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Mainstreaming gender in energy design practice: Insights from companies operating in sub-Saharan Africa's energy sector

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ABSTRACT

There are several readily available and freely accessible toolkits, handbooks, and manuals aiming to support gender mainstreaming in energy projects. However, with most of them targeting rural areas, their applicability by energy companies operating in urban environments is limited. This paper aims to shed light on the how energy companies operating in informal urban settlements in sub-Saharan Africa integrate gender mainstreaming into their practices, with a focus on their design processes, methods and tools. To address this knowledge gap we adopted an explorative, inductive and qualitative research based on reviewing existing gender-energy nexus supports (toolkits, handbooks, and manuals) and conducting semi-structured interviews with 15 private companies offering energy solutions in informal urban settlements in Sub-Saharan Africa. These companies focus on solutions to domestic energy needs (cooking, lighting, water heating, refrigeration, space cooling, space heating, washing, tool powering) and productive use of energy to support small entrepreneurship. The interview questions were defined to collect: 1) gender considerations in the design of energy solutions for informal urban settlements; 2) methods and expertise involved in the design of energy solutions; and 3) specifics of designing for informal urban areas. The results show that: 1] The interviewed companies are not familiar with and do not use any of the readily available supports on gender mainstreaming in energy projects; 2] They do not follow any step-by-step gender inclusion strategy but try to be impartial about considering gender through familiar and established methods used along the design process; 3] They seek for better understanding of how to integrate gender in their business practices and require specific support to do so.

1. Introduction

Energy security can be defined as an *"adequate, reliable and competitive supply of energy"* [1] or, more in details, the provision of sufficient energy needed to meet the basic needs of daily life of the household, with minimal disruptions to supply and at an affordable price [1–3]. Several authors point out that low-income women and girls are disproportionately affected by energy insecurity in the Global South [4–6] and the lack of energy access is detrimental to achieving gender equity and empowerment of women [7]. Women and girls are usually responsible for cooking, which is often done indoors using smoke-emitting paraffin and biomass and suffer from health problems associated with indoor air pollution [8]. Women often bear the burden of time-consuming fuel collection, spending four times longer than men [9], thus occupying their time which could otherwise be spent on education and income generation [10]. Overseeing housework, women are often responsible for making decisions related to choices of energy sources and devices, thus feel the mental burden to ensure reliable and continuous availability of energy in households [11]. Consequently, women handle low-quality unsafe energy devices in the absence of after-sale services [12,13].

The recognition that Africa is rapidly urbanising [14] is important for highlighting that the energy security challenge is impacting not only rural areas, but also urban poor environments in sub-Saharan Africa. Musango et al. [15] define poor urban environments as *"spatial locations with a concentration of urban dwellers who are deficient of something specified, both in quantity and quality, and are unable to meet a need or requirement or service fully"*. These environments usually face energy poverty, which can be referred to as *"the absence of sufficient choice to access adequate, affordable, reliable, quality, safe, and environmentally*

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benign energy services that can support economic and human development" [16]. In these environments, gender inequalities aggravate energy insecurity and unfilled energy needs [8].

As a result, there is the need to place gender at the core of energy interventions [17]. In fact, gender differences and inequalities have an effect on aspects such as resources and income, gender roles and responsibilities, as well as social and political capital interventions [17]. Without gender considerations, energy interventions in low-income communities are more likely to benefit men than women [18]. However, targeting women and leaving men behind, can cause a rebound effect of greater gender division, thus it is crucial to look at the issue through the gendered lens [19]. Despite the fact that research suggests considerable gendered impacts arising from energy insecurity [20,21], it must be highlighted that energy access policies and practices tend to be gender blind and thus unable to effectively respond to the needs of different genders and low-income households [22,23].

For these reasons gender mainstreaming –must be in place to ensure both women and men benefit from energy access for consumption and productive use [24,25]. Gender mainstreaming can be defined as *"the promotion of gender equality through its systematic integration into all systems and structures, into all policies, processes, and procedures, into the organization and its culture, into ways of seeing and doing"* [26] and a long-term strategy aimed at bridging gender awareness into consciousness and daily routines [15]. It is suggested that gendering energy innovations could provide opportunities for increasing innovation uptake in poor urban settlements and mitigating energy insecurity and energy poverty [27]. To this end, policymakers can contribute by ensure that women and low-income households are included in the decision-making process [23] and by supporting energy companies in developing gendered energy innovations [28].

Energy companies operating in the poor urban environments need to go beyond the provision of 'affordable, reliable and sustainable electricity services', as this might not be sufficient to reconfigure existing practices and norms and tackle gender equality and equity issues [29,30] (e.g. the benefits derived from the provision of a new energy service might not be evenly distributed between men and women [31]). There is a need for energy companies to be equipped with knowledge and know-how on how to embed gender mainstreaming into their processes and activities. A wide range of 'supports', such as toolkits, handbooks, and manuals, has been published to facilitate the practical implementation of gendered energy projects (e.g., [18,19]). However, the majority of existing supports are limited to rural areas thus their applicability by urban-oriented stakeholders is uncertain. Despite the availability of these supports, it is unclear if, and to what extent, energy companies in sub-Saharan Africa are aware of gender mainstreaming in the energy sector, and if they are integrating the above mentioned supports in their (design) processes. As pointed out by Clancy [21], although the Global South has adopted gender mainstreaming has been adopted in several sectors, including health, education and agriculture, it seems that the implementation and adoption in the energy sector has been slow. There are limited studies addressing gender mainstreaming in energy enterprises, and they tend to focus on the integration of gender equity and equality at the company organisational level (e.g., [32]). In addition, to our knowledge there is a lack of studies on the design methods and tools that energy companies use to develop gendered energy solutions. This paper aims to address this knowledge gap and understand if and how private companies offering energy solutions in informal urban settlements in sub-Saharan Africa apply gender mainstreaming practices in the design of energy solutions. In addition, we aimed to collect their gender considerations, analyse methods and expertise involved in the design process and understand the specifics of designing for informal urban settlements. The research question can be summarised as follows: *"How do energy companies operating in informal urban settlements in sub-Saharan Africa integrate gender mainstreaming into their practices, and what design processes, methods and tools do they use?"* This can be broken down into two main research objectives:

- To review existing gender-energy nexus supports (toolkits, handbooks, and manuals) and identify related strategies, methods, and best practice principles that can be adopted by energy companies;
- To carry out semi-structured interviews to understand if and how energy companies integrate gender mainstreaming into their practices, with a focus on the overall design process and the supports adopted.

In order to address this question we carried out an exploratory, inductive and qualitative research based on a review and analysis of existing gender-energy nexus 'supports' (toolkits, handbooks, and manuals), and semi-structured interviews with 15 private companies ranging from small enterprises with just 3 employees to large enterprises with over 500 employees.

The study was carried out as a part of the research project 'Mainstreaming Gender for Energy Security in Poor Urban Environments', in short Gender for Energy Security (GENS), involving researchers from South Africa, Kenya, and the UK. The GENS research aims to enhance energy innovations that consider the different roles, responsibilities and needs of women and men in dealing with energy insecurity in African informal urban environments [15]. One of the GENS goals is to establish Social Innovation "Living Labs" [33] for multistakeholder collaboration designing, prototyping, and testing gendered energy solutions in informal urban settlements in South Africa and Kenya. We see local private energy companies as catalysts for change initiating multi-stakeholder co-design activities in the project Living Labs. Therefore, energy companies need to be equipped and capable of designing context-relevant energy solutions with gender in mind. We aim to use the outcomes of this research to inform the development of a bespoke design toolkit made to support companies developing gendered energy solutions for informal urban settlements.

The paper is structured in 5 sections. Section 2 outlines the methodology used in this study. Section 3 presents the results of review of existing gender-energy nexus supports. Section 4 present the outcome of the semi-structured interviews and Section 5 discusses the collected results. Section 6 concludes the paper.

2. Research methodology

This section presents the rationale of the research methodology and, following Sanders' 'research onion' [34] discusses the adopted research paradigm, approach, methodological choice and time horizon, followed by the description of data collection and analysis process.

This research adopts an interpretivist *research paradigm*, which assumes that reality is (at least partly) subjective, and puts emphasis on interpreting subjective meanings and actions of subjects [35]. This suits our research, in which knowledge is generated by the interaction between the researchers and energy companies, and the interpretation of how these companies integrate gender mainstreaming into their practices.

In terms of *research approach*, the research is characterised by being exploratory, inductive and qualitative. Exploratory research is suitable to investigate a phenomenon that has not been clearly and adequately addressed before [36], as it is for the research question defined in this paper. We adopted an inductive approach because we aimed at generating new knowledge from the analysis of data collected [37] (in our case from semi-structured interviews). Our research was qualitative, because this is suited for interpretivist, explorative and inductive research, as it focuses more upon understanding, giving meanings, and interpreting a phenomenon, as well as the subjectivity of the researcher [38].

Two *research methods* were selected:

- Literature review was used to address the first research objective. We conducted a literature review to identify existing gender-energy nexus 'supports' (toolkits, handbooks, and manuals). We then

analysed these 'supports' to understand how they could be used to guide companies' practices, looking in particular at the project stages and related methods and tools. Academic and grey literature review was considered the most suited method to scan for existing gender-energy nexus 'supports'.

- Semi-structured interviews were used to tackle the second research objective. Interviews were recorded, transcribed and coded to find relevant patterns aligned with the aim of the research. A semi-structured interview approach was deemed to be the most appropriate method for collecting relevant information from the companies. Being non-standardised, semi-structured interviews allow probing more detailed responses and ask to clarify what was said [39], thus, dig deep into the issue under investigation. This was particularly important when aiming to understand complex business processes which are distinctive to each organisation.

In relation to the *research time horizon*, our research was cross-sectional, because we collected data from participants (energy companies) at a given point in time.

The following text goes into the details of the two adopted research methods.

2.1. Literature review of gender-energy nexus 'supports'

A literature review on existing design 'supports' (toolkits, handbooks and manuals) addressing the energy and gender nexus in low-income contexts was conducted. The key search concepts were "energy", "gender mainstreaming" and "design support", and the specific Boolean phrase we used was as follows: (Energy) AND ((Gender) AND (Mainstream*) OR (Equality) OR (Equity) OR (Fairness) OR (Women)) AND ((Design) OR (Support) OR (Tool*) OR (Handbook) OR (Manual) OR (Method) OR (Guid*) OR (Project) OR (Training)). In other words, we searched for design 'supports' which address the energy and gender nexus. The search was performed on the web and in Google Scholar since we knew that these kinds of supports are usually found in the grey literature. The search resulted in 20 design supports published between 2004 and 2019 (see Appendix A for the complete list). Supports were analysed to identify the design stages they address and the methods they offer.

2.2. Semi-structured interviews

Interviews were structured around six questions focused on three main themes addressing (Table 2): 1) gender considerations in the design process of energy solutions (questions 1 and 2); 2) methods and expertise involved in the design of energy solutions (questions 3–5), and 3) specifics of designing for informal urban areas (question 6).

2.2.1. Study participants

With a target to achieve theoretical saturation – a point at which additional data provide no new information and collected data are sufficient for analysis [40] – we invited 48 companies to take part in the study. 15 of them agreed to participate. The low participation rate can be linked to the Covid-19 pandemic, during which the study was conducted. Businesses operating in low-income contexts were severely affected by the Covid-19 restrictions and, as a result, could not easily commit their time to the study.

The companies contacted to take part in the study were selected based on their business focus: they had to be offering energy solutions to customers living or businesses operating in informal urban settlements. To stay in line with the GENS project goals, companies operating in South Africa and Kenya were invited first. However, saturation point was achieved through expanding the list of potential participants to other Sub-Saharan African countries. Interviews were conducted until no new information emerged for the three interview themes.

Convenience sampling was applied. Companies and their representatives to contact were selected after conducting an internet search or being suggested by the project partners based in South Africa and Kenya. Invitation emails introducing the GENS project and interview themes were sent to representatives from each company, who were either a CEO, project manager or employee from the design department. The contacted representatives were free to decide whether to attend the interview themselves or recommend a more knowledgeable colleague. Three interviews were attended by two participants from each company, while the rest were attended by a single employee.

Characteristics of participating companies and interviewees are shown in Table 3. Interviewees and companies are kept anonymous. This is crucial in order to [41]: protect the privacy of participants so that they are more comfortable in participating in the interview; ensure that participants are not connected to the study and/or to their employer in order to keep them safe from potential repercussions from employers (in case, for example, they share negative aspects related to the company they work for). In terms of business operations, most of the participating companies are engaged in the distribution of energy solutions, meaning that they either buy, develop and/or manufacture energy products and offer a service of distribution to their clients. One-third of participating companies are engaged in developing energy products and services. Four companies manufacture cooking stoves and cooking fuels, while one company offers wholesale of off-grid energy products, and one company provides energy consulting and auditing. In terms of energy end-uses, one-third of participating companies tackle clean cooking, while the rest focus on other end uses, such as lighting, IT/entertainment, cooling, and productive use of energy. Most of the interviewees were companies' representatives holding leading roles, such as a head, director, CEO, or co-founder of the company. Six representatives were managers, two coordinators and only one interview respondent had a designer role. While a gendered preference of the interviewee was not specified, 11 out of 18 interviewees were women, showing that women were considered as more appropriate participants for the nature of the study. Finally, nine participating companies offer energy solutions in Kenya, while four of them focus on the South African context. The rest of the companies are based in Nigeria, Tanzania, Uganda, Rwanda and Lesotho. One-third of participating companies offer energy solutions in multiple countries.

2.2.2. Data collection and analysis

Interviews were carried out between August and November 2020. All interviews were conducted online by the GENS researcher and lasted between 45 and 75 min each. The interview questions were shared with each participant at least two days before the interview allowing them to prepare. At the beginning of the interview, participants were introduced to the GENS research, the purpose of the study and asked to consent to their participation by signing a digital consent form. Later, respondents were asked the prearranged questions and follow-up questions for clarification to obtain further details, which allowed further exploration of the interview themes. All interviews were audio recorded and subsequently transcribed. The collected data were analysed applying inductive thematic content analysis [42]. Responses to each prearranged question were coded into categories to find relevant patterns aligned with the aim of the study.

3. Gender mainstreaming in energy projects

To understand the established gender mainstreaming processes, we analysed 20 gender-energy nexus 'supports' (Appendix A) – toolkits, handbooks, and manuals – issued by international organisations tackling poverty in developing countries, including but not limited to USAID [43], ADB [44,45], ENERGIA [46–48] and UNDP [49,50]. The supports target a wide range of stakeholders from within and outside of the publishing organisations: policymakers, consultants, community groups, private sectors companies, the academic community, etc. The supports include various strategies, methods, training, and best practice

principles on how to consider gender in energy projects. Only one out of 20 existing supports we analysed focused specifically on urban environments [43]. Five of our analysed supports served the training purpose [47,48,50–52] and 10 facilitated qualitative data gathering (e.g., [44]). None of the supports were specifically developed for idea generation or codesign. Most of supports describe the step-by-step process of gender mainstreaming in the energy project cycle. The most common and widely adopted four-step process has been introduced by the World Bank [53] and includes: 1] Gender assessment; 2] Gender action plan; 3] Implementation and monitoring; and 4] Completion and evaluation. The gender mainstreaming in energy projects described in other supports adopts and expands on the above mentioned four-step process. Table 1 summarises the comprehensive gender mainstreaming in energy projects process combined from 13 analysed supports. We categorised the process into four energy project phases, based on Nelson and Kuriakose [54] and listed the methods of each phase that leads to gender mainstreaming. The initial project concept phase includes most methods of all phases, meaning that the preparation and knowledge-gathering are critical for successful gender inclusion in energy projects. Gender considerations must be implemented throughout the energy project cycle starting with initial literature and documentation review and concluding with communication of gender-oriented results and lessons learned.

We use this table as a reference point to compare and discuss gender considerations implemented by the interviewed energy companies in Section 5.1.

Table 1
Energy project phases and corresponding methods of gender mainstreaming (adapted from: [43–58]).

Project phases	Methods	Aims towards gender mainstreaming
1. Project concept phase. *Build understanding about the topic*	Literature and documentation review	To analyse existing knowledge about gender and energy.
	Collection of sex-disaggregated data	To conduct a gender analysis of the demand and supply sides to identify gender issues.
	Collection of best practices	
	Organisational assessment	To assess the organisation's capacity to work on a gender project.
	Stakeholder analysis	To map and engage with gender-oriented partners.
	Gender category definition	To define expected contribution to gender equality, from minimal gender dimensions to gender-targeted projects.
	Fieldwork in community	To collect information for gender-responsive interventions, ideally with key partners.
	Gender assessment	To identify key gender issues related to the project.
		To explore opportunities and risks, constraints, and context.
	Allotting gender-responsive budgeting	To set resources and budget for gender equality promotion and integration (e.g., training of female technicians)
2. Project design phase: *Evaluate gender-related risks*	Gender action planning	To define the project goals, objectives, and outcomes.
		To set gender sensitive performance indicators measuring progress and results.
		To define gender-related entry points.
	Making organisational commitment	To institutionalise gender mainstreaming in the organisation.
3. Implementation phase: *Conduct activities in a gender-sensitive and participatory manner*	Supervising implementation	To select the implementation team.
		To ensure defined gender-focused activities are carried out.
4. Monitoring and evaluation phase: *Assess impact and lessons learned*	Monitoring and evaluation	To use gender-sensitive indicators towards reducing gender gaps or improving women's participation.
	Communicating gender results	To involve all partners in communicating lessons learned to reduce resistance to gender mainstreaming

4. Results of the semi-structured interviews with energy companies

This section discusses the findings according to the interview themes and questions presented in Table 2, which contain patterns that emerged from the data analysis. Supporting quotes by the interviewees were selected to illustrate the data and convey their lexicon.

Table 2
Semi-structured interview questions.

Theme		Question	Sub-question
1. Gender considerations in the design process of energy solutions	1	Does your company consider gender perspectives when designing new or improving existing energy solutions?	If yes, how? Provide an example. If not, what does prevent your company from integrating gender aspects into your energy solutions? If not, would your company like to integrate the gender aspects in the future?
	2	What design process does your company apply when creating new or improving existing energy solutions? How is the gender perspective (if any) integrated into the process?	N/A
2. Methods used and expertise involved in the design of energy solutions	3	Does the company currently adopt (or have adopted in the past) any design tools or methods to help with the design process? (e.g., guidelines, toolkits, gender-related handbook, etc.)	If yes, which ones? What are their pros and cons? If not, what support for designing new or improving existing energy solutions would you like to receive?
	4	Who in your company is involved in creating new or improving existing energy solutions?	N/A
	5	Does your company include external stakeholders in any stage of creating new or improving existing energy solutions?	If yes, who do you collaborate with and how? If not, what are the barriers, and how would you imagine a successful collaboration creating new or improving existing energy solutions?
3. Specifics of designing for informal urban areas	6	Which energy-related issues does your company address in informal urban settlements?	N/A

Table 3
Characteristics of participating companies and interviewees.

Company's code	Business operation	Energy end-use addressed	Role of interviewee	Gender of interviewee	Country of operation
C1	Development and distribution of clean cooking technologies	Cooking	Product manager	Male	Kenya
C2	Development and manufacturing of cooking stoves	Cooking	Managing director	Male	Kenya
C3	Development, manufacturing, and distribution of cooking stoves	Cooking	CEO/Programme manager	Male/Female	Kenya
C4	Manufacturing of cooking fuel and cooking stoves	Cooking	Co-founder	Male	South Africa
C5	Manufacturing and distribution of cooking stoves	Cooking	Director of operations / Research and reporting coordinator	Female/Female	Lesotho Uganda
C6	Development of solar powered enterprise platforms	Productive use of energy	CEO	Female	South Africa
C7	Distribution of clean energy products	Productive use of energy	Country director/Business development manager	Female/Female	Nigeria, Tanzania, Uganda
C8	Distribution of battery-backed solar systems	Lighting, IT/ entertainment	Institutional sales and experiential manager	Female	Rwanda, Kenya, Tanzania
C9	Development and distribution of solar lighting products	Lighting, IT/ entertainment	Grant manager	Male	Kenya, Nigeria, Uganda
C10	Distribution of solar home systems	Various[a]	Director	Male	South Africa
C11	Distribution of solar mini grids	Various[a]	Director	Male	South Africa
C12	Development of solar products and financing platforms	Various[a]	Project manager	Female	Kenya
C13	B2B software development for solar power device makers and distributors	Various[a]	Human-centred designer	Female	Kenya
C14	Wholesale and distribution of on and off-grid energy products	Various[a]	Head of projects and partnerships	Female	Kenya
C15	Energy consulting	Various[a]	Strategy coordinator	Female	Kenya

[a] Includes water heating, refrigeration, space cooling, space heating, washing, tool powering, etc.

Table 4
Design tools and methods used by the interviewed companies in relation to different business operations.

Design stage	Tool/method used by the companies	Applied by the companies from different business operations			
		Development	Manufacturing	Distribution	Energy consulting
1. Project planning	Stage-gate project management kit	x	x	x	
	Salesforce. A cloud-based customer relationship management support		x	x	
	IDEO toolkit	x			
	Acumen Academy			x	
2. Context assessment	Digital data collection form		x	x	
	Analogue context assessment survey			x	
3. Research and development	Focus group	x	x		
	Interview	x	x		
	Rapid prototyping	x	x		
	User testing	x	x		
	User questionnaire	x	x		
	HCD workshop	x	x	x	
	Ethnographic fieldwork	x	x		
	Laboratory testing		x		
	Brainstorming				x
4. Implementation and monitoring	Training guide/Awareness creation document	x	x		
	Monitoring application				x

4.1. Gender considerations in the design process of energy solutions

4.1.1. Question 1: gender mainstreaming considered by the companies. "We focus on women because we believe that the way energy poverty affects people in the society is not proportionate" (C7)

Interview results show that companies focus on gender mainstreaming at either or both of two levels: the company's level, e.g., achieving gender balance in staff; and the consumer level, e.g., focusing on women and men energy users. As may be expected, companies' answers regarding gender mainstreaming, target women more than men. Most of the interviewed companies admitted being male-focused at both levels, thus intentionally seeking better women representation and inclusion: *"obviously our scale is tipped towards women <…> if we are saying that we target everybody, we will get more of the men"* (C6).

4.1.1.1. Gender mainstreaming at the company's level. Firstly, the interviewed companies deliberately aim for gender balance among the employees by recruiting more women, especially in the technical roles: *"… for considering gender within the product design you need to have women in the technical space"* (C14). Two of the interviewed companies (C3, C14) already achieved a 50/50 gender balance on the production floor and in managerial roles. Furthermore, companies understand that household energy products, especially cooking stoves and fuels, are used mostly by women, therefore they focus explicitly on having more women sales agents: *"It's best to use women in that environment than men because they speak from the position of experience"* (C4). Additionally, companies see women sales agents fundamental to the adoption of innovative clean energy solutions: *"They need to sell a new way of doing things at home"* (C4).

Secondly, funders and external partners often urge energy companies to include gender considerations in their business operations: *"We do*

Table 5
Energy project phases and corresponding gender mainstreaming activities applied by the interviewed companies.

Project phase and activities	Implemented by the interviewed companies														
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
1. Project concept phase:															
Literature and documentation review		x	x									x			
Collection of sex-disaggregated data	x	x							x			x			
Collection of best practices		x					x								
Organisational assessment															
Stakeholder analysis		x	x	x		x	x	x	x			x			x
Gender category definition															
Fieldwork in community	x	x	x	x	x	x		x	x	x	x	x	x		
Gender assessment		x	x		x			x				x	x	x	
Allocation of gender-responsive budgeting					x		x								
2. Project design phase:															
Gender action planning						x									
Organisational commitment			x		x		x							x	x
3. Implementation phase:															
Supervision of implementation		x				x	x			x					
4. Monitoring and evaluation phase:															
Monitoring and evaluation			x		x					x	x				
Communication of gender results			x			x	x								

often get asked the gender question around funding, that we need to have something more explicit and substantial around addressing gender inequalities in the work that we do" (C10). Companies perceive these requirements as a positive incentive to become more gender-focused: *"The gender-focused grant works as a foundation to develop our gender-sensitive approach to products"* (C12). Alternatively, other companies deliberately seek meaningful collaborations with like-minded partners for gender inclusion: *"When we come to do B2B partnerships, we build relationships with other institutions, we consider solutions for a particular gender"* (C8).

Finally, companies shared that achieving gender balance across the organisation is only one way to address the twofold problem: *"Unfortunately, the solution that people think they should do now is just appoint more women in companies"* (C9). Even with appropriate women representation at the company's level, energy companies still have limited knowledge and skills on how to target women as consumers.

4.1.1.2. Gender mainstreaming at the consumer's level. Companies from the clean cooking sector are naturally more women-focused than their counterparts from other sectors, simply because cooking is seen as a women's domain. One company developing, manufacturing, and distributing clean cookstoves has a standard procedure on the inclusion of women and men customers: *"We collect gendered data on all of our customers, and so in that sense, we make sure that we are able to measure the differences between gender"* (C5). The companies are starting to feel the urge to carry out gender-disaggregated data collection and analysis *"to unpack a wider political, economic, social, cultural stressors and kind of influences behind a product, or a design, or a specific usage"* (C12). However, collecting and analysing these data is not a straightforward process and companies often lack expertise and resources for better understanding their customers: *"The challenge at the moment is that we just need a simple way to help us understand exactly what is going on at the ground"* (C9). The C9 analyses their call centre data to get women's insights, but this process is not yet fully established.

Another important finding is that companies notice and understand the difference between the "buyer" and the "user" of energy solutions. This was strongly emphasized by clean cooking companies that analyse who pays for the cooking stove or fuel, and who uses it: *"From day one having to think of that dynamic of who is purchasing the cooking service and who is actually cooking with it"* (C1). Therefore, these companies tend to include considerations of both genders in their research and development: *"It's a man that would register or buy the product and will be our main contact point, but we know that it's actually the wife that uses the product"* (C12). To tackle this disparity, companies focus on enabling women to afford energy products and services: *"The way that we make our products available by providing these zero-interest loans <…> it allows to our female customers to access it"* (C5). In addition, they offer hybrid multifunctional products appealing to both women and men customers, e.g., a cookstove with an integrated phone charger and/or a light. An interesting observation shared by C8 showed that gender considerations can be used as a strategy for innovations: the company tailors traditionally men-oriented solutions to women.

On the contrary, other companies, particularly those operating in South Africa see no need to specifically consider gender in energy. They believe that bringing energy access to low-income communities by default benefits women more than men: *"Simply through the number of hours that female occupants will probably spend at home during the day, it's probably more relevant to women than to men"* (C11). Other companies admit that they have no kind of gendered approach in the energy solution development and delivery process and that the gender perspective only comes in at the inception phase when the main iteration of the product is done (C9, C14).

4.1.2. Question 2: design process applied by the companies. "There are obviously different levels at which design comes in" (C10)

The second question aimed at understanding how companies use design to deliver goods and services to their customers and what gender considerations are included in the design process. When it comes to the design of energy solutions, most of the interviewed companies use the established human-centred design (HCD) process which varies depending on the specific project. The HCD is a collection of methods that aims to uncover behaviours and motivations of a target population to identify desirable, feasible and viable products and services [59]. The interview results showed that companies have four different takes on the design process depending on the type of business operations they engage in: development, manufacturing, distribution, and energy consulting.

4.1.2.1. Development: companies that create energy products and/or services. Nine out of the 15 interviewed companies develop energy solutions in-house, thus their design process is more comprehensive compared to those companies that manage off the shelf products. Below is described a generic energy hardware and software development process, which is then altered by each company according to their capabilities and resources, and whether they create a new or improve an existing energy solution: *"Those are two different sides of it: incremental improvements to products that already exists and a much larger 'this is a new product coming to market' process"* (C1).

When developing new energy solutions, companies tend to start

"with a more research or sort of observation phase" (C13), to understand generally the existing situation in the targeted context and customer needs. This is done through desk, market, and field research using questionnaires, interviews, and ethnographic fieldwork both remotely and on the ground. Companies that collect gender-disaggregated data do so at the research stage. Prototyping of the initial solution comes right after the analysis of the research findings and companies often seek additional funding and partnerships to materialise their idea. The initial prototype is then tested with its intended users in households or simulated environments to collect feedback, often using interviews: *"Once we get first prototypes, when we actually involve real users and real customers to test the products"* (C3). The feedback collection is often gender-sensitive since companies are familiar with their clientele and aim to test products with the relevant audiences. Some companies from the clean cooking sector receive customer feedback by giving an initial batch of products to be used in daily life and follow-up frequently. Prototyping, testing, and getting feedback usually iterate through multiple cycles. Customer engagement during the iterations is crucial, as the final solution is considered ready to market only when it is *"very much founded on anecdotal feedback we get from customers"* (C13).

When it comes to improving an existing energy product or service, companies first need to understand what and why needs improvements, e.g., affordability aspect: *"Making a reduced cost cookstove of the last version that we are having"* (C3), which requires a straightforward value engineering approach. However, more complex changes related to customer acceptance of a product or service require evaluation of the existing solution, which is often done by collecting existing customer feedback through surveys and questionnaires: *"We are using that feedback to realise what is our idea gap that we need to fill"* (C2). That feedback then goes into the new prototype development, which is then tested and revised as described in the new product development process before being released to the market.

4.1.2.2. Manufacturing: companies that produce energy products. Four out of nine companies that develop energy products have in-house manufacturing facilities and produce working prototypes as well as final energy products themselves. All of these companies are from the clean cooking sector. Companies agree that having a high-quality prototype at the early stage of the product development speeds up the customer testing and feedback process, because of *"more valuable customer interaction once we have something physical and working in our hands"* (C3). Since the final energy product prototype needs to go through laboratory or regulatory standard testing to make sure it is safe for customers to use, companies with manufacturing facilities can make alterations and meet standards promptly.

4.1.2.3. Distribution: companies that supply energy solutions to customer. Even though most of the interviewed companies are engaged in supplying energy solutions to their customers, only four companies focus on distribution as a single business operation. These companies tend to focus more on the design of overall operations rather than a product or service: *"The way in which we would do, technical response, the way in which we engage with clients, the way in which we would deal with the financial side"* (C10). Therefore, these companies focus on creating, improving, and testing different pricing models for existing products and services: *"On the design of a business model, I think the financial side is the dominant driver of how we design"* (C10). C5 focuses specifically on making their energy products affordable to female customers. Interview results show that distribution companies apply some unique methods and approaches, such as a quantitative technical household survey to understand if and what additional energy products customers need (C14). C7 uses human-centred design workshops *"curated around what types of products we would like to distribute, and also give feedback to the manufacturers"*. These workshops involve internal company personnel and customers, and their outcomes help to improve the design of the products distributed by the company.

4.1.2.4. Energy consulting: companies that provide auditing and consumption improvements. Even though energy auditing can look like a straightforward box-ticking exercise, the only interviewed company involved in energy auditing and consulting described it as a rather creative process: *"We first do the problem identification and then we brainstorm on what solutions would be best, what approach to take"* (C15). The design of the project plan they need to develop includes deliverables, timelines, stakeholders involved, costs, time and activities spent in the field, monitoring and assessment of suggested improvements. So far, this process does not include gender considerations.

Most of the interviewed companies admitted that they do not have a structured design process and established practices of gender inclusion: *"You will notice the absence of a structured process, that we kind of had to learn things hard way"* (C12). However, the companies agreed that the design process must be applicable to *"different projects in different stages"* (C3) and flexible: *"The timelines are sort of different and the involvement is different in terms of the process"* (C15).

4.2. Methods used and expertise involved in the design of energy solutions

4.2.1. Question 3: design tools and methods used by the companies. "A lot of standard methods don't work that well in the context we tend to be in" (C13)

The third interview question was designed to understand what design tools and methods companies use along their design process and what additional support they require. The results show that companies use a range of existing human-centred design tools or apply internally developed ones. When asked whether they use any of the readily available gender-focused toolkits, handbooks or manuals, all interviewed companies admitted that they have no knowledge about such tools: *"I am not very aware of them [gendered tools], to be honest, we are not using anything in that sense"* (C3), *"Oh, we haven't come across any tools like that"* (C7). Below are described current tools used by companies according to different stages of the design process followed by the requirements for the desired design support.

4.2.1.1. Current design tools and methods used by companies. At the early **project planning** stage, companies use well-established tools to help them manage complex energy projects. A stage-gate project management kit used by C3 helps *"make sure that we get the right things checked off during the project"*. Another tool used by companies is a cloud-based customer relationship management support Salesforce which can be customised for a specific project (C5). In addition, the IDEO toolkit [60] is seen as a great sort of resource with *"all the different methods used for each of the [project planning] stages"* (C13). One of the companies uses a human-centred design course by Acumen Academy [61] (C7). The companies shared that all the above-mentioned tools must be selected, mastered, and applied by experienced employees.

During the second **context assessment** stage, companies use internally developed data collection tools. One of them is a digital data collection form used on the ground by *"local agents who are all local and trained in those forms and data collection"* (C5). The form must be completed using a smartphone, thus people collecting data need to be trained up to a certain digital literacy and to understand data integrity. Another tool developed in-house is an analogue context assessment survey: *"A paper sheet technicians go through, and they check things of <…> they write down what it is and different features of the equipment"* (C14).

During the **research and development** stage companies *"use standard human-centred design tools to try to understand and unpack the users that we are designing for"* (C1). The most common methods that companies choose to adapt to their own needs are focus groups, interviews, rapid prototyping, user testing, user feedback and human-centred design

workshops. By selecting and applying well-established approaches, companies can manipulate them and find the right combination to achieve the desired result: *"Generally we use the best practice within design <…> we are not inventing new research methods"* (C1).

The final **implementation and monitoring** stages are supported through training and monitoring tools respectively. Implementation of energy solutions, whether it is an installation of a solar panel or distribution of clean cooking products, requires a certain level of skills from the implementer. For example, C2 developed *"a demo or an awareness creation document which is like a training guide which guides everybody"*. Once the solution is implemented, companies use internally developed energy monitoring tools: *"When people go on the ground, we have created an app that helps them: they can input any data they are collecting"* (C15).

The table below summarises design tools and methods used by the companies offering different business operations according to four design stages of energy solutions (Table 4).

4.2.1.2. Requirements for the desired design support. Firstly, the desired tool must help structure a design process: *"The intention behind it is to actually structure our design process, to actually have this structure in place"* (C12). According to the companies, a comprehensive design tool can be used by everyone who is involved in the design, including less experienced engineers and designers (C12, C3), and *"women and youth and non-technical groups"* (C14). A need for better stakeholder engagement through a design tool was mentioned by multiple companies: e.g., *"The limitations to the current toolkits are… it's not been fully adaptive across the board, because the design that we do includes so many different stakeholders"* (C13).

Secondly, a tool must be applicable in specific contexts companies work in: *"A lot of the issues that I have seen with a few [tools] that I've come across is that they are very very broad and toolkits that are more tailored for specific context would be more helpful"* (C3). In addition, the tool must include "best practices or anecdotes or sort of insights" (C13) from specific communities or help to collect context-specific data: *"If there is a tool that we could use while we are doing the site survey, just to gather additional information that would help us design the system better"* (C14).

Thirdly and in line with our research focus, the desired design tool for energy solutions must be gender-focused and *"to make sure everyone is reminded frequently to take those gender issues into consideration in the right way"* (C3). According to the companies, a design tool can help to embed gender awareness in organisational culture: *"It would be fantastic to have a toolkit that is able to translate human-centred design or any type of design process, gendered obviously, gender-focused, into engineering language, <…> or into operations"* (C12).

Finally, a tool must go beyond data collection, idea generation and stakeholder engagement and support commercialisation of energy solutions: *"A toolkit that brings in those commercial aspects, that does not slow it down, that could be integrated into those commercial perspectives and that bottom line and revenue generation"* (C12).

4.2.2. Question 4: internal personnel involved in the design process. "It cuts across every single department" (C1)

By asking this question we aimed to understand who in the company benefit most from support designing energy solutions. The results showed that a wide range of internal personnel plays important roles in companies' design processes: *"Basically, all of the departments with maybe the exception of HR and IT that are not too closely involved"* (C3).

In most of the interviewed companies, the **research and development (R&D)** department is the one largely involved in the energy solution design processes. The R&D department often includes a wide range of experts with research, product design, hardware and software engineering and consulting roles. The interview results showed that companies have extensive technical expertise in-house and that engineers and technicians are the ones in charge of design at different energy solution development stages: *"Each product development area has a side of engineers and product managers that work with them"* (C13), *"We have a team of technicians, we have a workshop, where then they would sit and discuss what modifications needed to be done"* (C2). On the other hand, the research part is done by a designer or a project manager or outsourced from an external organisation, such as a university or a research institution.

The **production** team of those companies with manufacturing facilities in-house plays an important role in the energy product design process: *"Because they need to finally produce the product, so we always be checking with them if it can be made"* (C3). Since the head of workshops or a technician is responsible for sourcing and logistics of getting the right materials, their input in the design of energy solutions is essential.

Another group of experts contributing to the design of energy solutions is based in the **marketing and sales** department: *"We usually have the team that first goes into the field and it's the sales team, the marketing team"* (C15). The role of the market research team is critical to unfold the needs of the customer or evaluate an initial prototype: *"We send them out to the street to evaluate what colour people would prefer"* (C3). In addition, companies benefit from having in-house salespeople with first-hand field experience and knowledge on the local context: *"We have a team of salespersons, who are then trained, they are exposed to this technology, and they give their own comments on the prototype"* (C2). Overall community engagement carried out by the community relation officer is *"probably the most important part of the business, to keep relationship with community transparent, friendly and honest"* (C11). The crucial work is also done by the customer service team, who contact existing customers and record their feedback so their criticism and suggestions can be used to improve existing offerings. While the production team makes sure the designed energy product can be manufactured, the finance team is responsible for advising on the affordability of the energy solution.

In small companies and start-ups formed of less than 10 people everybody despite their role contributes to the successful design and implementation of energy solutions, be it a CEO, a managing director, or an administrator. Even though the administrative personnel, such as human resource manager or administrator usually have no say in the design process, they are responsible for finding the right people for the job: *"We have HR in terms of who do we need to bring in because we don't have all the capacity internally"* (C15). The next section discusses the importance of collaboration with external stakeholders for the design of energy solutions.

4.2.3. Question 5: external personnel involved in the design process. "Multiple different parties that all bring a different angle or aspect to make sure the whole project is overall success" (C14)

Interviewed companies partner with different external stakeholders at various stages of the design process. These partnerships are flexible and depend on the type and stage of the project: *"From the onset, we know that we do not have the capacity in house to do everything, so <…> we identify possible collaborators, or partners, depending on their roles and their expertise that is required"* (C2). The findings of the previous question showed that companies have a strong technical base in-house and feel the need to outsource a range of other expertise: *"we actually outsource trainings, or research, or consultancy on some of our projects as we go into the technical side"* (C14). None of the interviewed companies uses the best practice-based stakeholder engagement methodology and is just making it up as they go along.

4.2.3.1. Gendered partnerships. Investors, NGOs, consultants and experts are those external stakeholders who often motivate companies to consider gender perspectives in their design processes: *"Investors often include gender components. They often do want to see the data disaggregated. <…> Clean Cooking Alliance sent us a gender consultant, to analyse how we did or did not integrate gender"* (C5). Companies understand that to improve their gender focus they need to seek external partnerships and expertise they do not have in-house: *"In the research phase, we are*

working quite closely with experts and consultants, who are either research experts, gender experts" (C12). C8 is particularly concerned with making energy products and systems that women can use and partner only with like-minded NGOs and foundations.

4.2.3.2. Government bodies and organisations. Governments have a considerable role in energy markets which cannot be ignored by the companies. Therefore, most of the interviewed companies by some means engage with local governments by involving *"one or two representatives from the government sectors"* (C7) from the early stage of the energy solution development process. These can be the Ministry of Agriculture, social services, or the local administrator (C2). Some companies rely on government organisations to obtain regulatory standards and certification schemes for new technologies (C1) or receive additional funding: *"We have results-based financing from governments, where they want to see the results"* (C5).

4.2.3.3. Other private sector companies. In addition, companies willingly engage with other key players in the same sector, other private businesses who share mutual goals (C6, C7). Those companies who do not provide distribution services, perceive distribution companies as key partners in the energy value chain, especially because of their extensive knowledge and understanding of the local energy market. However, companies agree that the involvement of distribution companies in the design process is limited: *"They are just distribution partners, they are just focused on numbers and sales, they are not really focused on why the product is not selling"* (C9). Even though companies often focus on capacity building and training of customers and wider communities, they often do not have trainers in-house and work with external associates (C15).

4.2.3.4. Investors and funders. Investors not only play the gender enforcement role but often urge companies to formalise their overall energy innovation process *"so that they can better predict what's going to happen"* (C5). C5 is supported by both financially minded and impact and development minded investors, thus needs to balance between satisfying the investors and retaining autonomy over its decisions as a company. Similarly, *"donors and funders are coming with a certain package of innovation of what they want to achieve"* (C3). Thus, the company is trying to avoid tailoring their design processes too much to the funder's needs and, instead, select those funders who share the mutual vision (C3).

4.2.3.5. Academia. A partnership between industry and academia is often initiated by an academic institution: *"If a university or somebody wants to come for a study, that's how we get involved"* (C9). These collaborations are driven by the academic interest of researchers and can contribute to the development of improved energy products and services. E.g., C11 works in partnership with a remotely-based university on how their service impacts the wellbeing of the community: they conduct a survey before and after the installation to identify potential improvements.

4.2.3.6. Communities. The interviews showed that close collaboration with community leaders and community-based organisations is often critical for the acceptance and implementation of energy projects. This collaboration must be established from the very beginning of the project development to understand what communities need, what they are willing to pay for and whether they are ready to accept innovations that can change their routine (C10). C7 established human-centred design workshops to empower local communities to have their say.

Even though the interviews showed that companies could not function without external partnerships, the outsiders usually do not have an important say in the design decisions made by companies: *"In terms of how much they actually contribute to the design is limited"* (C5). Companies prefer to retain most of their autonomy to specify certain milestones and obligations they must meet. Furthermore, *"getting external people coming for design change slows down the progress"* (C6).

4.3. Specifics of designing for informal urban settlements

4.3.1. Question 6: energy-related issues in informal urban settlements. "A household living in an informal settlement with almost no services, often very unstable work and income situation, it creates all number of issues" (C10)

The question exploring what type of energy-related issues companies target in informal urban settlements was important to ask from the design point of view since the design is often applied to problem-solving to come up with creative solutions [62]. The interviewed companies operate either exclusively in urban areas, or both rural and urban areas, thus the latter tend to compare issues experienced in different settings. The interviewed companies have noticed that energy solutions, originally designed for rural areas, are migrating and being adapted to urban areas: *"In Kenya, a lot of the markets, especially rural markets are pretty saturated with off-grid products and so a lot of our clients are expanding into more urban or peri-urban areas"* (C13). This insight shows a promising trend of more companies tackling energy insecurity by developing energy solutions for the urban poor.

The most common energy-related issues in informal urban settlements listed by the interviewed companies are linked to affordability and reliability of energy solutions, overall access to energy, health and safety, and capacity building, which includes productive use of energy and skill development.

4.3.1.1. Affordability. Customers' ability to afford energy products and services is a number one challenge targeted by most of the interviewed companies. Offering modern clean energy solutions to *"the people living at or below the poverty line"* (C9) requires the implementation of creative pricing models and partnerships. Even though many residents in informal urban settlements have access to unmetered "illegal", thus free electricity, they are willing to legalise their connection and start paying for it: *"Why are they doing this? <…> we hear an answer saying, look, it adds to my dignity if I can pay for the service that I have"* (C11). Therefore, companies need to understand how residents in informal settlements handle their income to be able to offer affordable energy products and services: *"We looked at the repayment ability, and we designed the repayments to on average be less than what they save"* (C5). Companies see energy monitoring as an effective strategy to ensure affordable energy provision: *"We need to know what exactly is taking up most of our energy <…> so we can figure out exactly what we can change to reduce our bills"* (C15). An interesting observation by C5 shows that affordability is perceived differently in urban and rural areas: *"The key difference between rural and urban customers is that urban customers rely more on purchasing fuels because they are not able to gather them"*. Thus it is easier to quantify the investment in and savings from the adoption of clean energy solutions in urban areas.

4.3.1.2. Accessibility. Another great challenge addressed by the interviewed companies is initial access to energy for those residents who *"don't have electricity access, don't have access to sustainable fuels, don't really have access to improved energy products"* (C5). Often, companies bring that very first access to modern energy to people who have been using traditional solid fuels for generations or those, who *"can't even access the mains because they live within the interior of a slum where there is no access"* (C9). *"There is this expectation that the government should be providing that [energy access]"* (C10), thus not many private companies dare to initiate what is believed to be the role of the government. Besides, companies face additional challenges of understanding and changing people's behaviour: *"If the person is used to putting four pieces to form a stove and the charcoal burns over four hours <…> they change their habits not necessarily easily"* (C4).

4.3.1.3. Reliability. Energy products and sources used in informal urban settlements often cannot be relied on: *"The main problem is unreliable power. There is a lot of illegal connections which means that your voltage is all over the place, it can burn up the products quite quickly"* (C14). Therefore, companies aim to address the demand for backup power (C9), and the uninterrupted supply of energy sources (C5). C14, which offers off-grid energy products to the urban poor, highlighted the issue of unreliable access to mobile phone service as their focal point to be addressed: *"This is particularly important for urban areas – you need to have your phone charged, otherwise you are not going to make that sale, you are not going to make that deal"*. Even though energy hardware is becoming increasingly more reliable, customers *"need maintenance, they need new batteries, down the line, things break, they want to upgrade"* (C10). Companies understand the importance of providing ongoing maintenance services to ensure the reliability of energy access in informal urban settlements.

4.3.1.4. Health and safety. Lack of safety of energy sources and products used by the urban poor is another issue looked at by the interviewed companies. Illegal connections widely used in informal urban settlements are unsafe and cause danger of fire, electrocution, and damage to electric appliances (C11). Therefore, companies see reliable electricity connections as a solution towards safe and healthy households: *"By supplying electricity to informal settlements you bring safety, because houses typically rely on illegal electricity, which is unsafe, you bring health, because houses typically rely on small diesel or petrol generators and kerosene"* (C11). Health and safety of energy were discussed by the clean cooking companies in the light of gender: *"What we've seen in energy is that most of the environmental impact, health impact, gender impact is on the cooking side"* (C5). Therefore, when designing new cooking solutions, companies need to make sure they are familiar with local contexts and create products with low emission, healthy to use inside the house (C4), and safe to operate for women and children who are at home on their own (C9). In addition, companies understand that cooking products need to be time-saving, thus empowering local women to use their time productively: *"Their requirement is that they get up early, the water heats very quickly, so they need much faster cooking than some of the charcoal"* (C4).

4.3.1.5. Capacity building. Finally, several interviewed companies aim to improve livelihoods through enabling productive use of energy, with a strong focus on gender mainstreaming. Urban areas are seen as fertile environments for entrepreneurial activities for women: *"In the cities there are a lot more single mothers and women are far more innovative and entrepreneurial than maybe the women in rural areas <…> they have been given chances of self-determination and deciding what they want to do with their lives"* (C4). C7 is in search of local women who have an entrepreneurial spirit and want to get into energy-related business and train them around solutions for energy poverty. For those residents who do not wish to set up their businesses, companies offer job opportunities in the energy supply chain: *"We've trained 17 of the youth, it's a mixture of young girls, so, now they are empowered, ready to go to work"* (C6). In addition, companies provide critical financial support *"to accelerate the output"* (C8) and collaborate with donors to obtain grants focused on providing productive use energy to micro business owners for women (C12).

5. Discussion

In this section we discuss current gender mainstreaming practices in energy projects implemented by the interviewed companies and identify gaps in these practices and support required. According to interviewees' responses, gender mainstreaming in energy projects is still very fragmented among private companies offering energy solutions in informal urban settlements. None of the study participants is familiar with and applied existing toolkits, handbooks and manuals supporting gender mainstreaming in energy projects. This can be related to the still early-stage focus on the gender issues by companies, or to the lack of proper dissemination of existing supports.

5.1. Comparison with existing process of gender mainstreaming in energy projects

To identify existing gaps that companies face in integrating gender mainstreaming into the design of energy solutions, we used the gender mainstreaming in energy projects process introduced in Section 1 as a reference point. Table 5 illustrates which gender mainstreaming activities are implemented by the companies, based on their responses to the interview questions.

Most of the interviewed companies admitted that they do not have a structured process of designing energy solutions, as well as established gender mainstreaming principles in each design stage. Companies still have limited skills and practice in disaggregating women and men energy users. However, two methods towards gender mainstreaming – fieldwork in community and gender-oriented stakeholder analysis – are implemented by most of the study participants. Companies, working in the clean cooking sector are more gender-focused than their counterparts from other fields and often work towards empowering women as main users of cooking solutions. These companies collect sex-disaggregated data at the research stage, test initial prototypes with female users and develop women-friendly pricing models. Understanding and collaborating with communities and external stakeholders are seen as a strategy towards successful energy project implementation in urban settlements. Since none of the interviewed companies has an internal gender expert, collaboration with gender-oriented NGOs and foundations often help companies to integrate gender considerations in their processes. Other methods implemented by some companies are gender assessment, gender-oriented supervision and implementation and monitoring and evaluation.

Companies often start mainstreaming gender from the company's level. Reaching gender balance within the organisation – on the production floor and among sales agents – is seen as a promising strategy to ensure comprehensive gender mainstreaming. As a result, five companies made gender-oriented commitments at the organisational level, related to the gender-sensitive recruitment processes. On the other hand, none of the interviewed companies carried out a gender-oriented organisational assessment, thus they are not aware of their capacity to work on gender-focused projects. In addition, none of the companies defined their expected contribution to gender equality, while only one company implemented an action plan on how to achieve gender objectives.

The interview results show that companies incorporate gender considerations in methods, which are well-established and familiar to the companies and not explicitly gender-focused, such as fieldwork, partnerships, and data collection. However, companies do not carry out gender-specific methods, such as gender action planning, gender category definition, gender-responsive budgeting. This gap in gender mainstreaming practice shows the absence of all-inclusive support for companies that aim to mainstream gender in the design of energy solutions.

5.2. Support required by the companies

Based on the results presented in Section 4.2, we found out that companies seek for better understanding of how to integrate gender in their practices. Gender is an integral part of the required support that must work as a constant reminder to consider women and men customers in every stage of the design process. In addition, gender awareness must be embedded in organisational culture, while the design support must be easily applicable by both genders and all expertise within the organisation and during stakeholder collaboration. The companies would like to be able to integrate gender considerations in their everyday practices by adding a gender component to the methods

and tools they are comfortable at using, rather than learning and integrating new techniques. The companies are keen on keeping their design process flexible and applicable to different projects at different stages, thus the gender components must be complementing the design process without limiting the freedom.

The interview results show that knowing the user is a crucial part of the design of energy solutions. Informal urban settlements are not easy to visit and collect information in, thus the companies would like to be provided with best practices and sex-disaggregated user stories to simplify understanding of the urban context. Only one of our analysed existing supports focus on urban areas, thus the urban context is still overlooked.

6. Conclusion

This paper presents and discusses findings from semi-structured interviews with 15 private companies offering energy solutions in informal urban areas in Sub-Saharan Africa. We aimed to understand if and how these companies design gender-focused energy solutions and what support they require to better consider gender in the design of energy solutions for informal urban areas.

Companies perceive the growing importance of integrating gender mainstreaming requirements into their activities, also because of the push from funders and external partners. However, gender mainstreaming is often approached by focusing mainly at the company's level, and in most of the cases is addressed by trying to achieve gender balance in staff. Thus, gender mainstreaming is often narrowly understood and applied. This is combined with the lack of adoption of the freely available toolkits, handbooks and manuals describing a step-by-step process of gender mainstreaming in the energy project cycle. Companies do not take advantage from these resources to guide their design process and to embed gender mainstreaming principles and best practices into their activities. Companies adopt a range of gender mainstreaming methods, but these are not integrated into a coherent and comprehensive gender mainstreaming process and strategy. In summary, even if it is true that companies seek to get a better understanding of gender mainstreaming and to better integrate gender mainstreaming into their (design) processes, it is also true that existing gender mainstreaming toolkits, handbooks and manuals are currently not used to fill this gap.

The results of this research highlight the need for better dissemination of existing supports and capacity building for integrating these supports into their practices. In addition, companies expressed the need for gender-energy nexus supports with certain characteristics: they should be specifically tailored for urban contexts; be easily integrated into different design processes; provide insights from specific urban communities or help to collect context-specific data. It is questionable if existing supports can satisfy these needs. In fact only one out of 20 existing supports focuses specifically on urban environments and none of the supports is specifically designated for idea generation or codesign. Furthermore, containing up to 176 pages of information, these supports provide a very structured approach and require time-consuming preparations, thus their practical applicability and ability to be integrated and adapted in specific design processes might be limited. This opens up an interesting area for future research to address the absence of applicable and effective support to guide gendered energy innovations in informal urban settlements. On the basis of this, the research team has recently published the first version of a codesign toolkit to equip private and public stakeholders with knowledge and know-how to conceive gendered energy solutions for informal urban settlements [63]. In particular, the focus is on enabling energy stakeholders along the energy value chain to: 1] learn about energy-related gender mainstreaming practices, issues and existing solutions in informal urban settlements; and 2] generate ideas for energy solutions for informal urban settlements considering different issues, needs and capabilities of women and men. We believe that developing a support to be used as a knowledge source as well as an instrument for idea generation is an effective strategy to better equip energy companies with gender mainstreaming knowledge and know-how.

In terms of potential future studies, it would be important to replicate the study with a wider range of companies and in different geographical contexts. This would provide a broader and clearer picture of how energy companies integrate gender mainstreaming in their design processes (e.g. how do they structure their design process? Which gender-energy nexus supports do they use and in which circumstances? Who is involved in the design process?). In addition it would be important to thoroughly test the effectiveness, applicability and usability of gender-energy nexus supports. This would entails carrying out longitudinal studies to observe how companies use certain supports, analyse the outputs at different stages of the design process (ideas, concepts, detailed design, project implementation), and assess how gender equity and equality are embedded in these outputs.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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Appendix A

Table A1
A list of gender-energy nexus supports analysed to define established practices of gender mainstreaming in energy projects.

Reference	Type	Context	Link
Morris, E., Greene, J. and Healey, V.M. Blueprint Guide for Creating Gender-Sensitive Energy Policies. United States: N. p., 2019.	Guidebook	ECOWAS countries. Rural and urban	https://www.nrel.gov/docs/fy19osti/73927.pdf
ADB. Gender-Inclusive Approaches in the Energy Sector. Asian Development Bank, 2018.	Tipsheet	Low-income Asia. Rural	https://www.adb.org/documents/tip-sheet-gender-inclusive-approaches-energy
	Guidebook		https://www.climateinvestmentfunds.org/sites/cif_enc/files/gender_and_re_digital.pdf

(*continued on next page*)

Table A1 (*continued*)

Reference	Type	Context	Link
Nelson, S. and Kuriakose, A.T. Gender and Renewable Energy: Entry points for women's livelihoods and employment. Climate Investment Funds, 2017.		Developing countries worldwide. Rural and urban	
DOE. Gender Toolkit for the Energy Sector. Manila, Philippines, 2016.	Toolkit	The Philippines. Rural	https://www.apec.org/docs/default-source/Publications/2017/5/Guidelines-to-Develop-Energy-Resiliency-in-APEC-Off-Grid-Areas/TOC/Annex-8-Philippines-DOE-Gender-Toolkit.pdf
Hjorth, H., Vyzaki, M. and Bergman, M. Gender Mainstreaming in District Heating Projects in the Commonwealth of Independent States: A Toolkit. CIF, 2016	Toolkit	Ukraine, Kazakhstan	https://www.climateinvestmentfunds.org/sites/default/files/gender_mainstreaming_in_district_heating_projects_-english.pdf
Smith, G. and Shankar, A. Empowered Entrepreneur Training Handbook, Washington DC: Global Alliance for Clean Cookstoves, 2015.	Training manual	Developing countries worldwide. Rural and urban	https://cleancooking.org/wp-content/uploads/2021/07/342-1.pdf
O'Neil, D.; Renzy, D.; McDermott, A. and Atanassova, A. Building a Safer World: Toolkit for Integrating GBV Prevention and Response into USAID Energy and Infrastructure Projects. Rockville, MD: USAID's Advancing the Agenda of Gender Equality (ADVANTAGE), Task Order 3, 2015.	Guidebook	Developing countries worldwide. Urban	https://www.usaid.gov/documents/1865/building-safer-world-toolkit-integrating-gbv-prevention-and-response
ESMAP. Gender Equality and Energy: Tools and Guidance for Integrating Gender Issues into the Energy Sector. WBG, 2015.	Guidebook	Developing countries worldwide.	https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/Gender_Energy_M06.pdf
SPC. Toolkit to Mainstream Gender into Energy & Climate Change Community Based Adaptation Projects in the Pacific, 2013.	Toolkit	The Pacific. Rural	https://gendercc.net/fileadmin/inhalte/dokumente/4_Our_Work/past_projects/Pacific_Islands/Toolkit_to_Mainstream_Gender_into_Energy___Climate_Change_Community_Based_Adaptation_Projects_in_the_Pacific.pdf
SPC. Gender Mainstreaming in Energy Projects in the Pacific, 2014	Training manual	The Pacific. Rural	https://gendercc.net/fileadmin/inhalte/dokumente/4_Our_Work/past_projects/Pacific_Islands/Training_Manual_Gender_Mainstreaming_in_Energy_Projects_in_the_Pacific.pdf
UNIDO. Guide on gender mainstreaming: Energy and climate change projects. Vienna, 2014	Guidebook	Developing countries worldwide. Rural and urban	https://www.unido.org/sites/default/files/2015-01/Guide_on_Gender_Mainstreaming_ECC_0.pdf
Rojas, A. and Siles, J. Guide on Gender and Energy for Trainers and Managers of Public Policies and Projects, ENERGIA, OLADE and UICN, 2015	Training manual	Latin America. Rural and urban	https://biblioteca.olade.org/opac-tmpl/Documentos/old0370.pdf
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ENERGIA. Mainstreaming gender in the energy sector: Training manual. 2012	Training manual	Mozambique, Liberia. Rural	https://www.energia.org/assets/2016/09/Mozambique-Manual-Mainstreaming-Gender-in-the-Energy-Sector-Training-Manual-final.pdf
ENERGIA. Mainstreaming Gender in Energy Projects: A Practical Handbook. Practical action, 2011.	Handbook	Asia, Africa. Rural	https://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/documents/Energia_Mainstreaming_gender_in_energy_projects_A_practical_Hand_book.pdf
UNDP. Gender Mainstreaming: a Key Driver of Development in Environment & Energy. Energy & Environment Practice: Gender Mainstreaming Guidance Series, New York, 2007	Training manual	Developing countries worldwide. Rural	https://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Sustainable%20Energy/Gender_Mainstreaming_Training_Manual_2007.pdf
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