cultures. However, the exchange rates may vary across cultures and across individuals according to status characteristics, such as gender, race/ethnicity, and social class (Ridgeway and Correll 2004b; Foschi 2000). Conversely, symbolic capital (legitimacy or prestige) converts into other forms of capital, providing or limiting access to financial capital, education, or social connection to individuals who fit certain stereotypes. Many entrepreneurs in resource-constrained environments find ways to overcome barriers to business financing, expertise, and human capital by investing time (sweat equity) into the business – an example of both bricolage and bootstrap start-up strategies (Baker and Nelson 2005; Senyard *et al.* 2014). Time poverty is a particular challenge for women entrepreneurs faced with time-consuming household and family care work, in addition to business demands, especially those living in resource-poor settings where many tasks are not automated (e.g. washing clothes, collecting firewood) (Blackden and Wodon 2006).

In many ways, women energy entrepreneurs face key challenges in access to, and mobilisation of, these five forms of capital, with the understanding that some forms of capital provide access to other forms of capital at exchange rates that are culturally defined and tied too often to gender ideology. In the following section, we outline key challenges faced by women energy entrepreneurs, highlight field programmes that provide support to these challenges, and identify other areas of opportunity to further strengthen the energy entrepreneurship ecosystem.

3 Key challenges to women's energy entrepreneurship

3.1 Challenges in economic capital: limited access to finance

Access to financial capital is one of the biggest barriers faced by women entrepreneurs attempting to start and expand energy enterprises (IFC 2011; Bardasi, Sabarwal and Terrell 2011; Ellwell *et al.* 2014; Sigalla and Carney 2012; Clancy 2000; Baruah 2016; Amatucci and Crawley 2010; Pachauri and Rao 2013). There are numerous reasons why women energy entrepreneurs face challenges when accessing financial capital, both money assets and financial services; for example, gender norms and resulting inequalities in land tenure and access can make it difficult to present the collateral needed to obtain a loan; cultural norms can contribute to the low bankability of women, such as family bank accounts established in the name of the male head of household only; and discriminatory banking practices, such as the requirement to have a male signatory on loans taken by women, which further discourage women's use of banking services and, in particular, access to credit (IFC 2011; Bardasi *et al.* 2011).

Importantly, women energy entrepreneurs are not a homogeneous group. As for all business owners, the type of financial capital needed varies by type and stage of business. For example, community collectives, micro-entrepreneurs, or SMEs come to the financial sector with different qualifications and requirements, including financing needs, credit histories, and financial literacy. The stage of business growth is a critical consideration, whether it is a new or small firm working towards breakeven or experiencing significant business growth. The primary sources of funding for businesses include personal/family savings, loans and grants from governments and foundations, commercial banks, microfinance or microcredit lending organisations, and institutional equity firms (private equity and venture capital) and angel investors (Coleman and Robb 2016). Research suggests that women entrepreneurs tend to have fewer personal savings (Jamali 2009), are less likely to have a bank account (Demirgüç-Kunt *et al.* 2017), and are less likely to apply for business loans than men (Treichel and Scott 2006).

3.1.1 Examples of programme supports to address economic capital

Start-up capital for female micro-entrepreneurs engaged in sales/distribution of energy products and services is often critical to purchase initial inventory (such as cookstoves or solar lanterns) or energy provision equipment (such as a solar kiosk).

Micro-loans. In some cases, energy-related programmes working with micro-entrepreneurs can help entrepreneurs to access microcredit by negotiating 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. These micro-loans can be provided more formally, through an external source such as a company or microfinance organisation, semi-formally, through savings and credit cooperatives, or informally, through local savings groups, such as

self-help groups, which use informal methods such as table banking to support savings and credit.

Micro-consignment. 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). The micro-consignment model puts the financial risk on the energy programme or larger enterprise rather than on the entrepreneur, and it allows entrepreneurs to test the product and their sales ability without making a large upfront investment. However, some social enterprises focused on energy distribution, such as Solar Sister working in Tanzania and Nigeria, have found that taking on the financial risk through micro-consignment is not an effective model to support business growth because of high attrition rates, presumably due to limited commitment from the women (Pailman 2016). In contrast, LivelyHoods, which works in Kenyan slum areas, distributes a variety of clean energy and other household goods and has successfully designed a micro-consignment model wherein sales entrepreneurs 'check out' products at the beginning of the day and return unsold products at the end of the day. While the micro-consignment model might be attractive to entrepreneurs of all backgrounds, the microcredit model may be attractive only to those who already have experience in taking and paying back loans. In fact, some studies have found that women from wealthier families are more likely to take the financial risk of taking out a micro-loan to support an entrepreneurial venture (Baruah 2016). Other studies have found that micro-consignment models may be more effective for micro-entrepreneurs because they do not have to take on the financial risk of purchasing inventory, and the models enable them to avoid the potential challenge of mixing household and business expenses (Dutt 2012; IUCN 2015).

Supplier credit. Case studies reviewed by Pailman (2016) demonstrate some of the diversity in models and the need for energy programmes to adjust their financing approach to both attract their entrepreneurs and ensure their sustainability. For example, Nuru Energy in Rwanda requires a US\$60 commitment fee and then entrepreneurs finance solar lighting products through upfront orders; the African Renewable Energy Distributor (ARED) programme in East Africa requires entrepreneurs who want to run their solar-powered mobile phone charging kiosks to pay 20 per cent of the first lease payment (for the kiosk) upfront; Juabar, which 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.

Equity investment. Angel investment and venture capital are important for SMEs 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 and Erboy Ruff 2014). While equity investing can be

Box 1 Key considerations for financial services to support women-led micro, small, and medium enterprises

- Recognise there is a strong business case for lending to women (in general, their risk profile is lower, loans to women are more profitable than those to men, and women tend to have more robust savings accounts, according to microfinance data).
- Understand that numerous factors influence whether women will seek out credit or financial services (e.g. limited understanding of financial services, lack of collateral and credit history, informality of their businesses, or inadequate documentation or record keeping).
- Establish a clear path for women to establish credit history and become bankable (e.g. joint bank accounts for households or separate bank accounts for women business owners).
- Provide outreach, training, and education for female entrepreneurs to support financial literacy and better understanding of available financial services.
- Encourage women entrepreneurs to pursue business opportunities in high-margin, high-growth markets, including in male-dominated industries.
- Provide training and education of staff at financial institutions to more effectively engage with women entrepreneurs, specifically in community information on new products and financial services.
- Modify 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). Customise offerings for the local context and markets (e.g. for new products or informal economic sectors).

Source: Authors' own.

more flexible, these investors often expect very high rates of return and prefer to invest in high-potential, scalable businesses targeting large markets. This goal is especially true for venture capital firms that run high-potential portfolio models. A study by the Omidyar Network (2013) found that angel investment and venture capital made up only 4 and 5 per cent respectively of funding sources for African enterprises. It is likely that these numbers would be even lower for women-owned enterprises, given that women-owned businesses in the USA receive less than 2 per cent of venture capital funding (NAVC 2019).

Impact investments and grants, on the other hand, are generally tied to developing market solutions for specific social needs.

Box 1 outlines some key considerations for lending institutions to consider as they develop targeted financial solutions to better suit the needs of women energy entrepreneurs. Of the various forms of capital, economic capital is probably the most pressing issue to address in resource-constrained environments and is often the most cited barrier reported by female entrepreneurs in any sector.

3.2 Challenges in time capital: time poverty and business ownership

Women often spend a disproportionate amount of time on household tasks, limiting their contributions to micro-entrepreneurship. Women in developing countries experience time poverty through longer working days compared to men – a study in Burkina Faso and Nigeria estimated that women have an average working day (including paid and unpaid work) of 11–14 hours, which exceeds the average ten-hour working day for men (IFAD 2015). 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 owing 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 per cent 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 per cent compared to 43 per cent, respectively (Espinal and 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 did not have enough time and could not be away from home for such long periods of time due to domestic and community responsibilities (Khamati-Njenga 2001; Misana and Karlsson 2001).

3.2.1 Examples of programme supports to address time constraints

Energy access, especially in the form of electricity, is central to saving time in a wide range of productive uses and entrepreneurial activities, such as tailoring, cookshops, and service-centred businesses (Cabraal, Barnes and Agarwal 2005; ESMAP 2008; Mohlakoana *et al.* 2019). Furthermore, a unique feature of many energy-related technologies is the capacity to reduce women's time burden for daily and/or arduous tasks. For example, moving from traditional biomass stoves to cleaner

and more efficient cookstoves and fuels, such as improved biomass stoves or liquefied petroleum gas (LPG), has been shown to significantly reduce time required for cooking and eliminate the need to forage for fuel (Cundale *et al.* 2017; Gould and Urpelainen 2018). Therefore, women energy entrepreneurs who sell these types of energy-related technologies are able to benefit from the technologies themselves. Correspondingly, consumers using these time-saving energy-related products report the time saved can be used to engage in economic activities (GACC 2014). In this sense, programming focused on increasing energy access to women fundamentally addresses time poverty issues faced by both entrepreneurs and consumers in developing contexts.

Unfortunately, time poverty resulting from the family demands disproportionately managed by women still constitutes a barrier to business start-up and growth in contexts where households have relatively easy access to energy sources and time-saving energy products. Programmes that offer scheduling of meetings and events at times that correspond to school timetables, that offer childcare, or offer online participation are friendly to women juggling family demands and time constraints. Hence, programmes that address gender gaps in mobile communications and transportation also provide solutions to time constraints.

3.3 Challenges in social capital: lack of mentors and business networks

For female entrepreneurs, and especially within resource-poor settings, lack of access to mentors and expanded networks is a common challenge. Prior research suggests that women entrepreneurs often have less effective business networks compared to men entrepreneurs due largely to gendered family roles (Renzulli, Aldrich and Moody 2000; Brush *et al.* 2002). Consequently, both scholars and policymakers recognise that financial capital is not enough of a solution and advocate for ongoing support and mentoring to provide an important source of new information, resource acquisition, and social support from other entrepreneurs (IUCN 2015; Pailman 2016; Amatucci and Crawley 2010; O'Dell, Peters and Wharton 2014).

Engaging women through self-help groups and/or cooperatives may help to overcome some of the challenges related to access to business financing (financial capital) in that they are able to pool funds or may have already established a system of savings and loans within the group (Brody *et al.* 2015; Pachauri and Rao 2013). By improving social networks, women entrepreneurs experience greater solidarity with peers, appear to demonstrate greater financial independence, and often gain greater respect in their communities. In other words, social networks are important sources of knowledge, social support, and legitimacy (symbolic capital) for women entrepreneurs.

Coaching and mentoring are the most commonly used types of social support programming provided to individual entrepreneurs. Creating ongoing touch points for mentoring and networking can help female

Box 2 Role of ICTs to advance women-led enterprises

- Increased access to financing – mobile money enables users to send and receive money through a phone.
- Reduced time constraints – because women can communicate with customers and suppliers while staying at home to increase time efficiency.
- Reduced need for women's physical mobility – mobile phones allow easy communication and reduce the need to travel.
- Improved access to information, education and training – and women who may otherwise be illiterate have the opportunity to learn to read.
- Diversified learning and data collection – with increasing access to the internet, ICTs are a central conduit for supporting entrepreneurial learning and growth.
- Increased links to markets and expanded supply chains.

Source: Authors' own.

entrepreneurs maintain a useful personal and professional network to address business challenges as they arise and learn best practices from other entrepreneurs, as well as expand their reach and share resources with their peers and communities. In the case of energy entrepreneurs, mentors with at least two types of skills are required – one to support general business development and another to support the technological aspects of the energy product.

Access to digital technology is another critical innovation to enhance social capital and to support scaling SMEs (UNCTAD 2014; Martinez and 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 and what type of information they have access to and by simplifying the exchange of money. In some cultural and geographic contexts, women are known to face additional barriers to social connection owing to gender norms that restrict mobility and connectivity to others, either through restricted access to mobile phones and motorcycles or via rules about how and when women are allowed to interact independently with others in public. Box 2 outlines several ways ICTs can support women to enhance social capital. 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.

3.3.1 Examples of programme supports to address social capital

The Women's Economic Empowerment (WEE) programme operated by ENERGIA, International Network on Gender and Sustainable Energy, is designed to expand the reach of women's energy enterprises in the renewable energy sector and supports five partner organisations working in Indonesia, Nepal, Tanzania, Senegal, Nigeria, Kenya, and Uganda. In this programme, women energy entrepreneurs' social capital is supported through business development associates that provide mentoring and technical advice as well as access to larger business networks and resources (Dutta 2019). Solar Sister, one of the WEE partners and a female-led organisation, takes the concept to building social capital further, through its 'sisterhood' meetings. These monthly meetings, which are designed to strengthen local ties, help build interpersonal relationships, as well as provide technical advice to last-mile energy entrepreneurs (MIT-CITE 2018). Monthly mentoring meetings supported by easy-to-use software to track sales performance have been crucial to the WEE programme's success (Dutta 2019).

Another women-led organisation, Frontier Markets, which works with over 5,000 entrepreneurs (50 per cent women) who are trained in technology, marketing, and technical repair as well as selling clean energy solutions, is expanding its networks throughout India with the use of ICTs. Its teams are currently expanding a technology platform to serve rural consumers and simultaneously leverage a network of digital rural women entrepreneurs throughout India.

3.4 Challenges in cultural capital: lack of business education and skill development

Gender ideology is socialised in the individual habitus (i.e. ways of thinking, feeling, and doing). In this sense, men and women tend to recreate their social and economic circumstances by conforming to the prevailing rules that govern their appropriate roles and resources in their communities. This pattern of social reproduction is particularly persistent in more traditional societies where women's basic educational levels are low. Significant progress can be made towards gender equity goals simply through education, as illustrated by research from advanced economies where the gender pay gap has largely been reduced through opening access to education and work experience for women (Blau and Kahn 2007, 2017). Business skills and financial literacy are important for building strong women's businesses, and also for increasing their knowledge base and ways of thinking about their business. Although there may be considerable variation in business education content, entrepreneurship training programmes tend to include accounting, financial planning, pricing and costing, marketing, and inventory management (McKenzie and Woodruff 2014). For example, favourable results have been reported for Goldman Sachs' 10,000 Women Initiative's business training programme focused on established women-led SMEs (Goldman Sachs 2019) and for Coca Cola's 5by20 Initiative (Coca Cola 2019). These types of business-training programmes have also shown promise for micro-entrepreneurs.

For example, a six-week fully subsidised training in Mexico found increased earnings for women's businesses (Calderon, Cunha and De Giorgi 2013), and similar positive impacts were seen with a three-month intensive training delivered by professionals in Peru (Valdivia 2015).

While many studies find a positive impact of business training on business practices and performance, these findings are probably due to very low levels of formal business practice in the populations observed (McKenzie and Woodruff 2014; Buvinic, Furst-Nichols and Pryor 2016). Additionally, research suggests that women entrepreneurs are much more prone to low confidence and strong reluctance to take risks in the face of a decidedly clear bias against women business owners. Women entrepreneurs in particular appear to benefit from programmes that support 'entrepreneurial mindsets' and address individual tactics for overcoming resource constraints. Moreover, trainings that reduce travel costs and provide accommodation for childcare (or organising the training to adjust for household obligations) are more likely to be successful, as they help women overcome structural barriers to participation. However, evidence from global studies of women's entrepreneurship consistently suggests that women need support to overcome high fear of failure and lack of confidence in their own skills to start and grow a business (Kelley *et al.* 2017; Elam 2008; Arenius and Minniti 2005).

3.4.1 Examples of programme supports to address cultural capital

Many university-based entrepreneurship-training programmes now incorporate training on entrepreneurial mindsets and growth mindsets, such as Babson College's Entrepreneurial Thought and Action methodology (Neck and Greene 2011; Neck, Greene and Brush 2014), to support traditional business skills and planning. However, few of these innovative university-based programmes have published scientific evidence that these enhanced entrepreneurship-training approaches actually influence business performance, rather than start-up intentions and business launch (Pittaway and Cope 2007).

Two exceptions come from a series of randomised experiments into the efficacy of entrepreneurial training programmes 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, Gielnik and Mensmann 2016; Glaub *et al.* 2014; Koop, de Reu and Frese 2000). This training combines knowledge acquisition and mental tools with direct actions, actively practising and repeating actions towards their goals. The second is a 'personal agency' approach that recognises 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, Siddi and Smith 2018; Shankar, Onyura and Alderman 2015).

In the personal initiative approach, tested by randomised controlled trial in several locations in Africa, training activities were designed to encourage entrepreneurial action. Sales for training participants rose 27 per cent, and the training led to a 35 per cent increase in the 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 per cent compared with a statistically insignificant 11 per cent for traditional training (Campos *et al.* 2017). The evidence from these studies suggests that psychological mindset training may lead to both improved entrepreneurial success and increased innovation practices over and above simple business and technical training curriculums. Finally, the researchers note that the training for the personal initiative programme was cost-effective and paid for itself within one year. The curriculum for this programme is available to the public via open source access (see Campos *et al.* 2017 for details).

A similar approach was recently tested by a randomised controlled trial in the energy sector. Shankar *et al.* (2015) compared sales performance of newly trained male and female cookstove entrepreneurs testing a personal agency-based empowerment training curriculum as compared with standard business skills training. The results showed a threefold increase in sales and a doubling of business retention over time for energy entrepreneurs who underwent personal agency as compared with traditional business training, with the biggest influence seen on women entrepreneurs. Notably, women participants outsold men in both intervention and control groups, owing in large part to their enhanced knowledge of cookstove use and their willingness to provide after-sales services. The results of this study demonstrate that women can succeed very effectively as 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. The curriculum for this personal agency programme, the *Empowered Entrepreneur Training Handbook* (Smith and Shankar 2015) is also available on an open access basis with support from the Clean Cooking Alliance (previously Global Alliance for Clean Cookstoves). More recently, the Empowered Entrepreneur Training Program (EETP) was deployed through a trainer certification programme that reached over 1,000 energy entrepreneurs via 67 trainers at more than 20 organisations in Kenya, Tanzania, Uganda, Nigeria, India, Bangladesh, Nepal, and Indonesia. The post-training monitoring further increased sales volumes and numbers of high sellers among those trained. A return-on-investment study conducted under real-life conditions found a return of 115.9 per cent and a significant (10.6 per cent) increase in monthly sales after the training programme (Shankar, Spurzem and Smith 2017). The EETP curriculum has been well integrated throughout ENERGIA's WEE

partner programmes, which include an integrated support package with 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 (Dutta 2019).

3.5 Challenges in symbolic capital: conflicting responsibilities associated with traditional gender roles

Because men are more likely to start a business and because entrepreneurship is widely viewed as a male endeavour, women face significant penalties of legitimacy and status as entrepreneurs starting and growing businesses (Bird and Brush 2002; Ahl 2006; Elam 2008). This reality is no different in the energy sector where energy-related businesses tend to be founded and led by men. Even when women entrepreneurs possess an effective mix of economic, social, and cultural capital, when the societies in which they live present gender inequities and barriers to their entrepreneurship these individual assets may not be enough to overcome social and institutional barriers.

3.5.1 Examples of programme supports to address symbolic capital

Gender inequity in entrepreneurship and access to key business resources, in our view, is influenced heavily by Bourdieu's concept of symbolic capital (i.e. social legitimacy). Evidence suggests, for example, that women entrepreneurs face discrimination in access to financial capital, especially in high discretion contexts such as venture capital (Brush *et al.* 2014; Brush *et al.* 2018). Even in highly regulated contexts such as banking, women can experience challenges in being taken seriously as business owners, even in their own judgements. There is some evidence that women business owners may feel reluctance to apply for business loans owing to an expectation of rejection (Constantinidis, Cornet and Asandei 2006; Coleman 2000). Women entrepreneurs may further experience a sense of low status in business networking. Indeed, evidence suggests that women are often judged on prior performance, while men are more often judged on potential competence (Player *et al.* 2019). One recent study from the USA also showed that while men CEOs tended to be fired in the context of poor business performance, women CEOs tend to be replaced independent of firm performance (Gupta *et al.* 2018).

It is clear that women in business face significant legitimacy penalties, particularly in the context of leadership and motherhood (Ridgeway and Correll 2004a). It is very likely that women entrepreneurs face further challenges to legitimacy in male-dominated industries over and above the general gender bias they face as entrepreneurs. Following the argument that gender ideology and resource access are reciprocal and self-reinforcing in nature, the question arises: How do we break the cycle of social reproduction? We propose that the answer lies in programming that provides women entrepreneurs with special access to business resources such as financial capital, social capital, and cultural capital, and programming that addresses the overarching bias against, and negative stereotypes of, women entrepreneurs.

Growing evidence suggests that engaging men in programmes targeted towards women's economic empowerment can greatly improve the impacts of those programmes for women and their families. This outcome is due, in part, to the fact that gender norms at the household level are directly examined and addressed through the participation of male family members. Recent studies by the International Labour Organization Women's Entrepreneurship Development programme and the International Center for Research on Women highlight the importance of engaging men at all levels – household, community, and policy – in women's entrepreneurship (ILO 2014; Gliniski *et al.* 2018). Effective strategies towards this goal include providing capacity-building activities encouraging men to adopt more positive, more gender-equitable masculinities, promoting the benefits that men will gain from women's economic empowerment, encouraging men's roles in care work, engaging men in trainings targeting women, and identifying and supporting gender champions.

Simply participating in a formal training programme can provide certification and increased legitimacy for women entrepreneurs and their firms, reducing risks of investment and support in the eyes of other stakeholders. Working with community leaders to hold successful women entrepreneurs up as role models may also go a long way towards debunking traditional gender ideologies, showing men within and outside the household that not only can women be very effective business leaders, but also that the success of these women shines brightly on their male partners and on male leaders in the community.

4 Conclusions

As women are increasingly engaged in clean energy value chains, it is crucial to understand the ways in which business models and practices provide enabling conditions for both scaling energy access and empowering women. Recent efforts to expand women's entrepreneurship in the energy sector have shown a range of effective strategies that attempt to merge these dual goals within the context of challenging cultural and economic conditions. It is important to understand that these programme elements may not be turnkey activities that lead directly to entrepreneurial success. Rather, they address gender gaps in the forms of capital (i.e. economic, time, social, cultural, and symbolic) that influence business success. Our concern is that many efforts to promote social change in this sector may focus on only one or two forms of capital and, therefore, are likely to miss critical supports with unique benefits for women within the larger ecosystem. By applying a practice theory lens that examines the interrelationship of gender ideology with access to and mobilisation of multiple sources of capital, we are better able to review, assess, and improve ongoing programming and policies to enhance their effectiveness.

As such, we find great value in current efforts to bundle support services and provide targeted support for women entrepreneurs. Emerging research offers compelling evidence that bundled services, such as

the provision of capital transfer (as cash or in kind) combined with business training and ongoing supervision, can lead to long-term growth (Banerjee *et al.* 2015a). An excellent example of such a programme in the non-energy sector is a graduation programme for the ultra-poor in Bangladesh and India that bundled intensive training, access to savings, capital in-kind supports, and cash grants (*ibid.*). In contrast to a systematic review of randomised impact evaluations for microcredit alone, which showed no significant impacts on poverty reduction over time (Banerjee, Karlan and Zinman 2015b), a similar systematic review of bundled support services programming suggested that beneficiaries experience significant benefits as much as two years after the intervention (Banerjee *et al.* 2015a). While it may be argued that the cost of bundled services cannot be borne by industries in the energy sector, we argue that long-term, sustained impacts that include shifts in the various forms of capital are unlikely without such efforts.

Of the five forms of capital considered in this article, cultural capital and symbolic capital are often the most challenging to address and measure within programmes and, as a result, they are too often overlooked completely. For example, increasing economic capital through access to finance is crucial, yet without also strengthening financial literacy and business education (cultural capital) these financial services may be underutilised. Education and work experience are keys to business success. Also central to the concept of cultural capital are the habits of mind (*habitus*) that lead to the expression of gender bias against women in business. Providing women access to critical business resources such as financial capital, social capital, and cultural capital in the form of relevant business education and experience is necessary and beneficial, but it may not be sufficient to overcome discrimination and low confidence that results from legitimacy discounts. Educational programming that directly addresses personal agency, personal initiative, and/or the entrepreneurial spirit in a very individualised manner can empower women entrepreneurs against negative stereotypes that may undermine their success.

While participation in a formal training programme can provide certification and increased legitimacy for women entrepreneurs and their firms, leading to support in the eyes of other stakeholders, there may be a gap in how these women's roles are seen within the home and business community. Efforts to strengthen social legitimacy (symbolic capital) of women as business owners and leaders could include cultivating champions within the community and household. For example, working with community leaders to hold successful women entrepreneurs up as role models could go a long way towards debunking traditional gender mythologies. Such programme elements are likely to be of particular value to women entrepreneurs working in male-dominated industries and markets and, more generally, for those women starting and growing high-potential energy firms. The social legitimacy conferred by high-status advisers and mentors (social ties) on women entrepreneurs and their businesses is an important programme strategy.

In sum, it is crucial to recognise that prevailing gender ideologies lead to limited access to key business resources for women, either through direct discrimination or through self-selection. Women entrepreneurs are held back by a complex web of gender bias and resource constraints. In order to break the cycle of social reproduction of gender inequity in entrepreneurship today, programme supports are needed that break the myth of female underperformance and address all forms of capital, including the legitimacy of women entrepreneurs. Moreover, women have multiple responsibilities associated with traditional gender roles. In order for them to more effectively pursue entrepreneurship opportunities, there needs to be shifts in household and community acceptance of women's participation in these roles, and in the distribution of household labour. More research is needed to understand intra-household dynamics and their relationship and connection with various forms of capital. Given the limited funds available to support development policy and programmes in the energy sector, programme efforts that recognise the value of various sources of capital on women's entrepreneurial success and also understand the reciprocal relationship between ideologies of gender and allocation of roles and resources are more likely to result effectively in supporting women's empowerment and reaching energy access for all by 2030.

Notes

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Gender and Entrepreneurship in the Renewable Energy Sector of Rwanda*

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Abstract Until recently, women have not been seen as having the potential for entrepreneurial success. Yet women's engagement in the energy sector could substantially improve energy access for those most underserved. This article examines the role of women as energy entrepreneurs from the perspective of gender inequality within the energy industry. Data from Nuru Energy, a social business focused on providing solar lighting to the ultra-poor, provide insights on how the inclusion of women sales agents can increase sales and how strategic modifications to the social business model can further support female-led businesses. Observational data from over 1,000 rural enterprises show that women, on average, sold significantly more units than men. Women operating in solo firms and leading group-based teams consistently outsold men-led solo and group-based enterprises. Findings further suggest that, when operating in groups, women tend to outperform men even more than when operating sole proprietorships.

Keywords: entrepreneurship, women, business, performance, sales, energy.

1 Introduction

Throughout the world, in both developed and developing countries, women face numerous social restrictions that impede their ability to engage in economic activities successfully. Not only do women carry the burden of household responsibilities in every society, but they also receive less schooling and lower returns for their labour. Further, in some countries, women face social restrictions on public participation, employment, and mobility. In fact, in 18 countries, married women require their husband's approval to take a job (World Bank Group 2015).

In a recent review, Buvinic and Furst-Nichols (2016) conclude that, at the subsistence level, female-operated firms are less profitable than

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male-operated firms primarily owing to these social barriers. Indeed, the 'female underperformance hypothesis' is a crucial point of debate within the field of management studies (e.g. Yousafzai *et al.* 2018; Baker and Welter 2017; Zolin, Stuetzer and Watson 2013; Robb and Watson 2012; Watson 2003; Du Rietz and Henrekson 2000). The findings from these studies are mixed overall, revealing that business performance depends upon the performance measure used and is tied closely to context, such that key controls often explain aggregate gender differences. While much of the research on gender patterns of business performance focuses on companies in highly industrialised countries (Da Vita, Mari and Poggesi 2014), studies on gender patterns in business performance in developing countries also find that women-owned businesses tend to perform favourably in terms of sales, profitability, and job creation when key factors such as industry and business age and size are considered (Ali and Shabir 2017).

Unfortunately, there exist widely held stereotypes of female underperformance that, combined with existing structural barriers, are holding women entrepreneurs back from high levels of economic success in business. Research from the Global Entrepreneurship Monitor (GEM), for example, shows that women entrepreneurs and established business owners (across all countries sampled over 20 years of data collection) tend to perceive fewer opportunities and report a higher fear of failure and less confidence in their start-up skills compared to their male counterparts (Kelley *et al.* 2017; Elam 2008). Moreover, even with the same level of education, women tend to feel less competent than men at entrepreneurship (i.e. starting and managing a new business) (Kelley *et al.* 2017; Thebaud 2010). While prior research has addressed the complex interplay of cultural, psychological, and structural factors in influencing women's participation in entrepreneurship, to our knowledge, no studies to date have compared the performance of female-led and male-led firms in a controlled research design comparing men and women selling the same products under the same terms and in the same cultural context.

In this study, we investigate the business performance of women and men entrepreneurs within a highly specific context – a large social enterprise, Nuru Energy, in the Rwandan renewable energy sector. This study is a small part of a large-scale prospective intervention study, including a randomised controlled trial in 272 rural Rwandan villages where a gender equality programme has been implemented. In this analysis, we compare female and male business performance in two different business models: (1) solo male versus female micro-entrepreneurs (deployed in 868 villages) and (2) female, male or mixed gender teams of four to ten entrepreneurs per village (deployed in 183 villages). Further to this, we use qualitative data to obtain additional insights about women's entrepreneurship-derived benefits that go beyond simple sales performance and consider explicitly personal empowerment achieved through increased household income, social status, and personal agency. Our findings show that females are as successful as

males at selling solar lights, which is encouraging news for empowerment programmes aimed at promoting female entrepreneurship. As a result, this study contributes directly to research on women's entrepreneurship by challenging the female underperformance hypothesis with respect to relative sales performance. It also provides important insights into how social enterprise programming that supports women entrepreneurs in subsistence-level contexts can improve business-level outcomes, such as revenues and profits, and also be personally empowering.

The rest of the article proceeds as follows: Section 2 presents an overview of the context of study, some myths surrounding female underperformance, and theoretical underpinnings and hypotheses. We present the methodology of the research in Section 3. The results of our study are presented and discussed in Section 4. Section 5 concludes.

2 Background

2.1 Female entrepreneurship in the energy sector: the case of Nuru in East Africa

Our study took place within the context of Nuru Energy (Nuru), a large social enterprise working in the African renewable energy sector. Nuru is a for-profit social enterprise, with operations in Rwanda, Burundi, and Kenya, which aims to address the global issue of energy poverty through the provision of low-cost solar recharging centres for mobile phones and lights to off-grid rural communities. Nuru has distributed lights to over 150,000 households in rural Rwanda alone. Its model operates by providing energy in the form of single rechargeable light-emitting diode (LED) lights that are sold by a village-level enterprise according to Nuru's pre-selected business model. Thus, village-level enterprises sell the rechargeable lights just above cost and generate additional revenue by charging small fees for recharging lights and mobile phones using the solar photovoltaic (PV) system provided by Nuru. This business model mimics the way kerosene lamps and battery-powered flashlights are purchased from a central source, with households frequently returning to buy fuel and dry-cell batteries. Selling solar energy as a service, rather than as just an upfront purchase, also spreads out expenditures for low-income households to address affordability issues.

East Africa's focus on promoting gender equity in recent decades presents a potentially attractive environment for female entrepreneurs, particularly for Rwanda with its continuous implementation of gender policies. We argue that the clean energy sector serves as a particularly favourable sector for women rather than men, given women's roles as primary household energy managers and their understanding of the value of clean lighting technologies for the advancement of their children's schooling, especially in situations where the availability of alternative income-generating activities is limited.

For this study, we use existing data from Nuru light sales to estimate the performance of female entrepreneurs in selling lights compared

to their male peers. We also interviewed a subsample of village-level entrepreneurs (VLEs) to unpack the benefits women derive from being an entrepreneur in the Nuru distribution model. We investigate, over and above sales performance, how females are empowered in other ways, including increased personal agency, social status, and time use.

2.2 Myth of female underperformance

Women are consistently underestimated in terms of business leadership and business performance (Ahl 2006; de Bruin, Brush and Welter 2007; Minniti and Naudé 2010; Brush and Cooper 2012). Management scholars have spent decades researching gender differences in business start-up and growth. The results of this body of research are mixed, and the mechanisms are complicated (Ross and Shin 2019; Zolin *et al.* 2013; Hughes *et al.* 2012). Early studies reported that women business owners tend to be less successful than male business owners (Kalleberg and Leicht 1991; Rosa, Carter and Hamilton 1996; Birley 1989). Over time, researchers have dug deeper into available data in countries around the world to uncover explanations for these population differences. Key predictors of business success include business characteristics, such as industry, business age, and size, and individual attributes, such as education and industry experience (Yousafzai *et al.* 2018; Baker and Welter 2017; Zolin *et al.* 2013; Robb and Watson 2012; Watson 2003; Du Rietz and Henrekson 2000). Gender differences across these key predictors are significant and often explain differences in performance observed at the population level.

Indeed, women around the world tend to own/manage very different types of businesses compared to men, with different preferences and motivations for growth (Brush *et al.* 2006; Du Rietz and Henrekson 2000). Research from GEM suggests that women run about one-third of businesses worldwide. According to the most recent global report, only 6 of the 49 economies surveyed reported equal entrepreneurship participation rates between women and men: Indonesia, Thailand, Panama, Qatar, Madagascar, and Angola (Bosma and Kelley 2019). Prior research shows that women are over-represented in the informal sector in every economy and among sole proprietorships (Kelley *et al.* 2017; Klapper and Parker 2011). Women-owned businesses are also over-represented in industry sectors with relatively low barriers to entry but with high levels of competition and lower profit margins, such as textiles/fashion, hospitality/food, and education and health services (Kelley *et al.* 2017). Women-owned firms tend to be small and newer than men-owned businesses and tend to grow more slowly with less access to the resources required for growth (Brush *et al.* 2006; Cliff 1998).

Many of the differences between female-owned and male-owned firms are explained by horizontal segregation across industry sectors (Sappleton 2018; Klapper and Parker 2011; Du Rietz and Henrekson 2000). Businesses in retail and services, for example, are often smaller and newer, serving local markets resulting in smaller profit margins and lower eligibility for either debt or equity financing (Coleman and Robb 2016;

Hughes *et al.* 2012; Brush, de Bruin and Welter 2009). The fact that women tend to start businesses in different industry sectors or sell different types of products within a given industry sector complicates the comparison of male- and female-owned businesses in some significant ways. These fundamental differences in business characteristics have, unfortunately, contributed to negative stereotypes about the abilities of women business owners and managers around the world (Jennings and Brush 2013; Gupta and Turban 2012; Ahl 2006). Not only are women viewed broadly by the general public, investors, and researchers as less successful business leaders, but the hypotheses that drive studies of business performance also tend to start with that same bias.

Research into what scholars have described as the ‘female underperformance hypothesis’ has emerged to directly challenge the assumption by controlling for key factors and testing multiple measures of business performance in large studies around the world. In a study of 4,200 Swedish businesses, Du Rietz and Henrekson (2000) found that, while women-owned firms did tend to underperform men-owned firms at the population level, these differences were primarily explained by business size and industry sector. Men tend to run larger businesses selling to larger customers and more often in the manufacturing sector. Importantly, they also found that men-owned businesses reported significantly more sales on average compared to women-owned businesses, but that there were no gender differences in other performance measures – the number of orders, number of employees, or, notably, profitability. Similarly, in sub-Saharan Africa, Bardasi, Sabarwal and Terrell (2011) found a significant gender gap in the firm size of male- and female-owned businesses. However, a much smaller gender gap is reported for firms’ efficiency and growth. They explain that their observed gender gap was partly due to the overpopulation of women in smaller business operations. In a study of over 4,016 US businesses, Robb and Watson (2012) found no difference in closure rates over four years, no difference in return on assets, and no difference in risk-adjusted profitability, controlling for key demographics, business size, and industry. Using a sample of 183 Australian firms to replicate the Robb and Watson (2012) study, Zolin *et al.* (2013) also found no gender differences in four-year business closure rates, return on assets or risk-adjusted profitability, controlling for key confounding variables such as industry and business size and age. Hence, while men-owned businesses tend to outperform women-owned businesses at the population level, studies that make direct apples-to-apples comparisons find that women are just as capable as men of achieving significant business success. In this study, we extend this stream of research by comparing the business performance of men and women VLEs selling the same products under the same supplier terms in the same country.

2.3 Theoretical frame and hypotheses

The feminist theory includes multiple perspectives with different underlying assumptions, including but not limited to social feminism, radical feminism, Marxist feminism, and socialist feminism. Liberal

feminism argues that gender difference is a false construction and that, *ceteris paribus*, men and women are equally capable both intellectually and physically (Tong 2013). The focus of this perspective is on changing the political and institutional forces that constrain women from participating as equals in private and public spheres. Social feminism posits that men and women are fundamentally different but should be considered equal (Black 1989). The focus of this area of theory is on the centrality of motherhood to the family and society and the unique skills and perspective that women bring to work and politics. Finally, socialist feminism combines the social domination hypothesis of radical feminism (Mackay 2015; Willis 1984) with the economic class oppression hypothesis of Marxist feminism (Vogel 2013) but argues that the root of female oppression lies in class oppression and the economic dependence of women on a male head of household (Gordon 2013).

Recent findings debunking the idea that female-owned businesses underperform male-owned businesses are consistent with a liberal feminist perspective on business performance. Liberal feminism argues that, given a level playing field, women are equal to men and just as likely to perform well in business (Zolin *et al.* 2013; Calás, Smircich and Bourne 2007; Robb and Watson 2012; Fischer, Reuber and Dyke 1993). In other words, given the same product/service offering under the same supplier terms and in the same country, women-led village-level enterprises and men-led village-level enterprises should perform comparably. Accordingly, our hypotheses are that:

H1: Women solo entrepreneurs will perform as well as men entrepreneurs by selling an equal number of lights.

H2: Women-led entrepreneurial teams will perform as well as men-led entrepreneurial teams by selling an equal number of lights.

H3: Access to lighting will confer economic and non-economic benefits on Nuru VLEs.

3 Methodology

Data for this study were drawn from a larger research project that examined the impact of Nuru Energy's solar light and recharging distribution programme in Rwanda. The programme was designed to provide rural households with access to rechargeable lights and recharging services. VLEs were recruited to sell the rechargeable lights and to provide recharging services. We obtained administrative data on 1,047 village enterprises in Rwanda, including the gender of the entrepreneur and the number of lights sold, as depicted in Table 1. Most VLEs were men (81 per cent) with only 19 per cent being women. On average, female VLEs sold 90 lights while men sold 58 lights. These data were collected under two different business models that Nuru rolled out in Rwanda. In the first model, VLEs included one micro-entrepreneur per village across 868 villages in 11 districts in Rwanda, with the majority of participating villages concentrated in Nyamasheke and

Table 1 Summary statistics

	All	Male VLEs	Female VLEs
Number of VLEs	1,047	847	200
Percentage	100%	81%	19%
Average lights sold		58.13	90.97
Standard deviation		78.72	110.99

Source Authors' own, based on Nuru administrative data.

Gicumbi districts. The second model included village-level enterprises of four to ten members per village, in 183 villages covering 14 districts in Rwanda. These enterprises were operative by 30 March 2015 and had at least three months of operations. Although Nuru entered the villages at different points in time, the vast majority of lights are sold during the first couple of weeks from the date when the VLE is set up, so differences in the timing of Nuru's entrance are unlikely to affect the number of lights sold in a village.

We estimated four ordinary least squared (OLS) multivariate linear regression models to study the difference in business performance of female versus male entrepreneurs, across the two Nuru business models (solo VLE vs VLE teams). The dependent variable, representing business performance, is the number of lights sold. We included a specification with the dependent variable in logarithms to address potential measurement error and to facilitate coefficient interpretation (e.g. the percentage difference in lights sold). The key explanatory variable is VLE gender (or gender of the enterprise team leader), which takes the value of 1 if the VLE is a female. We included two controls: district characteristics and number of villages with only men micro-entrepreneurs.

Controlling for district-fixed effects reduces the level of bias in our estimates, as there may be regional differences that may potentially influence the number of lights sold by gender. Owing to data limitations, we were unable to control for other key variables such as entrepreneurs' education and age, which may also influence the number of lights sold. Given these limitations and the non-experimental nature of our data, we do not draw causal conclusions in this article.

To better understand the empowerment potential of including females as energy entrepreneurs for this analysis, we supplemented our quantitative analysis with 30 qualitative interviews with VLEs and community members in 13 sectors of Rulindo in Rwanda. All interviews were conducted in Kinyarwanda, the official local language in Rwanda. Semi-structured interviews with VLEs working in groups of four included open-ended questions covering demographic information, micro-enterprise operations, livelihoods before and after

Table 2 Number of lights sold and gender of the VLE, OLS

	Solo businesses		Businesses with 4–10 entrepreneurs	
	(1) Level	(2) Log	(3) Level	(4) Log
Female	24.855** (8.414)	0.305*** (0.084)	77.832 (46.065)	0.471*** (0.045)
District fixed effects	Yes	Yes	Yes	Yes
Mean lights sold by male entrepreneurs	57.855		73.074	
Number of observations	868	868	183	179
R-squared	0.145	0.198	0.199	0.210

Notes Standard errors clustered at the district level. Statistically significant from zero at the 90(*), 95(**), and 99(***) per cent confidence.

Source Authors' own, based on Nuru data 2016.

becoming an entrepreneur, and general gender awareness. Interviews with community members were conducted using a different interview guide to understand better the context in which these entrepreneurs are working. We further supplemented our interview data with observational data from the daily activities of entrepreneurs. Qualitative data were prepared for analysis by transcription and translation of all questionnaires before coding using a thematic analysis approach.

4 Results

4.1 Empirical analysis of female business performance

Table 2 presents the OLS regression results of the difference in the performance of female versus male entrepreneurs. As shown in column 1, on average, solo female VLEs sell 25 lights more than solo male VLEs, statistically significant at the 95 per cent confidence level.

As shown in column 3, female-led teams sell 77 more lights on average than male-led teams, but with a large standard error (46.1) rendering the finding not statistically significant, due to the relatively small number of observations potentially combined with measurement error in the outcome variable. Columns 2 and 4 show the results of each model with the dependent variables expressed as natural logarithms, reducing the measurement errors and showing large, statistically significant effects for both models. These findings show that female solo VLEs tend to outsell male solo VLEs by 36 per cent and that villages with female-led VLE teams outsell villages with male-led VLE teams by 60 per cent.⁷ Our additional qualitative findings suggest that women are more likely to be available at the shop to serve customers, either because of limited mobility or because they value the position more highly than men and

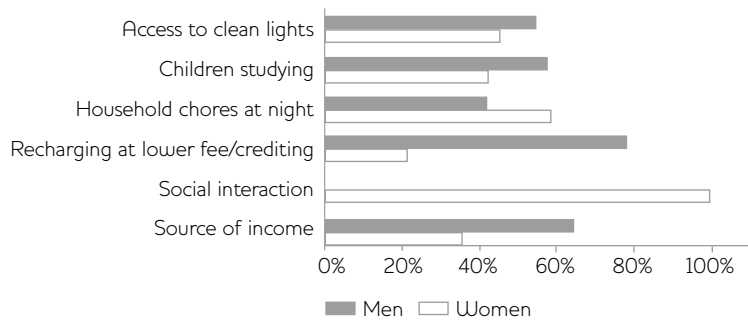
are especially motivated to succeed. This may explain the reason why women in these villages tend to perform better than men.

Our analysis, however, was severely limited by the administrative data available and their non-experimental nature, so we cannot draw causal conclusions with certainty. It is possible that missing variables or other exogenous factors might influence these findings. For example, given high discrimination levels, selection effects may be present where only the most motivated, supported, or capable women ended up as VLEs, and thus their performance is higher than the average male VLE. In addition, men may not be entirely focused on Nuru sales and have other paid work that conflicts with selling Nuru lights and recharging services. The men in these villages bear the responsibility of herding animals, while women's family care duties tend to keep them at home and, as such, are highly compatible with Nuru solar sales. The VLE start date could also influence the number of lights sold; specifically, women-led enterprises may have started selling lights earlier than male-led enterprises. Again, this data point was not available to us. Women entrepreneurs could also be older and more experienced in business than men entrepreneurs. We were unable to control for entrepreneur and business characteristics as the data were not available. Nonetheless, the findings are very compelling and stand in contrast to the conclusions broadly communicated based on prior findings from studies across multiple industries in other countries that find that women-owned businesses tend to see lower sales than men-owned firms. Consistent with previous studies in other countries, when controlling for industry (product/service) and business characteristics (size and age), the female underperformance hypothesis is not supported by the available evidence.

4.2 Qualitative analysis of female entrepreneurship in the energy sector: the potential for women's empowerment

Within the original Nuru programme, many community members – both men and women – were interested in becoming entrepreneurs. However, the final choice of VLEs is left to the village leadership. The result has been that women rarely take on the role of entrepreneurs. Instead, men with senior roles in the village frequently end up running the enterprises. As a result, women run only 19 per cent of village enterprises in the original Nuru model, and only 4 per cent of village enterprises in the newer model are women-led. Qualitative findings further reveal that when women take part in the business, they are usually assigned as the enterprise's secretary or bookkeeper. However, informal discussions with female VLEs suggest this pattern is not due to lack of interest by women in entrepreneurship. Instead, during village- and sector-level presentations on forming Nuru village-level enterprises, women expressed interest and excitement about this prospect of entrepreneurship, and the cause for their exclusion from the enterprises is probably due to traditional gender arrangements and authority structures in their communities.

Figure 1 Benefits of becoming a VLE by gender



Source Authors' own, field data 2017.

Despite the constraints imposed by village-level patriarchy, the results from our qualitative interviews of entrepreneurs in Nuru's entrepreneurial team model (four entrepreneurs per village) suggest that the goal of promoting gender equity in Rwanda presents an attractive environment for female entrepreneurs. Our qualitative analysis shows that, indeed, there are many benefits associated with engaging women as entrepreneurs in the energy sector. First, as shown in Figure 1, both men and women reported the vital benefit of generating family income as VLEs. However, we find that women and men report different use of the income gained. While most women (80 per cent) report spending income from their energy businesses on food and essentials for their households, men tend to spend their extra income on either recreational activities or informal forms of savings.⁸ Thus, an extra income source for women enables them to support their families' basic needs such as food, clothing, and health expenditures.

The importance of entrepreneurship as a source of family income in this study is consistent with previous entrepreneurship studies. For instance, the research of Sharma, Dua and Hatwal (2012) and Sidhu and Kaur (2006) reveals that entrepreneurship is beneficial to rural women compared to wage employment as it enables them to remain close to home while double tasking family duties and work demands as well as contributing to family income. Similarly, Abdo and Kerbage (2012) in their study cited family income as a key benefit of including women as entrepreneurs. A respondent from their study reported 'from the proceeds of selling milk; I am now able to secure regular income for my family' (*ibid.*: 68). These findings provide evidence that empowering women through entrepreneurship cushions women by providing them with an income source that they use to support their family.

A second positive impact for women is that they become recognised in their villages after becoming business owners and gain significant social status. By continually charging lights for customers, women become well known in their various communities. In many cases, they serve as mediators in times of conflict for other community members.

In the words of a female VLE who participated in our qualitative study, 'because I am a VLE I get to now meet a lot of people, and others come for advice from me. I am trusted, and I think I can now contest for the position of a village leader.' Non-VLEs also validated this finding as they also agreed that female VLEs were now recognised in the villages owing to the constant engagement with community members at recharging centres. Women are, therefore, able to reap social benefits, such as prestige and societal acceptance, especially in the rural areas where community engagements and a sense of belonging are highly valued. These benefits increase their self-confidence, which motivates them to take on other leadership roles. In line with our findings, Sharma *et al.* (2012), in their study on micro-enterprise development and rural entrepreneurship, clearly outlined status in society, increase in confidence levels, and social identity as key factors when women take on entrepreneurial roles. While attaining social recognition in the villages is very important to female entrepreneurs, no males reported improvement in social status as one of the main benefits of becoming an entrepreneur. It may be that men do not experience a substantial change in their social status since they are already recognised by village members before running the energy micro-enterprises.

Establishing solar recharging businesses in communities with no access to grid connection means that entrepreneurs and the villages in which these micro-enterprises are operating will now have access to clean lights. This benefit is also evident in Figure 1, which shows that most respondents reported access to lights as a benefit of establishing the Nuru energy business model in the area of study. Access to clean portable lights is shown to have health, educational, and economic benefits (Jacobson *et al.* 2013; Zahnd and Kimber 2009; Saghir 2005). In our case, the benefit from access to lights differs between women, men and children. Women often use these lights for domestic activities, which enables them to reduce the time spent on domestic activities such as cooking, collecting firewood or alternative sources of cooking energy and doing other household chores. With solar lighting, women can do other productive activities during the day while shifting house chores to after dark; and with the aid of the lights, women can conduct their domestic chores at night more quickly than before. Thus, access to lights provides women with the flexibility to re-appropriate their time use. As supported by results from Barnes (2007), access to power (clean lighting) can drastically reduce the amount of time women spend on household chores when compared to women who do not have access to electricity (clean lighting).

Qualitative interviews with local stakeholders and local gender specialists further suggest two main reasons behind the success of female VLEs. Women are more likely to be available at the shop to serve customers, either because of limited mobility or because they value the position more highly than men. Also, women who manage to get a spot in the businesses are especially motivated to succeed. We further observed that villages having fewer barriers to the participation

of female VLEs might be less stringent in other forms of gender discrimination. Further research is required to identify the reasons behind these effects.

Overall, our qualitative study indicates that, apart from access to clean lights, which reduces women's time use on domestic activities, becoming an entrepreneur in the energy sector provides additional income that is used by women to support their households in various ways. Also, female VLEs report gains in social status that have given them some level of respect and influence in their communities.

5 Conclusions

Few studies on business performance directly compare men and women entrepreneurs. Their findings are sometimes misinterpreted and can bolster inaccurate stereotypes of women business leaders and lead to biased research hypotheses such as the female underperformance hypothesis. Instead of conforming to habit, we based our hypotheses on liberal feminist theory, arguing that in a true apples-to-apples comparison of the sales performance of women- and men-owned businesses, women entrepreneurs would perform as well as their male counterparts. We further addressed the limitations of prior research by comparing the sales performance of male and female village-level entrepreneurs selling the same products/services based on the same supplier terms under the Nuru Energy solar distribution programme in Rwanda. Much to our surprise, our empirical findings reveal that female solo VLEs tend to outsell male solo VLEs by 36 per cent and that villages with female-led village-level enterprise teams tend to outsell villages with male-led teams by 60 per cent. These findings were further supported by qualitative research findings suggesting that women VLEs not only gain the opportunity to bring in much-needed family income but also gain in social status and confidence and in time efficiencies where domestic chores are concerned.

Overall, these findings suggest that women entrepreneurs make excellent sales agents in the solar energy sector in Rwanda and that social enterprises such as Nuru Energy can achieve higher levels of sales and market reach for renewable energy products by strategically recruiting women entrepreneurs at the village level. However, our qualitative findings also suggest that recruiting programmes for women may receive some pushback from the village patriarchy, necessitating strategic management of stakeholder relationships among village leaders.

Although promising, these data are only suggestive, since they are observational and thus correlational owing to the small percentage of female entrepreneurs in this sample and likely selection effects. Findings from the larger Nuru Energy research project will address whether these correlations are causal and can be consistently observed with larger samples of female enterprises. Our empirical data were minimal, and it is possible that our findings may be influenced by factors not measured in our dataset, including alternative sources of paid work.

Nonetheless, our findings have important implications for practitioners, policymakers, and researchers. Women can be excellent entrepreneurs and sales agents and may be in a position within the household and the village to perform extremely well in solar product/service sales. Serving as VLEs further confers to women important benefits, not reported by men, including an increase in social status, confidence to pursue village leadership roles in addition to family and business roles, and some relief from the time poverty that results from the necessity of completing most domestic duties during daylight hours. Policymakers may take insight from these findings when selecting programmes and policy strategies in support of women's entrepreneurship, economic development, gender equality, and energy access for all. Future studies should address other factors that may influence business performance in subsistence village contexts as well as additional measures of business performance and personal benefits to entrepreneurship for women and families. We see promise in experimental studies showing that women tend to perform better when competing exclusively against other females than when competing against males and females (Gneezy, Niederle and Rustichini 2003; Niederle and Vesterlund 2007). Importantly, the disadvantages that women business owners face is aggravated by the contribution of traditional cultural and social gender norms to important structural barriers to business growth, such as access to credit, which can be constrained by lack of credit history, lack of collateral (Bushell 2008), lack of mentors, and low social approval (Rodríguez and Santos 2009). Finally, we hope that, in the future, more researchers will consider the importance of basing hypothesis development on theoretical propositions supported by rigorous prior findings rather than on spurious preconceived biases against women business leaders.

Notes

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- 7 These figures are obtained from the coefficients in columns 2 and 4, respectively $e^{0.305}-1=0.36$; $e^{0.471}-1=0.60$.
- 8 This is not to say that women do not participate in informal savings, but as far as income from the Nuru business model is concerned men are more likely to save while women spend their income on basic needs for their households.

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Promoting Women's Entrepreneurship in Distribution of Energy Technologies: Lessons from ENERGIA's WEE Programme^{*†}

Soma Dutta¹

Abstract In the energy access space, women's entrepreneurship has gained momentum in the last few years. ENERGIA, International Network on Gender and Sustainable Energy, has been implementing the Women's Economic Empowerment (WEE) programme since 2014, focusing on developing women's enterprises in the clean energy sector. With its five partners, ENERGIA has supported more than 4,000 women in clean energy businesses in seven countries. WEE programme experience in the dissemination of clean energy technologies shows women entrepreneurs to be effective in 'last-mile' distribution for affordable clean energy technologies through their social networks. Supporting women entrepreneurs calls for a multi-pronged strategy combining the approaches of enterprise development and women's empowerment. Useful tactics to promote women energy entrepreneurs include combining technology and business skills upgrading with empowerment and agency building; sustained mentorship support; and trust-based one-to-one selling approaches. There is also a need to take an ecosystem approach that places an equal emphasis on the enabling environment and direct support to entrepreneurs.

Keywords: gender, energy, women's entrepreneurship, economic empowerment, last mile.

1 Introduction

The United Nations 2030 Agenda for Sustainable Development provides an ambitious roadmap to eradicate poverty and achieve sustainable development for all. The Sustainable Development Goals (SDGs) seek to address key challenges such as eradicating poverty and hunger, eliminating inequalities and violence against women, and achieving sustainable energy for all. While the SDGs recognise separately the importance of gender equality and energy access, in reality these are inextricably linked, and addressing them together can

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offer multiple development gains. More broadly, gender equality and women's economic empowerment can bring significant gains in human development and wellbeing for individuals, families, and societies through many channels, such as enabling greater autonomy and choice for women and boosting investment in children (UN Secretary-General's High-Level Panel on Women's Economic Empowerment 2016). Increasing the share of household income controlled by women tends to increase spending on children's education and health (World Bank 2011).

In this context, women's entrepreneurship in energy is gaining recognition as an emerging strategy to bring energy services to unserved and underserved communities that collectively also represent a huge economic growth potential (ENERGIA, World Bank Group/ESMAP and UN Women 2018; SEforALL 2018; OECD 2010). This is in line with the thinking that female entrepreneurship represents an untapped source of innovation, job creation, and economic growth in developing countries (Niethammer 2013).

Despite these developments, engaging women as entrepreneurs is yet to be viewed as a 'mainstream' strategy for 'last-mile' energy access, and the opportunities surrounding women's energy enterprises are far from being realised. Female entrepreneurs operate well below their potential owing to gender-specific barriers that include discriminatory gender norms, lower levels of education and business experience, competing demands of family responsibilities, and limited access to financing and to productive resources (Kelley *et al.* 2017; Mastercard 2017; Global Entrepreneurship Monitor 2017, cited in SEforAll 2018; FAO, IFAD and ILO 2010). Further, systematic documentation and literature on the strategies and impacts of women-centric entrepreneurial approaches to expanding energy access are limited mostly to clean cooking (Clancy, Oparaocha and Roehr 2004; Rewald 2017; SEforAll 2017, cited in Johns Hopkins University, Babson College and ICRW 2019) and the approaches are not sufficiently well known in the energy sector. For these reasons, national governments and private sector and development partners are yet to invest in these at a scale that can make a meaningful dent in the projected access gap.

ENERGIA, International Network on Gender and Sustainable Energy, has been implementing, together with its partners, the Women's Economic Empowerment (WEE) programme in seven countries – Senegal, Kenya, Uganda, Tanzania, Nigeria, Nepal, and Indonesia – since 2014, focused on developing women's enterprises in the clean energy sector and in the productive use of energy.² During this period, more than 4,000 women were supported in setting up energy businesses and have delivered clean energy products and services to 2.9 million consumers, mostly in rural areas and in low-income communities. The objective of this article is to share insights into the WEE programme experience to create and upscale new approaches that promote women as energy entrepreneurs. The article is targeted mainly at practitioners who are working with, or are interested in working with, women entrepreneurship models in the energy access space.

The article starts with a description of the analytical perspective adopted, followed by an overview of the WEE programme strategy. The subsequent sections are a deep dive into three specific areas: training and mentoring women energy entrepreneurs; sales, marketing, and promotion; and supply chain development and management. I acknowledge that there are other important strategies such as access to finance, but these are not covered in this article. This is followed by a discussion of the results achieved by the programme. The article concludes with thoughts on broader programmatic and management lessons that go beyond individual strategies.

2 Methodology and analytical perspective

This article presents the results of a self-reflection process as a learning methodology that was undertaken collectively by the WEE programme partners. Spread over more than six months, the process involved a comprehensive mapping of strategies adopted by each partner; the classification of strategies under different themes such as finance, sales, and promotion; and analysis of each strategy, separating what worked from what did not and why. In addition to the iterative process of developing the narrative, it drew on numerous progress reports, mission reports, webinars, blogs, PowerPoint presentations, phone calls and face-to-face learning events and meetings. An important source of data was the end-of-project surveys that were commissioned in each of the seven countries and an external evaluation commissioned by ENERGIA (Sustainable Energy Solutions 2017). The end-of-project surveys included a structured survey of 700 entrepreneurs that received programme support and 1,490 users of energy products, key informant interviews, and focus group discussions. Overall lessons were compiled into a publication (Dutta 2018), which this article draws upon.

The article attempts to analyse the various strategies with which the WEE programme employed in different contexts. It draws out common features of the most promising strategies, as well as lessons from efforts that did not go so well – or failed completely. In the context of strategy, it examines the obstacles that women entrepreneurs face and shares possible strategies to counter these. While the enterprises operate in varying sectors and have unique products and services, they all experience comparable challenges and share a common objective, and their comparative analysis revealed common features in their ways of working and their business models.

In the context of the WEE programme, this article examines three questions that are central to the design, implementation and management of a women's energy entrepreneurship programme.

- 1 For a programme implementer, what are the good practices or key elements of a successful business model to engage with women micro-entrepreneurs involved in the sale of clean energy products? In the context of this article, a good practice is one that has proven its relevance as an effective way to achieve a specific objective; solves a particular problem and has a positive impact on women and

- men individually and/or communities and institutions; is feasible to learn and to implement; helps men and women to improve their livelihoods and empowers them; and has the potential for replication and should therefore be adaptable and cost-effective (FAO n.d.).
- 2 Utilising these strategies, what were the results achieved in terms of economic empowerment impacts on women entrepreneurs and their families and on energy access for the communities, especially the poor rural ones they serve?
 - 3 What lessons can be learned from the WEE programme from a management and programmatic point of view?

3 The WEE programme approach

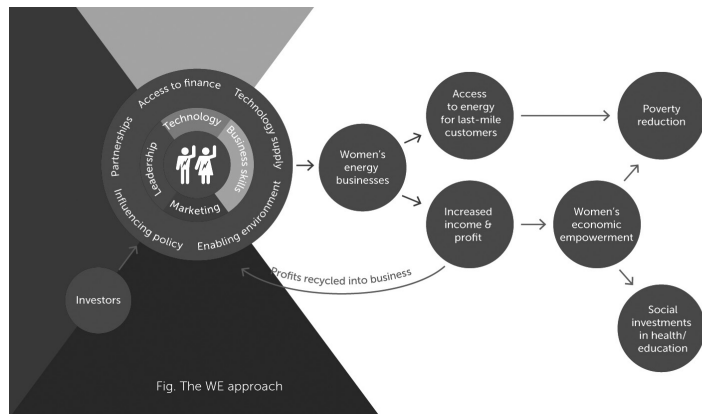
The WEE programme is implemented under the overall umbrella of ENERGIA by five partners: Practical Action Eastern Africa, with Sustainable Community Development Services (SCODE) as co-partner, in Kenya; Centre for Rural Technology, Nepal (CRT/N), with the National Association of Community Electricity Users Nepal (NACEUN) and Practical Action Consulting as co-partners, in Nepal; Kopernik Solutions in Indonesia; Solar Sister in Nigeria, Tanzania, and Uganda;³ and Energy 4 Impact, with Social and Ecological Management Fund (SEM Fund) as co-partner, in Senegal.

The central objective of the WEE programme was to achieve economic empowerment for women, through entrepreneurship in clean energy and productive use of energy. There are several definitions of 'empowerment': Kabeer (2001) defines empowerment as 'the expansion in people's ability to make strategic life choices in a context where the ability was previously denied to them'. It involves both individual agency – the idea of acting on one's own behalf – and collective actions to engage in a process of transformative change. Economic empowerment has been defined by the Organisation for Economic Co-operation and Development (OECD) as the capacity of women and men to participate in, contribute to, and benefit from growth processes in ways that recognise the value of their contributions, respect their dignity, and make it possible to negotiate a fairer distribution of the benefits of growth (OECD 2010). The notion of economic empowerment, as adopted within the WEE programme, encompasses all of these.

The programme design was centred on the belief that, because the factors limiting women's entrepreneurship are manifold and intertwined, integrated measures are needed to realise women entrepreneurs' potential. Accordingly, in collaboration with various stakeholder partners at national and sub-national levels, the organisations implementing the WEE programme provided:

- An integrated support package including skills development on technical, business, and leadership aspects; and
- Ongoing mentoring on business planning, growth, and capital access.

Figure 1 The WEE approach



Source Author's own.

The programme's strategy encompasses a comprehensive entrepreneurship development process that entails a careful identification of the barriers women face in starting a business and then systematically addresses them (see Figure 1, which depicts the process adopted for women's entrepreneurship within energy distribution value chains). After enrolling in the WEE programme, each entrepreneur receives training in technical and business aspects of energy businesses, as well as in leadership, empowerment, and agency – skills that transcend their energy businesses. Each of them also receives customised support from trained mentors, who help them on an ongoing basis to identify new market opportunities, develop marketing strategies, transact with suppliers and government authorities, prepare business plans, and negotiate with financial institutions. The mentors take the support package right to the entrepreneur's place of work and demystify 'business' for them. The project also supports the partner organisations to strengthen product supply chains through linking them with international high-quality suppliers of energy products, and links entrepreneurs to financing institutions and with the local government.

In working with entrepreneurs, the partners work with a range of business models, continually evolving their strategies. As summarised in Table 1, the strategies can be broadly organised under the themes of recruitment; training and mentoring; promotion, marketing and sales; distribution; and access to finance.

4 Teaching and practising entrepreneurship through technology and business training, agency and empowerment training, and mentoring

When entrepreneurs enter an energy business, they have to deal with challenges related to, for example, unfamiliar technologies, learning to reach out to new customers and negotiating with suppliers, in addition to the gendered barriers that women face. To deal with these, they need continued support until their enterprises are mature and they are confident of running them independently. The WEE programme

Table 1 Strategies adopted by WEE partners in different countries in working with micro- and small-scale women entrepreneurs

	Practical Action	Solar Sister	CRT/N	Energy 4 Impact	Kopernik Solutions
Country of operation	Kenya	Tanzania, Uganda	Nepal	Senegal	Indonesia
Recruitment	Through existing groups such as village savings and loan associations (VSLAs) Community meetings used to spread project information	Women with background in nursing, teaching, farming, and business Recruitment using community champion model	Members of microfinance institutions and those endorsed by community-based organisations are preferred Community meetings used to spread project information	Members of existing women's groups preferred Community meetings used to spread project information	Women with social or community services encouraged to join as entrepreneurs Community meetings used to spread project information
Learning and practising entrepreneurship: training and mentoring	In-session start-up and refresher courses (technology, business skills, and leadership) Mentoring through technology and business mentors	Start-up and refresher courses (technology, business skills, agency empowerment, and leadership), provided through sisterhood groups	In-session, start-up and refresher courses (technology, business skills, and leadership), separate for starting and existing businesses	In-session start-up and refresher courses (technology, business skills, and leadership) Mentoring through technology and business mentors	In-session start-up and refresher courses (technology, business skills, and leadership) Mentoring through technology and business mentors
Promotion, marketing, and sales	Market assessments used to develop focused marketing strategies Women supported to register businesses, brand products; local networks to sell products	All entrepreneurs are equipped with a shirt, backpack, and marketing materials, with clear branding Entrepreneurs use sales techniques such as Site Seller for personal, one-to-one selling	Generic promotion on improved cookstoves (ICSs) through linking with local government programmes and channels	Village chiefs and local community leaders are informed about the project and activities Organisation of customised marketing events and support to entrepreneurs	Entrepreneurs are trained in conducting technology fairs Village chiefs and local community leaders are invited to technology fairs Wonder Women are equipped with branded shirt, tote bags, and marketing materials
Reaching the last mile	Women members of VSLAs make own sales reaching out to other counties Women are hired as commission agents to sell in distant locations	Solar Sister entrepreneurs live and work in last-mile communities	ICS entrepreneurs hire other women in their district as sales agents on commission basis	Members of women's groups each make sales, reaching out in distant locations	Entrepreneurs hire other women, friends and relatives to reach distant locations and other islands
Finance facilitation	Using community-based savings groups that are empowered to lend to members	Entrepreneurs are provided with start-up kits but encouraged to purchase inventory in small batches in line with their affordability	For productive use applications, entrepreneurs are linked to local financing institutions Women's entrepreneurship development funds set by local community-based organisations	Loan guarantee fund used to ease loan terms and buy down interest rates to provide equipment on credit to entrepreneurs Support supplier credits	Early in the programme, technology was provided on a consignment basis Later, entrepreneurs were linked to local financing institutions but made little use of the credit functionality

Source Author's own.

partners use a 'recruit, train, and mentor' approach to provide this support. After recruitment, the entrepreneurs participate in in-session training, which usually takes several days. This is followed by periodic shorter refreshers spread over a longer time. In parallel, the women receive one-on-one support from a designated mentor for at least a year, either individually or within small groups.

Before they start off, the entrepreneurs need to be trained in technology use and maintenance, sales and marketing, bookkeeping, public speaking, and agency and empowerment. Training involves everything from teaching entrepreneurs how to leverage existing networks for sales to managing their businesses. Specific areas for skill building include: technical, managerial, and business aspects of commercial operations; sales; legal requirements; equipment and inputs, and inventory management; and leadership, agency, and empowerment aspects.

A conclusion drawn from these five projects is that in-session training should combine business aspects with agency and empowerment. The reason for this is that one of the main challenges women entrepreneurs experience is lack of confidence in themselves. Being an entrepreneur calls for scaling new mountains every day, from opening a stall in the local market, to travelling in search of new customers, to managing monetary transactions and employees, and administering inventory. All of these require self-confidence and the courage to step out of one's comfort zone, and a change in women's perceptions of themselves. Research shows that, controlling for individual context and business characteristics, psychological factors are the strongest predictors of business start-up (Arenius and Minniti 2005; Elam 2008; Kelley *et al.* (2017), Johns Hopkins University *et al.* 2019). Accordingly, the agency/empowerment training provided covers aspects of empowerment (identifying and appreciating one's own strengths, while developing positive mental habits to overcome limiting beliefs); leadership (developing understanding of leadership, developing a vision and setting goals for oneself, being proactive, solving problems, and improving communication); and business skills (marketing, financial planning, customer care, record-keeping, and business modelling).

In the WEE programme, mentoring has been a critical strategy for taking the project services to where the women entrepreneurs are, often in distant locations. Mentoring can be defined in several ways; for the WEE programme, it includes setting up a one-to-one relationship, in which an expert (mentor) provides consistent support, guidance, and practical help to a less experienced person (mentee) on a sustained basis (Lowbridge 2012). The mentor visits the mentee in order to provide specific, customised, and timely support. An important aspect of mentoring is goal setting and action planning. In every session, the mentors, in discussions with the entrepreneurs, agree on time-bound goals and make an action plan, which lays out the activities that are necessary to keep the entrepreneur on track. Action planning also helps to map out clearly where the mentee needs support, to agree on

goals that they can work towards, to gauge how they are doing and to celebrate when a goal is achieved. Another lesson learned was that mentoring is best viewed as a dynamic process: as businesses grow, the needs of the entrepreneurs evolve and, thus, the mentoring inputs must evolve accordingly. Initially, both business and technical aspects need equal and frequent attention. However, once businesses grow, the technology mentorship is scaled back and the business inputs are scaled up. In some cases, when the capacity needs of the various entrepreneurs become more similar towards the end of the project, a group mentorship approach is adopted, where entrepreneurs are mentored together in clusters while learning from each other's experiences.

5 Linking women to customers and markets

Creating an awareness and demand for clean energy products in last-mile communities is the first and most difficult part of marketing and sales. Building an appetite among risk-averse, mostly poor customers for clean energy products, particularly in rural locations, and establishing sales and distribution channels increases both costs and risks for entrepreneurs. For women trying to set up energy businesses, these challenges are even greater because of the additional constraints they have in terms of literacy, education, time, and mobility. The WEE programme intervention approach builds on two of women's most valuable assets, their social network of family, friends, and neighbours and the trust they enjoy in their communities. However, realising the potential of these assets requires women to be supported in a systematic manner.

First, women need to be coached on how to reach out to new customers, beyond their comfort zone. As Katherine Lucey, Founder of Solar Sister says,

When they start, women entrepreneurs run through their immediate market, which is their families, their friends, their neighbours, maybe their church group and then they hit a wall because now it's selling as a profession, which is a little bit different than selling as a hobby, you know, selling to your cousin or your sister (Pailman 2016).

Even though the initial sales are valuable ones, the enterprises will be sustainable only if they push themselves to sell in newer and further locations, going beyond their family and friends. And this is where sales training and mentorship support help, to step up to the next level of entrepreneurship. One effective strategy for selling beyond the 'inner circle' is holding technology demonstrations in public places. However, many of the implementing partners found that conducting demonstrations requires a high degree of skill. It is not sufficient to hand out promotional materials to the entrepreneurs: they have to be trained and to practise using the materials. Good practices in conducting successful technology demonstrations include:

- Organising product demonstrations during harvest or festival seasons, when people, especially farmers, have cash in hand.

- Organising demonstrations in areas where there is a large need for the technologies, such as off-grid areas.
- Ensuring the entrepreneur has a complete understanding of the product's features, including warranty and aftersales service.
- Ensuring the entrepreneur has some technology stocks with her for selling on the spot.
- When possible, inviting an influential figure (e.g. a village chief or government official) to attend the demonstrations.

Branding is another effective strategy to improve sales. In rural areas, where trust plays a major role in purchase decisions, the brand value of the organisation that the entrepreneur represents plays a big role. It is critical that potential customers know the brand well and associate it with quality and reliability. All the WEE programme partners equip each entrepreneur with a t-shirt, a tote bag or backpack, a notebook and marketing materials (posters, flyers), all with clear branding. This start-up kit provides entrepreneurs with the essentials for running a professional, 'recognisable' business. In some communities, Solar Sister also provides the entrepreneurs with a hijab in bright orange,⁴ the colour that is widely associated with Solar Sister. In Nepal, CRT/N provides each of its entrepreneurs with an identity card, which certifies that they have been trained under the WEE-Nepal project.

In addition to demonstrations, one-to-one trust-based selling works well in rural areas. Clean energy products require people to change the way they consume energy and make a relatively substantial investment that will pay off over time. Therefore, traditional ways of selling need to be adjusted. Selling techniques need to respond to a market that has already been spoilt by cheap, but low-quality, clean energy products. This market spoilage has proven to be a major challenge for entrepreneurs in all the countries ENERGINA works in, and it has also been highlighted by a number of previous studies (Koch and Hammond 2013; Bardouille 2012; Pailman 2016; Lighting Africa 2010; ODI *et al.* 2016). One strategy is for neighbourhood/community product demonstrations to be followed up with one-to-one conversations with potential customers. Women entrepreneurs are able to reach out to and hold these conversations with other women who are making the decisions about household energy purchases and are potential clients. In a survey of 362 respondents, 97 per cent of Solar Sister entrepreneurs report selling to women customers, with 32 per cent selling almost exclusively to women (Solar Sister 2016). In all countries, this close relationship with the customers also provides direct real-time customer feedback on the products (also reported in Heuér 2017).

6 Managing the distribution network

Building a reliable supply chain that reaches remote and rural consumers is undoubtedly one of the most challenging aspects of

distribution. In most countries, distributors of energy products have minimal, if any, distribution networks in rural and remote areas. It is as costly and time-consuming to find reliable supply-chain partners offering commercialised products as it is to recruit and retain an effective last-mile salesforce. When products have to be imported, as in many developing countries, import taxes are high, and the importation processes can be difficult and time-consuming (Colenbrander and Miller 2017). Another challenge is that, in response to a growing demand for solar energy products, cheaper, lower-quality, and faulty products have flooded the market. In most cases, the price sensitivity of these markets makes it difficult for entrepreneurs trying to sell good-quality products at a higher price, even though they may be more reliable, certified, and tested. In addition, in rural areas and remote locations the logistics of distribution is difficult: distances are long, road networks are poor, clean energy equipment and technologies may be bulky, and the means of transportation are insufficient and expensive.

Women entrepreneurs are hampered by all of the above realities as well as by societal norms and attitudes that often restrict their mobility, thereby hindering their growth opportunities. Given these challenges, engaging women as part of the distribution chains to reach last-mile areas requires putting efficient systems in place: for transporting technologies and creating trusted points of sale; for ensuring reliable and 'local' repair and maintenance services; and for encouraging a supportive family system that shares some of the entrepreneur's domestic responsibilities and also participates in the business. Women entrepreneurs are generally more successful if their spouses and/or other household members support their activities. This can be in the form of putting money aside to invest in their businesses, using their own network to increase the outreach of the businesses, and helping with the distribution of the products or record-keeping.

From the experience of the WEE programme implementers, it is clear that for seamless distribution of energy products a number of partners need to be engaged, including private sector technology suppliers, transporters, micro-entrepreneurs, sales agents, and producers (especially for some technologies such as *in situ* improved cookstoves). The WEE programme partners utilise existing retail infrastructure where available, including linking with non-governmental organisations (NGOs), community-based organisations, local financing institutions, and women's groups. They also work with international suppliers of high-quality products, complementing their sales forces in distant, remote locations with women-centred door-to-door entrepreneur networks.

At the same time, it works well for women to engage other people in sales, including family members. Given the mobility constraints women face, an effective strategy is a 'relay system' in which the entrepreneur recruits agents or resellers who further distribute the products and are paid a commission on sales by the entrepreneurs, agreed by both parties. In Indonesia, when Ibu Sekeda learned about the Kopernik

programme, she was interested in joining but busy with other work. Consequently, she hired other women from among her friends to sell on her behalf. Kopernik calls these ‘downlines’ and has introduced a downline incentive system to encourage such growth and initiative among entrepreneurs. Similarly, in Nepal, within a relay system, many women work as marketing agents for improved cookstoves in the remote districts. The relay system helps them to be part of the business without having to invest in purchasing inventory. As they gain experience as marketing agents, many gain confidence and start their own businesses employing others. Popularly known as ‘network sales’, this methodology encourages the sales agents to tap into their personal and professional networks to find customers (Zaniewicz 2017). The relay system helps entrepreneurs to increase their sales and, at the same time, creates jobs for other women and young people. The entrepreneurs are able to reach distant markets and a second layer of employment is created for others. For the agents, the main advantage is that they are able to participate in a business and earn an income without having to make an investment in the purchase of product inventory, which many find difficult to do. For the relay system to work well, the following aspects need to be ensured:

- A reliable supply of products, so that orders placed with agents can be met and delivered to the customers in time, otherwise there can be a loss of credibility.
- A pre-agreed system of commission per unit of sale.
- Agents that are fully trained and knowledgeable about the products and aftersales services, in effect as well trained as the entrepreneur herself. This is an additional cost that may have to be built into programmes.

Another effective way of expanding the reach of entrepreneurs is for them to work in groups. In Kenya, many of the women entrepreneurs work in groups of 12–30 members. When working in groups, the entrepreneurs come together for specific tasks such as pooling individual contributions to purchase products and raw materials in bulk, renting a shared space for stocking inventory, sharing transport for bringing products to markets, or sharing the costs of conducting promotional events. All of these enable them to reap economies of scale. In most groups, however, the selling is mostly done on an individual basis, ensuring a ‘business-like orientation’. Group members divide up areas among themselves so that they do not compete with each other. Women say that by buying together they are able to place larger orders, negotiate better prices with suppliers, and transport their inventory in bigger batches. This cuts the cost of transportation and for technologies such as improved stoves and reduces breakages, as the entrepreneurs, when transporting jointly, are able to hire better vehicles to cart their inventory. This is a big gain in rural Kenya where the roads are bad and *boda bodas*⁵ are used to transport fragile equipment such as the ceramic

liners of improved cookstoves. Working in groups also gives women much-needed peer support, both for the business and more generally. Group members support each other, and most groups have set up a small fund that they lend to members in emergency situations at zero interest rate for short durations. When working with groups who will take on distribution functions, it is advisable to ensure that:

- The groups have been in existence for some time and have been engaged in some income-generating activity.
- A savings practice is in place. This helps tremendously: it not only provides some investment capital, but is also an indicator of financial discipline (keeping records of members' savings, maintaining minutes of group meetings, etc.) and basic financial and business management literacy.
- They have set in place systems to ensure all members understand and operate within the given requirements.
- When conducting commonly planned events, all members of the groups are given ample notice so that they can ensure they have enough products for on-the-spot sales.
- Group members understand that contributing towards shared costs is part of giving back to the business to ensure sustainability, as opposed to expecting the project to cover costs.

7 Results of interventions

Utilising the above strategies, the WEE programme supported 4,153 entrepreneurs between 2014 and 2017. These women sold clean energy technologies and fuels (such as fuel-efficient cookstoves, solar lights, and biomass briquettes) to 2,960,756 consumers who previously did not have adequate and affordable energy services (ENERGIA/Hivos 2018). The programme's outcomes are visible at two levels: entrepreneurs and users.

7.1 Programme outcomes for entrepreneurs

Women entrepreneurs set up and operate clean energy enterprises. Data collected across all seven countries showed that in 2017:

- Seventy per cent of the entrepreneurs receiving programme support recorded a consistent growth in profit margin each quarter;
- More than 95 per cent of the entrepreneurs who had taken out loans or consignments had not defaulted on loan repayment instalments;
- Eighty-two per cent of the entrepreneurs were involved in major household purchase decisions; and
- Seventy-two per cent of the entrepreneurs were actively taking business decisions for their enterprises.

When women start working, they often feel empowered and in control of their lives, making decisions in their businesses and in their homes, often together with their husbands or business partners. They may gain greater respect and influence in the household decision-making process. As the entrepreneurs earn additional incomes, they are able to contribute to children's education, health care, clothing, or food. Further, as part of the project, the entrepreneurs acquire skills in sales, pricing, record-keeping, and technical knowledge about how to repair the products – skills that can be transferred to other activities. In fact, most entrepreneurs diversify to include other items in their product range. Finally, they develop confidence and knowledge as they travel to new areas and extend their networks. In the case of CRT/N, in the end-of-project survey, 80 per cent of the entrepreneurs reported making their own decisions in the enterprise; 67 per cent also said they were involved in decision making at the household level, either solely or jointly with their husbands; and 94 per cent of them reported increased confidence in doing business as the most important change they have observed in themselves, while 48 per cent thought it was their increased ability to maintain books and records (some were of the opinion that while the businesses were small, they were able to track inventory and sales without formal account books) (Scott Wilson Nepal 2017).

A majority of these entrepreneurs become role models for other women in their communities, showing that women like them can run successful businesses, and negotiate and advocate for their interests.

7.2 Programme outcomes for users

Through these enterprises, poor and difficult-to-reach populations have gained access to clean energy products and services, such as solar task lights, lamps and home lighting systems, improved cookstoves, and fuel briquettes.

Women entrepreneurs contribute to building new markets for energy products and services and serve customers at the last mile. The WEE experience shows, as has been documented by Bardouille (2012), that when women serve last-mile markets as entrepreneurs, they can contribute to developing new markets and establishing trust. In Tambacounda region in Senegal, Energy 4 Impact has supported 124 women's groups (representing 5,357 women) as energy enterprises in the Energy Opportunities for Women in Senegal project. The end-of-project impact study (Clowes and Benigni 2017) showed that, as compared to the nine control villages in the surrounding areas where the project was not active, in areas where these women enterprises were operating, community members were:

- Willing to pay over 40 per cent more for a solar lamp or an improved cookstove than in other non-project areas;
- Over twice as likely to be able to recall specific benefits of solar lamps or improved cookstoves as compared to other areas; and

- Fourteen times more likely to know where to buy a solar lamp or improved cookstove than those in regions where the project is not active.

A 2017 survey of Solar Sister operations in Tanzania, covering 610 respondents (250 Solar Sister customers and 360 non-customers), showed that the majority of Solar Sister customers are living in communities away from the main highway and hence represent the last mile (MIT-CITE 2018).⁶ The survey also showed that 97.8 per cent of Solar Sister's customers were dependent on kerosene before purchasing a solar product from Solar Sister. Another survey by the Miller Center for Social Entrepreneurship showed that of the customers who purchased solar lanterns, 91.6 per cent no longer used kerosene (Gray, Boyle and Yu 2017).⁷

When they gain access to energy services, users save time and money on fuelwood (through using improved cookstoves) and kerosene (through solar lighting devices). The end-of-project survey in Senegal showed that the households using solar lamps sold by the women entrepreneurs spent a fifth (US\$0.60 per month) of those using grid power for lighting (US\$3.11 per month). Similarly, households using solar lamps or a solar home system used them for more each day (6.2 and 5.4 hours respectively) than those who used grid power for lighting (4.6 hours per day). Those relying on candles and battery-powered devices had the fewest hours of lighting per day (Clowes and Benigni 2017).

8 Lessons in designing programmes for women's energy entrepreneurship

Going beyond specific strategies, this section offers some broader lessons that are relevant for those interested in developing and executing multi-country, multi-partner programmes on women's energy entrepreneurship.

An enabling environment is as important as direct support to the entrepreneurs. Most women's enterprise development interventions are focused on addressing the 'immediate' challenges that women face in starting and expanding a business, and this is an important area. However, larger systemic factors, or the 'enabling environment', play an equally decisive role in shaping the circumstances within which these businesses operate. To improve women's participation in energy value chains, the enabling environment – including policies and resources available – must ensure that structural barriers that create bias against women within policy are overcome. At the same time, the markets and institutional environments in which governments, financiers, energy companies, and consumers operate support such initiatives. Such a conducive, enabling environment is one that includes measures that directly support women's businesses; for example, through improvement in the ease in doing business for women, including streamlined processes for business registration and licensing, easy access to information,

guidance, application submission and follow-up, and easier access to financing (e.g. not requiring husbands to sign onto bank accounts/loans).

An ecosystems approach based on partnerships is central to women's enterprise development. An energy access ecosystem has been defined as an

interconnected network of organisations working on the supply of modern energy services to poor people. From national governments, donors, utilities and businesses, to NGOs, civil society, community groups, and individual consumers, all of these actors have a crucial role to play in creating universal energy access. No single entity can do this alone. Indeed, these organisations are interconnected and their success is linked both to each other and the system as a whole (Practical Action 2012: xi).

In promoting women's enterprise development, a number of stakeholders need to operate in conjunction: entrepreneurs, specialised support organisations, financial institutions, civil society organisations (e.g. women support groups), and the public sector. Together, they need to perform multiple functions: to provide a conducive policy and regulatory environment; to facilitate access to funding; to provide business development support and mentoring; to link entrepreneurs to markets; and to strengthen the value chains as a whole. Multi-stakeholder partnerships also help harness knowledge and interorganisational learning, for pooling resources and capabilities, for navigating bureaucracy and accessing finance, and for promoting the enterprise's added value to customers, donors, and the wider community (Bymolt *et al.* 2015).

For the WEE programme, such collaborations helped the partners fill gaps in capacities; they also enabled scale and speed and, most importantly, brought fresh perspectives into the thinking. When a range of actors work together, they can sustainably bring about the changes in attitudes, practice, and policy necessary to support women's energy entrepreneurship. The range includes:

- The entrepreneurs, who bring energy products and services to last-mile communities. They also play a crucial role in increasing awareness concerning energy and environment issues and about available options.
- Clean energy product suppliers, who benefit from increased distribution, sales, and aftersales service networks as a result of their ability to extend credit to enterprises and to final consumers.
- Banks, microfinance institutions, cooperatives, and village savings and loan associations, which extend credit to a pipeline of potential clients (investment-ready women entrepreneurs, equipment suppliers).

- National government agencies and local authorities, which set the policy environment and the regulatory framework in which women's energy businesses have to operate, including issues related to taxes on energy products and quality assurance.

In programming, aggregation of efforts is an important function.

ENERGIA and the WEE implementation partners played this role on multiple levels. In approaching local financial institutions, the partners aggregated demand for credit from a number of entrepreneurs, making it a viable packet for the financial institution; they also aggregated demand for energy products when approaching product suppliers, thereby negotiating better prices. For ENERGIA, aggregating the services provided to its partners enabled it to optimise resources significantly. At the same time, aggregating the collective experience of its partners enabled it to generate credible evidence and data from the field, which has been useful for global advocacy.

9 Conclusions

In the energy access space, women's entrepreneurship will increasingly matter in the years to come, for communities, for businesses and the private sector, and for governments. Globally, several bilateral and multilateral donors are prioritising women's economic empowerment. Increasing the role of women in the economy is viewed globally as critical for economic resilience and growth (OECD 2010). Women's economic participation, and their ownership and control of productive assets, is reported to speed up development, help overcome poverty, and reduce inequalities.

While the reality is that women continue to face obstacles as entrepreneurs, there are now a number of organisations and businesses working with women in the energy sector. As a result, there is an emerging body of documentation around lessons and successful approaches for promoting women's access to finance, training, and markets in energy businesses. The WEE programme experience with supporting women's entrepreneurship in clean energy indicates that such approaches that keep women at the centre of the business models are not only workable, but have a significant role to play in the distribution and uptake of clean energy products and services at a large scale.

This article has highlighted the key challenges experienced by women's enterprises working in the clean energy sector, and has provided a set of possible solutions to address these. Clearly, each market is unique, as is each woman, and women entrepreneurs' demands are not universal; instead, they need customised solutions. While women still face obstacles to establishing and growing their businesses, there is a growing number of approaches to promote them as entrepreneurs in the energy space. Building on available experience and expertise, both public- and private-sector players have an opportunity to collaborate in order to bring these initiatives to scale.

Notes

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- 1 Soma Dutta, Senior Technical Advisor, ENERGIA, International Network on Gender and Sustainable Energy, hosted by Hivos Foundation, The Netherlands
 - 2 In this article, productive use of energy is used to mean ‘utilisation of energy – both electric, and non-electric energy in the forms of heat or mechanical energy – for activities that enhance income and welfare’ (Kapadia 2004).
 - 3 In late 2016, Solar Sister’s operations in Uganda were wound up.
 - 4 A hijab is a veil, usually covering the head and chest, worn by some Muslim women in the presence of any male outside of their immediate family.
 - 5 *Boda bodas* are bicycle and motorcycle taxis commonly found in East Africa.
 - 6 In 2017, with the support of the US State Department’s wPOWER programme, Solar Sister partnered MIT’s Comprehensive Initiative on Technology Evaluation to study last-mile customer preferences and evaluate the reach of Solar Sister’s women-centred distribution chain. MIT conducted over 600 interviews in Tanzania with both Solar Sister customers and non-customers, resulting in the report *Reaching the Last-Mile: Women’s Social and Sustainable Energy Entrepreneurship* (MIT-CITE 2018). The study created a customised framework to evaluate the ‘last-mileness’ of interviewees. MIT combined poverty level, grid access and remoteness to form a Last Mile Index (LMI).
 - 7 In June 2017, the Miller Center for Social Entrepreneurship conducted action research to study the social and material impact of Solar Sister’s model on end customers. The report, *Turning on the Lights: Transcending Energy Poverty Through the Power of Women Entrepreneurs* (Gray *et al.* 2017), assessed the impact of solar lanterns on education, health, productivity, finances and women’s economic and social empowerment. Sample size: 257.

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ENERGIA's Gender and Energy Research Programme: Findings and Experience from Research for Policy^{*†}

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Abstract It has long been understood that energy is a key contributing input to reaching development goals, but little is known about the extent to which energy supply benefits men and women equally, and how interventions could contribute to a reduction of any gender inequalities. Filling in gaps in knowledge on the gender equality of benefits of energy supply and providing insights for policy and practice were the starting points for ENERGIA's Gender and Energy Research Programme. This article has a dual objective: highlighting findings and policy implications from the research programme and reflecting on aspects of programme design on doing research for policy. Findings from the nine research projects in the programme illustrate the links between energy interventions and impacts along an adapted energy results chain. Reflection on research programme design is based on the experiences in this international multimethod interdisciplinary programme.

Keywords: gender, energy, policy research, multimethod, interdisciplinary, research programme.

1 Introduction: the need for policy-relevant research on gender and energy and the ENERGIA Gender and Energy Research Programme

1.1 The need for evidence on gender issues to reach energy objectives for development

A landmark achievement in energy access was reached in 2017 when the number of people without electricity access fell below one billion for the first time (IEA 2018). With 99 million people gaining access to electricity during 2017, the international goal of achieving universal electricity access by 2030 is coming closer to being achieved. Progress in access to clean cooking also appears to be gaining pace, with 525 million people gaining access since 2011, but continued

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acceleration is needed as currently nearly 2.7 billion people still rely on biomass, coal, or kerosene for their daily cooking needs (*ibid.*).

In this dynamic context, it is clear that effective policies to reach targets are crucial. As energy access is a prerequisite for many aspects of human development and for reducing inequities, current policy decisions can have a big impact on the equality of men and women in benefiting from energy supply interventions. However, little is known about the extent to which energy supply benefits men and women equally, and how interventions could contribute to a reduction of any gender inequalities. Development of evidence to inform policy on gender issues in energy is therefore urgent.

The topic of gender in energy supply is typically associated with access to clean cooking. The explicit separate measurement of access to clean cooking for Sustainable Development Goal 7 on energy reflects the increased attention for policy priority on this topic. Indeed, cooking is a key nexus topic within the gender and energy space, as in nearly all countries in the world women have a higher responsibility to prepare family meals than men. However, considering cooking on its own is insufficient to capture gender issues. Firstly, many different household and productive tasks such as water collection or pounding grains may also be gendered, and especially for such heavy work, mechanisation can have a significant impact. Secondly, even when energy supply is in principle available at household level, regulations and social norms form barriers to equal access to energy services for women and men. Together, these two sets of factors lead to inequity of access to energy supply and inequity in benefits from energy use between men and women.

Taking a deeper look at energy access, energy use, and how benefits are obtained can uncover the occurrence of gender inequity and its reasons. This includes recognising that energy access in itself does not contribute to reaching development outcomes, but that this involves several causal steps from energy supply, through, for example, use of energy services, and changes in economic and social status and agency. An in-depth study should also include insights into contextual factors, including gender norms, which influence uptake of energy supply and benefits of use. Finally, gender issues exist in the energy supply chain, where women, as entrepreneurs and employees, have a role to play in reaching the energy access targets and objectives for development outcomes.

1.2 Which evidence has policy relevance?

For evidence to have policy relevance, it is important that it is credible, and that the mode of communication is appropriate to the targeted audience. In the gender and energy nexus, the audience ranges from international policy level for the Sustainable Development Goals, in which energy is an instrument to broader development, to national governments' departments of energy, gender, or economic

development, but also to utilities, energy supply businesses, non-governmental organisations (NGOs), advocacy organisations, civil society organisations, and academic audiences. Each of these has a direct or indirect role to play in influencing the gender benefits of energy supply. Although what is seen as credible research may differ depending on the audience, for research in the complex and dynamic multidisciplinary field of gender and energy, ‘credible’ research is seen to have several key elements (in agreement with Crewe and Young (2002) and DFID (2014)):

- Engagement between researchers and stakeholders both in the phase of development of research and in the dissemination phase, if possible by researchers with an established credibility for their target audience.
- Multidisciplinary or interdisciplinary research, where specific expertise on the topic or topics of study includes gender expertise.
- Multimethod research, in which quantitative and qualitative methods are designed as appropriate to specific research questions, for triangulation of findings, but also to increase local and policy relevance of research in the design phase.
- Transparency of methodologies, assumptions, deduction of conclusions, and data.
- Careful consideration of contextual factors and especially cultural factors, (gender) power relations, to ensure validity of the research both from a local perspective, and to establish the relevance of findings to different geographic, social, and economic contexts.

These elements of credible research for policy were incorporated in the design of the ENERGIA Gender and Energy Research Programme. Section 3 of this article presents experience with two of the above topics for which consensus may be less definite: multidisciplinary research and multimethod research.

1.3 The ENERGIA Gender and Energy Research Programme

Filling in gaps in knowledge in the gender and energy nexus to provide insights for policy and practice were objectives for the ENERGIA Gender and Energy Research Programme. This five-year programme (2014–19), funded by DFID, was implemented by ENERGIA, International Network on Gender and Sustainable Energy, and was carried out by nine teams with 26 partners in 12 countries in Africa and Asia.

The research programme focused on five thematic areas, selected through a literature review of current research and needs on gender and energy.

In total, five research projects (RA1–RA5) were developed following a call for proposals, each defining specific research questions within these

Table 1 Overview of the projects in the ENERGIA Gender and Energy Research Programme

Research theme	Project	Research area	Project research reports
Electrification	Exploring factors that enhance and restrict women's empowerment through electrification	RA1	University of Oslo <i>et al.</i> (2019)
Productive uses of energy	Productive uses of energy in the street food sector	RA2	University of Twente <i>et al.</i> (2019)
	Unlocking the benefits of productive uses of energy	RA6	IDS and GIZ (2019)
Energy and related sector policy dynamics	Gender factor in political economy of energy sector dynamics	RA3	MSSRF and CRT Nepal (2019)
Energy sector reform	Gender and fossil fuels subsidy reform	RA4	GSI-IISD <i>et al.</i> (2019)
Role of the private sector in scaling up energy access	Female micro-enterprise creation and business models for private-sector distribution of low-cost off-grid light-emitting diode (LED) lighting	RA5	EPRU UCT and IPA (2019)
	Building the evidence base for women's empowerment and entrepreneurship to improve energy interventions' effectiveness: a literature review	RA7	Johns Hopkins University, Babson College and ICRW (2019)
Gender mainstreaming approaches	Lessons learned on gender approaches in energy sector policy and practice	RA8	Clancy <i>et al.</i> (2016)
Trends in gender and energy	How global trends impact gender equality and social inclusion in access to sustainable energy	RA9	SEforALL (2018)

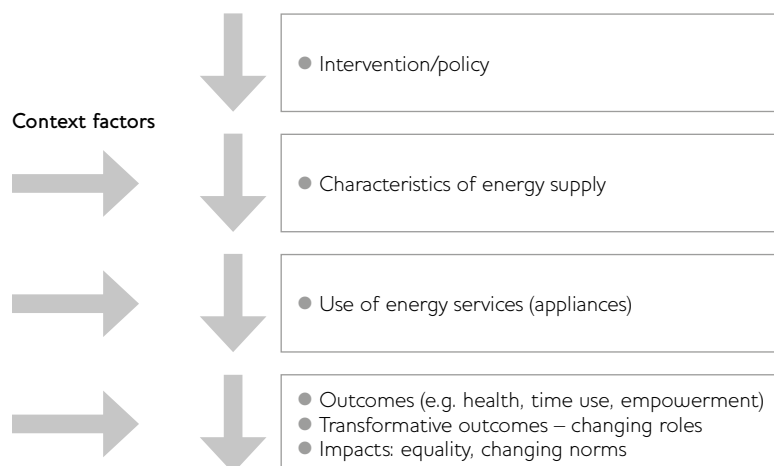
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thematic areas. Two further projects (RA6, RA7) were developed within two of the thematic areas to fill in remaining high-priority questions, and two projects were commissioned separately (RA8, RA9). Table 1 provides an overview of the projects and their abbreviated names according to research area (RA) numbers for reference in this article.

The research projects used a multimethod approach and stakeholder engagement, which was achieved through the establishment of consortia with a broad representation of expertise across research disciplines and countries, and from universities, research institutes, and NGOs.

Through its large capacity and focus on creating evidence for policy, the ENERGIA Gender and Energy Research Programme has been able to contribute substantially to the availability of evidence within a large variety of topics within the gender and energy nexus and to the visibility and awareness of the gender issues in energy.

This article presents selected findings on cross-cutting issues from the research programme in Section 2, and in Section 3 it also provides a reflection on doing research for policy in this multidisciplinary and multimethod programme.

Figure 1 The energy policy to impacts chain in context

Source ENERGIA (2018).

2 Findings and policy implications

2.1 The energy policy to impacts chain as a framework to structure findings

In this article, highlights of findings from the research reports and the synthesis report of the research programme are presented following the framework of the energy policy to impacts chain shown in Figure 1. The ENERGIA research programme adopted this framework to introduce and discuss key issues of commonality and cross-cutting learning. The chain illustrates a causality logic from energy policy interventions to outcomes on users of energy. It is essentially an adapted energy results chain, such as that used in the Multi-Tier Framework (Bhatia and Angelou 2015).² During the research programme, each of the research teams mapped early findings against an elaborated template of the chain, which provided additional linkages including opposite directions of causality.

Looking at the simple framework in Figure 1, a key observation is that gendered energy uses of energy services are central in the chain. The term ‘energy service’ is used to reflect the user’s perspective related to the function, such as lighting, milling, or cooking, rather than the access to energy sources such as electricity or liquefied petroleum gas (LPG) since it is the service that people ultimately aspire to rather than energy sources. On the supply side of the chain, energy policy influences the provision of physical infrastructure and, importantly, also the characteristics of the energy supply, such as price, capacity, and reliability. The supply influences not only initial access to energy connections but also the choices and extent of uses of energy for energy services. Further, energy policy and interventions can encourage women playing a role in energy supply.

On the use side of the chain, the different roles of men and women and power relations within households and communities are relevant factors

that influence access to energy services and also the differences in outcomes of energy use between men and women. These outcomes can be direct benefits such as in health or reduced time poverty, but they can even be transformative when roles of women in their household change and, eventually, social norms shift. A key element of this approach is that the understanding of use and energy demand looks beyond the level of 'connection' or 'household', which is the typical unit of data collection for both researchers and policymakers.

Key to the ENERGIA Gender and Energy Research Programme is the consideration of context factors. The framework illustrates that both supply and demand (including use) are influenced by many different context factors. Making explicit geographic, socio-political, and economic factors and how they interact with the decisions and links throughout the chain provides necessary insights for the interpretation of findings.

2.2 Gendered differences in energy demand and use of energy services

To highlight the perspective of women and men as energy users, we start the presentation of findings in the middle of the chain, with the topic of gendered differences in the current use and aspired use of energy services. It focuses on questions of how gendered differences in roles, responsibilities, and norms between men and women influence access to energy, energy demand, and use of energy services. An important finding from the research programme is that energy demands are not necessarily met equitably for men and women, even when energy supply is physically available at household or community level, for agriculture or for income generation. These gendered differences are evident not only in households, but also in income generation in agriculture and in non-farm activities.

Within the household, cooking is one of the energy services that is highly gendered. However, ownership and use of other appliances is also gendered. Use of lighting, for example, can be gendered depending on the location of the light – especially in households where men and women spend significant amounts of time in separate locations – such as the kitchen or separate living quarters. In many contexts where women have limited income and decision-making power, priority appliances for women are those that save time, increase convenience, and reduce drudgery, such as rice cookers, kettles, and irons, whereas men tend to buy appliances for business and leisure activities (e.g. TV, radio, sound systems) (RA1, University of Oslo *et al.* 2019). Nevertheless, there are signs that men are getting involved in domestic activities, such as cooking and ironing, when modern appliances are available in the household (RA6, IDS and GIZ 2019). As evidence on these changing roles was found only in the RA6 study in Ghana, it appears that the relatively more equitable norms facilitated this unlocking of gendered tasks.

Agriculture is the largest sector for women's employment in a great part of the southern hemisphere, and in northern Africa, Oceania, southern Asia, sub-Saharan Africa, the Caucasus and Central Asia and western

Asia, women are more likely than men to be working in this sector (UN 2015). Research in India and Nepal (RA3, MSSRF and CRT Nepal 2019) indicates that the agricultural tasks that men are engaged in (land preparation, sowing, irrigation, harvesting, and selling crops) are the ones that have benefited from higher levels of mechanisation, while tasks traditionally performed by women (transplanting, weeding, and smaller-scale post-harvest processing) are only recently becoming mechanised to some extent. The research found that in Nepal, a contributing factor to the mechanisation of women's tasks was the social change following out-migration of men.

In enterprises, it was found across research projects that gender differences in energy use between men and women follow largely from differences in the type of enterprise men and women own and run. For example, in Homa Bay, Kenya, women's income generation is often through small shops while men's income is from involvement in fishing, working as casual labourers, or through employment in larger enterprises (RA1, University of Oslo *et al.* 2019).

IDS and GIZ in their RA6 research report present the following finding:

Case studies of PUE [productive uses of energy] interventions in Ghana and Tanzania... showed that male-dominated sectors were more likely to benefit than female-dominated ones from improvements in electricity supply. This is because men typically operate more and larger enterprises, which consume more electricity than female-owned enterprises, which instead dominate cooking fuels such as firewood, charcoal and liquefied petroleum gas (LPG) (IDS and GIZ 2019: 39).

However, within a certain sector and type of enterprise the differences in energy use and preferences for energy services between men and women were found to be small. The example of the African street food sector (RA2, University of Twente *et al.* 2019) illustrates the remarkably small differences in wants and aspirations between the majority of women and the men in the small enterprises in this sector. Stereotyped gender differences obviously get lost in the pre-selection of people choosing a type of enterprise (sector, scale of operation) to engage in (RA2). The policy implication is that, while supporting such a female-dominated sector in the first place is highly gender relevant, there seems to be no need in this particular sector to differentiate the policy interventions by gender.

2.3 Outcomes of energy use

Once appropriate forms of energy supply are available and energy services are used, these can lead to outcomes such as time savings and reduction of drudgery. These in their turn can induce second-order outcomes (impacts at individual level) depending on how the time saved is used and whether this changed status, roles, or negotiating power. Even transformative changes are possible.

The evidence on saved time and reduced drudgery confirms that these are a priority outcome of use of energy services.

At the household level, the evidence showed that access to and use of modern energy brings savings in time, reduces drudgery, and provides convenience, collectively allowing for better time management. In the surveys done in Chhattisgarh and Jharkhand (India), women estimated that using liquefied petroleum gas (LPG) instead of biomass saved them around an hour per day in cooking and cleaning pans (RA4). For Nepalese women, using rice cookers instead of biomass meant that there were fewer dirty pans to clean (RA1) (ENERGIA 2019: 50).

It is relevant to note that there are other areas of potential demand for time saving and reducing heavy work that can be supported through energy services. An example is the 1.5 hours per day on water collection reported by the women in the study area in Kenya (RA1, University of Oslo *et al.* 2019). Although increased income through improved energy supply is not an outcome for the majority of modern energy users, statistical data from Ghana and Tanzania showed that there was a positive relationship between productive use of electricity and women's economic empowerment (RA6, IDS and GIZ 2019). The evidence illustrates that the use of electrical appliances allowed for diversification in products for sale, which had positively influenced income for both women and men.

In the final stage of the chain, transformative changes in gender roles or even norms as an outcome of energy interventions are considered. The evidence in the research programme indicates that this is not a typical outcome of energy interventions. Where changes in gender ideologies and norms and ability to influence life decisions have taken place, this is mainly related to women being socially and economically empowered. Evidence of structural or increased empowerment was found in cases in which women were involved in energy supply (RA1, University of Oslo *et al.* 2019), or when modern energy services and appliances enabled women to undertake jobs that were traditionally 'male' (RA6, IDS and GIZ 2019). The evidence of transformative changes was found mainly in contexts where gender norms were less inhibiting to women making choices. Such norms may have been undergoing change as part of societal processes, but also evidence was found where energy interventions themselves supported wider acceptance of women taking up new roles (RA6, *ibid.*).

2.4 Characteristics of energy supply

The precondition for meeting energy demands leading to the potential outcomes presented above is that an appropriate energy supply is in place. The characteristics of energy supply itself have a big influence on the use and benefits of supply. Starting from the need to understand energy supply beyond the level of 'numbers of households connected', the Gender and Energy Research Programme has explored different

characteristics of supply. The findings (e.g. in Rwanda, Bonsuk Koo *et al.* (2018)) indicate that the attributes of supply in the Multi-Tier Framework³ are useful indicators to uncover issues of access from a gender perspective.

Gender analysis in energy access typically takes place at household level, although gender issues also occur within households. Gender analysis at household level compares female-headed households with male-headed households. Understanding the differences between these categories is essential. For instance, many male-headed households include at least a husband and wife, while female-headed households have only one adult of working age, and single adult households (such as the divorced or widowed) are often relatively poor. Further, women (irrespective of civil status) may face difficulties in meeting requirements for registration for formal energy access. Therefore, improvements to the attributes of energy supply (not only affordability but also, for instance, availability, reliability, quality, formality, and health and safety) for poor households have a strong relevance to reducing gender differences at household level.

Additionally, characteristics of supply influence access to energy of men and women *within* households and taking a gender perspective may shed light on how changes in energy attributes can contribute to improving women's quality of life. Examples illustrate the need for gender analysis to go beyond the inter-household level.

Affordability

Affordability is not only related to levels of household income, but to the value given to women's time. Where biomass cooking fuel is collected by women it is perceived by the household to be 'free', i.e. there is no monetary cost, while cleaner alternatives will have a financial cost, which is likely to be high relative to household income even with subsidies. Hence for low-income households it is possibly considered 'unaffordable' (RA3, MSSRF and CRT Nepal 2019, and RA4, GSI-IISD *et al.* 2019). Specific targeting of poorer women in the case of India's scheme for LPG connections (Pradhan Mantri Ujjwala Yojana (PMUY)) is shown to reach women in low-income households and to lead to uptake of LPG, which earlier schemes had failed to achieve.

Location of energy supply

The urgency of providing energy sources to the location of use is especially striking in areas where violence outside the home is common. The example of Homa Bay, Kenya (RA1, University of Oslo *et al.* 2019), where 43 per cent of respondents said that women members of their household have been victims of violence when going to fetch firewood, provides an indication of the difference that supply of fuel to the household could make.

Even when electricity supply is available in a household, the research found gendered differences in use of lights related to the location of lights in the household (RA1, University of Oslo *et al.* 2019). Lights were

most common in the kitchen in India and Nepal where the person installing the systems advised on suited locations for light.

Also for productive uses of energy, it was found in Rwanda and Senegal (RA2, University of Twente *et al.* 2019), and in Tanzania and Ghana (RA6, IDS and GIZ 2019) that the location of electricity supply has a gender dimension, where women's considerations for the choice of a business location more frequently include being close to home, while men more frequently choose based on how likely the location is to attract customers. The same consideration was not found to be significant for the male or female entrepreneurs in the street food sector in South Africa (RA2, University of Twente *et al.* 2019).

2.5 Gender-sensitive energy interventions including women in energy supply

At the top end of the energy policy to impacts chain, energy policies and interventions provide opportunities to create gender equality through the whole chain.

As women are underrepresented in energy supply, from a gender equality and women's empowerment perspective, the research looked at opportunities and pathways to include women in the energy supply chain. The research finds that women sell energy products as successfully as men (LED lights in Rwanda) (RA5, EPRU UCT and IPA 2019) or outperform men (solar systems in Kenya) (RA1, University of Oslo *et al.* 2019). The results of the randomised controlled trial (RCT) in 272 villages in Rwanda (RA5) show that business performance is similar across gendered micro-enterprise groups: female teams of entrepreneurs perform as well as male teams. To support women in overcoming challenges induced by gender norms, the literature identifies four types of support that significantly enhance the performance and sustainability of women's energy businesses: 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 (RA7, Johns Hopkins University *et al.* 2019; Dutta 2018).

However, it is clear from the findings presented above that making energy more gender sensitive also goes beyond including women in supply. To capture the potential contribution of energy on reducing gender inequality, gender-sensitive policies would address issues of energy supply and demand, and even go beyond the energy sector. Clancy *et al.* (2016) state that for effective gender mainstreaming in energy policy, each project should be contextualised in the design phase in terms of both the political economy and the local culture, particularly in respect of gender norms and values.

2.6 Synthesis messages for policy

The implications for policy are captured in six main messages cross-cutting the research programme in the synthesis report:

- 1 Universal energy access targets are unlikely to be met unless energy policies are aligned to women's as well as men's energy needs, their assets, skills, limitations and capabilities, and existing gender norms.
- 2 Involvement of women in energy-system supply chains is good for women and their families, and it is good for business.
- 3 Modern energy services for women's productive uses contribute to women's empowerment.
- 4 End-use appliances that deliver modern energy services to reduce drudgery and save time can transform gender roles and relations.
- 5 Improving the affordability, reliability, capacity and convenience of modern energy services can help achieve gender-equitable access and outcomes.
- 6 Engaging with political processes can help women access modern energy services and change gender norms (ENERGIA 2019).

3 Reflections on doing research for policy

3.1 Introduction to highlighted approaches used in the ENERGIA research programme

As conducting research to contribute to policy is an ambitious endeavour, considerations on doing research for policy were taken into account in programme design, from the preparation of commissioning research projects and throughout the programme. This section reflects on learnings from experiences with multimethod approaches, the use of a framework, and the development of common indicators. Finally, lessons may be taken from experiences with the development of a new research community in the gender and energy nexus, where collaborations between researchers from diverse disciplines and countries were both a challenge and a rich resource. The analysis is presented from the perspective of programme coordination and management, and builds upon feedback provided by the researchers, Principal Investigator and the Technical Advisory Group in programme meetings, reporting, and anonymous reviews.

3.2 Reflection on multimethod approaches

The research programme supported a multimethod approach to optimise relevance of research for policy and practice. The experiences of the original proposers of the research programme had led them to conclude that credible and convincing evidence for policymakers would not come from a single discipline. The collection of quantitative data was emphasised as a priority for this research programme, as the availability of quantified evidence and quantitative analysis was identified as a gap in literature studies on gender and energy. The complementary use of qualitative data collection served as triangulation and to look into questions of understanding phenomena and uncovering new or local perspectives. The experiences with this approach have been positive, and the reflection presented here indicates possible lessons for other multimethod programmes.

Across the projects in the research programme, quantitative data were drawn from surveys (covering over 11,000 people in total), including a longitudinal survey, and also from a systematic literature study, analysis of national statistical data, and experiments. One of the teams used RCTs with 1,072 enterprises and 5,000 households that allowed for deeper levels of quantitative analysis. The range of quantitative outputs includes quantitative analysis, correlation analysis, and quantified descriptive findings. The qualitative outputs range from in-depth case analysis and stories to quotes and photographs. Also for qualitative data, the number of cases studied at different levels of detail was substantial, as indicated by the listing of methods for qualitative data gathering: semi-structured interviews (547), key informant interviews (188), participatory focus group discussions (293), and stakeholder meetings ranging from workshops to discussions with experts, and literature studies. A combination of methods was used within each team and with different focus methods across the research programme.

One of the objectives for the use of qualitative methods was to refine research questions to stakeholder demands and detailed study of available evidence. Together, the interaction with stakeholders as key informants, the qualitative literature reviews allowing for gathering of insights from 'grey' literature including programme experiences, and the early field research provided a more in-depth understanding of priority research questions and hypotheses to be tested, of local context, and of the guiding contrasts for purposive sampling methods. Without such flexibility to adapt, the validity of the research would have been lower, especially for the research projects where differences between research sites were large – such as the energy sector reforms in Nigeria, Bangladesh, and India (RA4, GSI-IISD *et al.* 2019), and the productive uses of energy in South Africa, Senegal, and Rwanda (RA2, University of Twente *et al.* 2019).

In terms of the content of the research, the combination of both qualitative and quantitative methods was found to be essential to this research programme. Both qualitative and quantitative research enriched the understanding and provided eye-openers. Both qualitative and quantitative methods were effective in giving women 'voice'. For example, quantitative data on aspirations of men and women in the study on the street food sector (RA2, University of Twente *et al.* 2019) provided innovative findings that are not found in many qualitative studies, and qualitative methods were effective in learning from exceptions that would be lost in presenting only the averages, such as the stories of women who venture into 'male' professions or how men experience their gender roles (RA6, IDS and GIZ 2019).

Quantitative data in the study based around an RCT provided evidence on both business development and social impacts. The development of quantitative data for technical, social, and economic aspects of the research programme has been useful, and an added contribution to the gender studies field.

National-level statistics were hardly used for analysis in this research programme. An exception is the R4 study on LPG in Indonesia (Kusumawardhani *et al.* 2017), in which a quantitative analysis of macro-level national statistics was performed on the topic of income groups reached through subsidy mechanisms. However, the existing macro-level data, and the lack of gender-disaggregated data for the topics studied, do not allow for useful analysis for many urgent questions in the field of energy and poverty. Finally, also for the communication of findings, the multimethod approach is beneficial in targeting different audiences, both in numbers and through stories or quotes.

3.3 Framework development

The development of a framework had the objective of instigating and providing inputs to discussions of generalisation for each project and of developing cross-cutting findings, especially for the development of a synthesis report that targets a broad and international audience.

The framework was adapted from standard causal energy chains, from energy intervention to socioeconomic impacts. Such chains are also used by the World Bank, including the prominent central positioning of the Energy Results Chain in the background document to the Multi-Tier Framework (Bhatia and Angelou 2015). The simplified framework as presented in this article was used for the development of common concepts and indicators and used, for example, for both the call for proposals in 2014 and the presentation of findings, such as at the Sustainable Development Goals High-Level Political Forum (ENERGIA 2018). Participatory sessions at annual meetings to elaborate and detail the framework to capture more in-depth insights led to the identification of common research interests in a very complex mapping of interlinkages of factors, effects, and mechanisms of influence. However, it was found that a single framework was not appropriate to capture the essence of each of the studies. For instance, the energy chain focuses on energy supply characteristics as a major factor in reaching outcomes, while some studies used (complementary) frameworks that focused more on issues such as social norms, power relations, and political economy.

The experience with the participatory development of an emerging framework is that differences between disciplines and selected theoretical frameworks can be too large to bridge. If a common framework for analysis had been a priority, for example to ensure options for cross-cutting analysis and the presentation of overarching findings, the selection of projects would have been based on a predefined detailed framework. However, the flexibility of the approach used had the advantage of allowing learnings from diverse disciplines and of introducing local perspectives.

A common aspect of the frameworks and approaches was the attention to context and relevance from the target group perspective. Even more than expected, the local and personal perspective steered the research well beyond case study level. The approaches based on local

perspective led to findings that would not have emerged or might not have been prioritised through the use of predefined questions. An example of a grounded approach is the role of appliances as central from a user perspective (rather than only energy supply). The women's perspective brings a much stronger focus on social norms, gender roles, and traditions associated with ethnicity and religion rather than with technology or economic issues.

3.4 Indicators on gender and energy

One of the initiatives cross-cutting the research projects was the development of harmonised *indicators*⁴

- To develop a common language and interpretation of indicators, both to stimulate discussions between teams and for use in joint outputs of the programme such as the synthesis report;
- To provide a platform for the sharing of experiences with methodological, conceptual, and contextual issues between research teams; and
- To develop policy messages on the priority indicators on gender and energy.

The discussions on indicators made very clear that 'going beyond access' to dive into understanding of benefits of energy supply required the development of indicators at every level.

At the level of the attributes of energy supply, indicators provided a clearer profile of gender issues that can be addressed through energy supply – such as the location of energy supply in relation to the use by women for cooking and for productive uses. Such indicators could be added to the attributes of energy access mentioned in the Multi-Tier Framework.

Within the level of outcomes, general indicators such as agency, economic empowerment, social empowerment, and transformative change were earmarked as relevant cross-cutting concepts rather than as indicators for specified causal links. The metrics for such indicators are largely context specific. Typical indicators such as time use per energy service (e.g. the use by women of light in the evenings for productive uses) may reflect increased opportunities at the individual level but are not necessarily related to positive developments at the societal level. For most energy services, ownership of appliances such as rice cookers or mobile phones (rather than time use) was seen to provide a first impression of their potential benefits. Gender-disaggregated data on such indicators can provide an idea of the extent of inequity. However, to capture the nature and occurrence of outcomes, and to understand their attribution to energy supply, evidence from the perspective of the user on benefits and barriers is needed to optimise the validity of findings.

To facilitate discussions on external validity between research areas, the research programme also endeavoured to identify a priority list of indicators for three categories of context factors – social (gender), geographic/infrastructural, and economic – and to position these in national-level statistical data on the same indicators. Eventually, such data were mainly presented as background information while discussions on external validity and comparisons between field study areas were based on case studies with indicators specific to the research questions. The availability of national-level data relevant to the gender and energy nexus such as the level of electrification, the United Nations Development Programme Gender Inequality Index, or the female share of employment in senior and middle management was found to be low. To add to the potential for learning from cross-country comparisons, a ‘wish list’ of priority indicators was developed by the members of the research programme, compiled from different sources and based on programme experience. This list included aspects of gender sensitivity of the energy chain, such as specification of gender issues in energy policy documents and the minimum cost of a unit of cooking fuel.

3.5 Developing a gender and energy research community

The establishment of a research community in a new nexus of expertise, at the interplay between very different sciences, has been an important outcome of the Gender and Energy Research Programme. The research programme stimulated and developed an active learning agenda, for instance by organising webinars and annual workshop sessions on gender concepts, indicators, and policy influencing, by organising inputs to projects from members of the programme with different fields of expertise, and presentations and discussions with all programme members. An even more important factor in learning, though, has been the high level of collaboration between researchers from different organisations, from different disciplinary and country backgrounds, with the objective of optimising the credibility of research.

Whereas research in the field of energy is typically characterised by ‘a worryingly low number of women publishing in the field, a possible underrepresentation of social science and humanities disciplines and methods, and a lack of interdisciplinarity’ (Sovacool 2014), the experience in the Gender and Energy Research Programme has been very different, with a shifted balance on each of these topics.

Collaboration between disciplines may be one of the main innovations of the research programme. Owing to the nature of the research field, each project was multidisciplinary, with collaboration between disciplines, and first steps were made into the development of a new trans-disciplinary discourse. At the same time, in developing a framework and indicators across the research programme, as illustrated above, the collaboration between disciplines was a major challenge. In energy research, collaboration between researchers from different disciplines is most common in the fields of economics and engineering (Sovacool 2014), while the disciplines represented in the Gender and

Energy Research Programme ranged from anthropology and political sciences to econometrics and engineering, presenting a large range of priorities and research methods, and even convictions about the essence of science.

Collaboration between disciplines took place mainly within research consortia. To address the multidisciplinary nature of research questions, consortia were formed of experts from different disciplinary backgrounds. Research consortia used a variety of approaches to bridge disciplinary differences. These ranged from consecutive, or parallel, approaches – with the research framework defined from one main discipline – to ones using an integration of concepts and research methods. For instance, as in the literature survey performed as part of the RA6 project:

The combination of insights from different disciplines informs a framework of analysis that challenges the predominant neoclassical view of electricity as a gender neutral technological shock to households and enterprises... We use concepts such as occupational segregation, agency, or the care economy from feminist economics, as well as social norms, from anthropology (Pueyo and Maestre 2019).

At the programme level, collaboration between research teams was supported in a number of ways. One innovative approach was the development of smaller collaboration projects between research teams on topics of shared interest. This collaboration further extended the level of learning from research disciplines (e.g. political economy) and comparisons between contexts and energy sources, and through sharing of literature and data.

Whereas Sovacool (2014) identifies a general underrepresentation of women in energy research, the gender distribution of researchers within the programme was balanced, with in total 71 female researchers and 56 male researchers (with 88 per cent of researchers from the South). With eight of the nine research teams being led by women, it is safe to conclude that the gender balance was not biased towards men. As gender is not an issue only for women, we consider it at least as relevant that many male researchers have developed or built on their practical experience in gender research. It is the quality of the findings, the good reputation of researchers, and the networks of the researchers that are currently influencing policy.

Another dimension of diversity of the members of the research programme that contributes to the quality and credibility of the research was the high level of representation of Southern partners. Of the 26 research organisations that constituted the research consortia, 19 project partners were from the South. One consortium was entirely Southern based. All partners (both Northern and Southern) had experience with research in a country that was part of the fieldwork.

As the overview in this article clearly profiles, the number of different perspectives for the development of synergies, reflections, and learnings is substantial. While many researchers indicated that they appreciated the opportunities for collaborations and exchange (as evidenced by this anonymous quote from a programme review: ‘Love the diversity of academic and policy perspectives and research methods! Excellent basis for generating rich and practical considerations for policymakers and future research’), others experienced the collaboration and level of exchange, especially the cross-project initiatives, mainly as a burden. Indeed, it requires substantial effort to bridge gaps to other geographic areas, research methods, and even disciplines. The results from the programme reflect that the many gaps have been bridged, following on from the personal curiosity of the researchers to explore beyond boundaries and facilitated by the level of trust between the members of the research programme. As Robert Chambers states in his plea for a fundamental reflection on ‘knowing’ about development:

This entails epistemological, behavioural, and experiential transformations through synergies: of vocabulary and concepts; participatory ground-truthing; the behaviours, attitudes, and relationships of good facilitation; critical reflection and reflexivity; and principles, values, commitment, and energy (2017: 149).

4 Concluding notes

Developing evidence for policy on the gender equality of benefits of energy is an ambitious endeavour. In the ENERGIA Gender and Energy Research Programme, multimethod and multidisciplinary approaches have been essential in developing insights into mechanisms and factors that form and influence the links between energy policy interventions and outcomes on gender equality. By viewing the energy chain from the perspective of gender issues as experienced by men and women, the findings reflect the dynamic local reality of power relations and norms, and provide some indications of external validity. The research has contributed to the evidence base on gender differences in benefits from energy services related to gendered requirements and desired uses of energy services within households and between types of enterprises. The benefits of appropriate energy interventions can be significant and increase through targeted characteristics of energy supply and involvement of women in supply, but for effective approaches it is seen that contextualisation is needed to support the shifting of norms to increasing gender equality. The gender and energy research community that has been established is well positioned to contribute to furthering the messages that emerged from this research programme, and welcomes further expansion of the evidence base to increase the effectiveness of energy policy in optimising development outcomes for all.

Notes

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- † This article is based on the findings and experiences of all the research teams in the Gender and Energy Research Programme, the Principal Investigator of the programme, and the members of Technical Advisory Group. With special thanks for feedback on a draft of this article by Joy Clancy, the Principal Investigator, and Soma Dutta.
- 1 Annemarije Kooijman-van Dijk, Research Programme Coordinator, ENERGIA, International Network on Gender and Sustainable Energy, The Netherlands.
 - 2 The Multi-Tier Framework (MTF) was developed under the SEforAll initiative by the Energy Sector Management Assistance Program (ESMAP) to monitor and evaluate energy access based on multidimensional aspects of quality of supply. It distinguishes between tiers of access, from Tier 0 (no access) to Tier 5 (the highest level of access).
 - 3 The MTF specifies the following attributes of energy supply:
 - (1) For electricity – capacity (to supply the loads for different energy services), availability, reliability, quality, affordability, formality, and health and safety. These attributes are used to define the tier of access that is available at local or country level, ranging from Tier 0 (no access) to Tier 5 (full access) where higher tiers stand for larger versatility of the supply to meet energy demands at household level.
 - (2) For cooking, the MTF defines a separate set of attributes that describe the combination of fuel and stove: fuel availability, affordability, convenience, cookstove efficiency, and health related: cooking exposure, and safety.
 - 4 We use the term 'indicators' to refer to the specific factors that are studied under general issues of interest, and the term 'metrics' to refer to the measurable quantification/qualification of the indicator. For example, the Multi-Tier Framework (Bhatia and Angelou 2015) assesses the level of energy access, where availability of supply is one of the indicators and the metric provided is the number of hours per day for household electricity.

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Glossary

BIDS Bangladesh Institute of Development Studies
CRT/N Centre for Rural Technology, Nepal
DFID Department for International Development
DRE decentralised renewable energy
EETP Empowered Entrepreneur Training Program
EPRU UCT Environmental Policy Research Unit, University of Cape Town
ESMAP Energy Sector Management Assistance Program
GIZ Deutsche Gesellschaft für Internationale Zusammenarbeit
GSII- IISD Global Subsidies Initiative, International Institute for Sustainable Development
ICRUW International Center for Research on Women
ICS improved cookstove
ICTs information and communication technologies
IDS Institute of Development Studies
IEA International Energy Agency
IPA Innovations for Poverty Action
IRADe Integrated Research and Action for Development
LED light-emitting diode
LPG liquefied petroleum gas
MSSRF M S Swaminathan Research Foundation
MTF Multi-Tier Framework
NACEUN National Association of Community Electricity Users Nepal
NDCs Nationally Determined Contributions
OECD Organisation for Economic Co-operation and Development
OLS ordinary least squared
PV photovoltaic
RCT randomised controlled trial
RUBEN Research Unit in Behavioural and Neuroeconomics Research
SCODE Sustainable Community Development Services
SDG Sustainable Development Goal
SEforALL Sustainable Energy for All
SEM Social and Ecological Management Fund
SMEs small and medium-sized enterprises
TERI The Energy and Resources Institute
VLE village-level entrepreneur
VSLAs village savings and loan associations
WEE Women's Economic Empowerment

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Transforming Development Knowledge

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ENERGIA’s Gender and Energy Research Programme: Findings and Experience from Research for Policy
Annemarije Kooijman-van Dijk

‘Men and women do not benefit equally from the global drive to provide universal access to sustainable and modern energy by 2030. As users they have different energy needs linked to their different gender roles, and women’s needs are often ignored. This issue of the *IDS Bulletin* aims to fill some of the evidence gaps to inform more equitable policymaking, with particular attention to women’s involvement in the supply chain as energy entrepreneurs.’