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Gender imaginaries in energy transitions: How professionals construct and envision gender equity in energy access in the Global South

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ABSTRACT

The importance of gender is increasingly recognised in energy research, with growing awareness of the intersections of energy access and gender equity. Yet, a major knowledge gap exists regarding the role of professional intermediaries and institutions in reproducing and/or challenging gendered forms of energy exclusion, especially in the Global South. This paper addresses this gap by considering the gendered energy imaginaries of energy professionals in Global South contexts. Integrating literature on socio-technical imaginaries – which to date has been developed in predominantly Global North contexts – with feminist accounts of gender, energy and development, this paper investigates gendered imaginaries of energy access among energy professionals across four Global South contexts (India, Pakistan, Nigeria and Ghana). The case-study approach involved thematic analysis of interviews with 86 energy professionals, and revealed a spectrum of gendered energy imaginaries with two archetypes at the extremes of the spectrum: (1) The Gender-Neutral Grid Imaginary (GNGI); and, (2) The Gender-Aware Decentralised Development Imaginary (GADDI). These two imaginaries are unpacked in terms of their underlying actors, practices, and outcomes. Special attention is paid to how different constructions of the 'end-user' within professional imaginaries work to perpetuate or alleviate forms of gendered exclusion. These visions propagate energy access outcomes by shaping women's access to and use of technologies, decision-making, and employment in the energy sector. Findings reveal that whilst the GADDI imaginary shows better considerations for gendered energy access, existing gendered imaginaries among professionals fall short across the spectrum in generating equitable outcomes. The paper concludes by providing specific recommendations for energy practice and policy dominating the energy transition landscape in the Global South and reiterates the need to move beyond 'gender-mainstreaming' towards intersectional conceptions of social equity and energy justice. This is vital to address the gaps in existing professional and institutional imaginaries that shape energy access outcomes.
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1. Introduction

Although significant improvements have been made towards universal access to affordable, reliable, sustainable, and modern energy services (UN Sustainable Development Goal (SDG) 7), 789 million people still do not have access to electricity and one-third of the global population lacks access to clean cooking (IEA, 2020). Within the context of this global challenge – and growing acknowledgement that more needs to be done to integrate gender sensitivity into energy research (Anfinsen and Heidenreich, 2017) – there are increasing calls for better appreciation of the "important intersection between energy access and gender" (ENERGIA, 2018, p.3) among actors working in energy and development. However, gender equity represents a largely under-researched area within energy transitions literature, which has only recently gained traction (Johnson et al., 2020). This paper addresses this gap by contributing to the underexplored area of gendered imaginaries, specifically concerning energy access among energy professionals in the Global South. In doing so, it seeks to add to emergent work on gender equity in energy-and-development[2] (some of

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[2] Here we refer to a body of scholarship that considers the complex nexus of 'energy-and-development' across the Global South (See Carbonnier and Grinevald, 2011).

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which has been published in this journal e.g., Maji et al., 2021; Pueyo et al., 2020; Vyas et al., 2021).

Much of the social scientific research on energy focuses predominantly on end-user (e.g. householder) perspectives (see e.g. Devkota, 2014; Ding et al., 2019; Gustavsson and Ellegård, 2004). Less attention has been paid to understandings of gender within professional and institutional spheres (cf. Listo, 2018; Mechlenborg & Gram-Hanssen, 2020; Schiffer et al., 2022). That said, although not from a gender perspective, energy social science research has explored how professionals' interpretations of the world (which we call in this paper, 'imaginaries') steer ideas and pathways of development, including energy technologies and systems of provision (Ingeborgrud et al., 2020; Skjølsvold et al., 2015; Sovacool et al., 2020; Kumar, 2019). Such imaginaries include collective visions of desirable societal futures used to justify different energy socio-technological pathways and development practices (Jasanoff and Kim, 2009; 2015; Levenda et al., 2019; Smith & Tidwell, 2016), as well as expectations and assumptions about end-users that shape what, how and for whom energy technologies are designed (Berg, 1995; Chambers, 2020; Richardson, 2009; Strengers, 2013). Despite these advances, there remain significant gaps in understanding the gender dimensions of energy imaginaries, and their impacts on energy access. Furthermore, most of the work on professional imaginaries has been conducted in the context of Global North energy transitions. However, Global South countries are expected to host the majority of economic development and energy consumption under transitioning energy systems by 2050 (IEA, 2020) and thus provide an important context in which to study gender energy imaginaries.

In this paper, we explore professional imaginaries of gender equity in the context of transitions towards universal access to affordable, reliable, sustainable and modern energy services in four Global South countries (Nigeria, Ghana, Pakistan and India). Combining insights from literature on socio-technical imaginaries and feminist perspectives on gender and energy, we analyse collective visions in a range of professional accounts. Specifically, drawing on 86 semi-structured interviews with energy sector professionals working in these four countries, we identify a spectrum of gendered energy imaginaries and critically present the two archetypes at the extremes of the spectrum (i.e., the Gender-Neutral Grid Imaginary; and the Gender-Aware Decentralised Development Imaginary). These two dominant imaginaries are not mutually exclusive as they coexist within institutional agendas, policies, and discourses, but differ in the socio-technical pathways they entail (Mohan and Topp, 2018). As we will show, these two imaginaries are imbued with constructions of gender relations as well as expectations and assumptions of masculine/feminine uses of, and roles in, energy systems and services. We argue that these constructions have implications for gender equity and describe the dynamics of inclusion and exclusion that they imply.

By engaging across these literatures and using rich empirical material, we make two important contributions. First, we fill a gap in the literature on gender and energy in the Global South. By moving the focus from the unequal experiences of end-users to professional imaginaries, we emphasise the role professionals have in transforming or (re)producing gendered outcomes. Second, we extend the geography and scope of literature on professional imaginaries in the energy sector by illustrating how these are produced and enacted in the context of Global South countries and by pointing to their gender dimensions and gendered implications.

The paper is structured as follows: Section 2 presents the theoretical underpinnings for the socio-technical imaginaries of gender equity in access to energy. Section 3 explains the methodology, including the sampling strategy and thematic analysis. Section 4 presents the findings; first introducing the two imaginaries (Subsection 4.1), before describing how these are inscribed with different gendered constructions and expectations of energy access, and their implications in reproducing and/or reducing gendered patterns of energy access (Subsections 4.2 and 4.3). Section 5 concludes with reflections on how socio-technical energy imaginaries can be re-imagined for more equitable future access, and a call for wider engagement with gender in research on professional imaginaries.

2. Literature review: Gender imaginaries of energy access

We begin by introducing the concept of socio-technical imaginaries and outline how it can be of use in addressing our research aims by accounting for different, but coexisting, visions of gender equity and energy access. We then highlight some key contributions of feminist research on gender and energy that help identify and challenge the gendered outcomes of these imaginaries.

2.1. Socio-technical imaginaries

Socio-technical imaginaries have been defined as the collective interpretations of the world that underline and shape technological or infrastructural projects (Jasanoff and Kim, 2015). They are shared visions of what is attainable through science and technology, but are also imbued with normative ideas of how societies, and everyday lives, should function. In particular, they involve socially-shared ideas of desirable (and undesirable) futures, that are adopted and stabilised by institutions (ibid.). Socio-technical imaginaries are not only discursive visions of the future, but have real, material implications. Imaginaries play an important role in justifying different pathways of development, and shape how technologies/infrastructures are designed, deployed, and for whose benefit (Delina, 2018, Jasanoff and Kim, 2009; Jasanoff and Simmet, 2021). When they become institutionalised (embedded in the strategies and practices of dominant actors), they also act as powerful tools that can 'lock in' particular directions in technological shifts and policy interventions.

The concept of socio-technical imaginaries is increasingly being applied in the fields of development and sustainability (e.g. Simmet, 2018; Cloke et al, 2017), as a way of exploring the complex roles of technological visions within social and environmental transitions. In the energy field, specifically, researchers have found socio-technical imaginaries a valuable "prism" (Hermann et al., 2022) through which to analyse how "competing imaginaries mobilise specific actors, institutions, and visions of a greener future" (op. cit. p1) and how various normative visions (of environmental sustainability, social justice etc) are implicitly embedded in different energy policies, pathways and technologies.

Initially, energy scholars using this concept focused on historical analysis and cross-country comparisons of the imaginaries embedded in state-centred energy technological projects (e.g. Jasanoff and Kim, 2009). This emphasised monolithic national energy imaginaries produced by high level governmental actors through top-down processes. More recent work suggests that multiple national imaginaries can coexist and can be articulated and propagated by non-state actors such as "corporations, social movements, and professional societies" (Jasanoff and Kim, 2015, p.4). As such, attention has shifted to diverse actors involved in the promotion of imaginaries, and to the ways in which multiple imaginaries may coexist in contradictory, competing and complementary ways.

Much research on socio-technical imaginaries of energy (or energy imaginaries, for short) has focused on the Global North. However, there is a small but productive body of scholarship exploring energy imaginaries in the Global South. This work is showing how diverse actors shape different, and often conflicting, imaginaries that clash and coexist to various extents within

national policy arenas (see Barandiarán, 2019; Delina, 2018; Cloke et al., 2017; Marquardt and Delina, 2019; Mohan and Topp, 2018; Simmet, 2018; Fathoni and Boer, 2021). For example, Kumar and colleagues (Kumar, 2019; Kumar et al., 2019) call into question dominant narratives around solar power for universal energy access in various Southern countries that depend upon the flexibility of the socio-technical system and the decentralisation of agency. Further, simplistic assumptions about demand embedded within such imaginaries can lead to predetermined pathways of technological dependency and social inequities. In Afghanistan, Fahimi et al. (2022) show how political path dependencies are reinforced through dominant energy imaginaries that represent Afghanistan as an energy corridor between Central and South Asia, relying on imported energy that hinders its renewable energy transition. Koepke et al. (2021) critique the energy epistemologies developed in the North and applied to the South, which carry with them assumptions regarding energy system development, and that fail to capture the heterogeneity of energy infrastructures, stakeholders and modes of provision that make up the energy landscape in Southern cities. In Senegal, for example, an internationalist discourse of technology-driven energy transition triumphs over local histories and societal benefit (Simmet, 2018). Mohan and Topp (2018) studied imaginaries in the energy policy of India, and found two dominant, competing visions: an imaginary focused on 'energy for economic growth and energy security', advocated by the national government; and an imaginary focused on 'energy for development and ending poverty', advocated by civil society organisations and local communities. These two imaginaries are "governed by competing logics with different regulatory contexts and distributions of power, technology, and institutional arrangements" (Mohan and Topp, 2018, p.78); in other words, these two different ways of imagining energy have real, practical implications for how energy systems in India are designed, implemented and governed (Mohan and Topp's valuable analysis is discussed further in section 4.1). The socio-technical imaginaries framework is thus a highly-relevant framework for explorations of different, and often contradicting, visions of energy access that coexist in Global South contexts.

A final key point is that the energy imaginaries adopted and promoted by experts and professional actors are an especially important, but relatively under-researched topic. Some recent studies in the Global North have highlighted how expert and professional constructions of the end-users of energy can lead "to very tangible outcomes such as gender exclusion or the exclusion of other minorities" (Skjølsvold and Lindkvist, 2015, p.44) from energy projects and futures (Berg, 1995; Richardson, 2009; Skjølsvold and Lindkvist, 2015; Strengers, 2014). However, the question of how different imaginaries reproduce or transform existing inequalities by enabling or curtailing access to energy for different groups of individuals, particularly women, has been largely under-researched in the Global South.

In summary, the visions of energy professionals in the Global South are likely to have substantive impacts on the implementation of energy policies and technologies. The concept of socio-technical imaginaries is valuable in exploring these issues of energy governance, as it facilitates an in-depth, critical analysis of how professionals' visions embed specific assumptions about end-users, technologies, and normative goals, and how these shape outcomes for energy access in the Global South. In particular, we build on existing scholarship on socio-technical imaginaries to explore how professional constructions of the end-user, contained within different imaginaries of gender equity, work to reproduce or transform intersectional and gendered dynamics of inclusion and exclusion in access to energy.

2.2. Feminist perspectives on gender and energy in the Global South

Scholarship on gender and energy has largely neglected how professional imaginaries shape gender and intersectional dynamics of access to energy (for an exception dealing with professional narratives about women and energy poverty in the Global South, see Listo, 2018). However, feminist scholarship on energy in the Global South does provide some insights into how policies and interventions, households and women are constructed in imaginaries of equitable access to energy (e.g. see Cornwall and Rivas, 2015).

In the context of energy-and-development, two dominant discourses prevail in which energy access is portrayed as gender-neutral (Clancy et al., 2020; Standal, et al., 2018) or as an agent of gender equity and empowerment (Listo, 2018). Researchers have shown that these contrasting constructions are particularly problematic in the way they shape and inform policy developments. The former often leads to policies and interventions that are gender-blind, reproducing unequal dynamics of access and discriminating against women (Clancy et al., 2007; Govindan et al., 2020). The latter translates into technocentric policies and interventions that fail to understand that energy access alone cannot end structural gender inequalities (Listo, 2018). According to Bell et al. (2020), a feminist approach to energy goes beyond simply focusing on women, gender equality and economic empowerment. Rather, it takes account of underlying power asymmetries and injustices inherent in existing energy systems that result in differential socio-material processes of distribution and precarity, e.g. along the lines of race and gender (Phillips and Petrova, 2021). Further, these power dynamics are at play at all scales of the energy system, including within the household.

In relation to constructions of the household, energy-and-development scholars have shown that, despite it forming "the basis for much thinking around policy making" in energy (Clancy et al., 2020, p.293), the household is often treated as an unexamined, homogenous unit by policy and practice (Clancy et al., 2020; Petrova and Simcock, 2021). This lack of consideration among energy policies for the intra-household domain contrasts with extensive research on gender and energy in the Global South, which has drawn attention to the household as a key site for the construction of gendered energy uses and inequalities (Barnes and Sen, 2004; Cecelski, 1995, Köhlin et al., 2011; Matinga et al., 2019; Winther et al., 2017).

Finally, most narratives of women in energy-and-development literature tend to present a homogenised construction of women, which essentialises women's domestic roles and paints women as passive victims of energy poverty (Listo, 2018). These limited constructions problematically overlook women's heterogenous experiences based on their varying gendered (and other) identities and power relations. In this regard, intersectional feminism provides a much needed lens that accounts for how gender interacts with other social categories of difference, such as income, class, ethnicity, education, geographical location, etc that produce gendered energy inequalities (Cho et al., 2013). Previous intersectional feminist studies on energy and gender in the South have shown how women's access to energy can vary based on their changing roles and household composition within the same house (e.g. Khalid and Razem, 2022). Engendering energy policy therefore requires acknowledging different men and womens' differential energy needs, roles and decision-making (Feenstra and Özerol, 2021).

Thus, feminist critiques of energy-and-development research, policy and practice provide an essential foundation for our investigation of gender constructs within Global South professional imaginaries and how these shape gendered outcomes for energy access.

3. Methodology

3.1. Case-study approach

To achieve a rich understanding of professionals' imaginaries, while encompassing a range of geographic contexts (and recognising the limited scale of our project), we selected four countries as sites for empirical research. We refer to these four countries as case-studies, because each offers a different socio-technical context within which to explore our core themes.

In selecting these countries, we first prioritised two UNESCO regions with the lowest energy access levels (Sub-Saharan Africa; Asia), based on data contained in SDG7 energy access monitoring reports (IEA, IREA, UN, WB GROUP, & WHO, 2020). We then prioritised countries where we had strong networks of local partners, who could ensure in-depth engagement with professionals essential to the success of the research. The selection process was also informed by quantitative data from the OECD[3]; however, we recognise the Eurocentric nature of these statistics, and treat them with caution.

The selected countries included Ghana, India, Nigeria and Pakistan. All four countries have set high energy access targets for 2030–40, while also committing to meet their Nationally Determined Contribution (NDC) to United Nations Framework Convention on Climate Change (UNFCCC) targets. Further contextual information on each country's energy system histories and trajectories can be found in Appendix A. Finally, we note that all four countries are in the bottom 30% of the 2019 SDG Gender Index (Ghana: 94th/129; India: 95th/129; Pakistan: 113th/129; Nigeria: 122nd/129)[4].

3.2. Data collection

The case-study approach comprised a literature review of energy policy contexts and an in-depth qualitative investigation of professional imaginaries. This qualitative component included 86 semi-structured interviews (carried out between Dec 2020-Feb 2021) with energy sector professionals: 25 interviews across Ghana ('G'); 20, Nigeria ('N'); 20, India ('I'); and 21, Pakistan ('P'). Interviews were conducted by the country-specific teams, and were mostly done virtually due to Covid restrictions, although where possible, face-to-face interviews were conducted. Interviews lasted a mean average of ~ 59 min (range: 18–144 min), with a gender split of 53.5% Women, 46.5% Men, no non-binary. All data have been anonymised and openly shared (Gender equity and energy access in the Global South, 2021). Interview quotations utilised in this paper have anonymised interviewee identifiers for country, gender and stakeholder type (e.g. G15, Woman, Policy).

Our sampling focused around six stakeholder types, all of which were actively influencing energy access interventions. These included: (1) government policy institutions and regulatory bodies (labelled here as 'Policy', representing 14% of the 86 interviews); (2) companies concerned with the generation, distribution and supply of electricity (labelled 'Electric', at 14%); (3) non-governmental organisations working on energy-related projects for electrification and/or cooking solutions ('NGO', 28%); (4) development authorities, planners and architects ('Planners', 15%); (5) engineers and other delivery services responsible for implementing energy access projects and infrastructures ('Engineers', 20%); and, (6) individuals from relevant organisations outside of the aforementioned categories, which the local interviewers believed needed a voice in the sample ('Other', 9%).

An interview protocol template was developed through piloting (one pilot interview per country) and tailored to the particular local contexts of each case (for example, translating to local language for Pakistan and Nigeria) as per guidelines (Campbell et al., 2013; Saldana, 2015). The protocols included foci such as participant's understanding of the issues (meanings and practices). Interviewers completed reflective 'interview memos' (Ortlipp, 2008) in which their overall impression, reflections on respondents' answers and methodological adaptations were noted.

3.3. Data analysis

Data analysis followed a thematic approach guided by the initially-broad coding question of how gender issues in energy access are constructed by professionals. The inductive approach taken was designed to generate findings around major themes that reflected the gendered imaginaries of energy professionals. Whilst cultural and contextual differences between countries exist and are of significance, a comparative analysis was not used for the findings in this paper which focused on drawing out the overarching gendered imaginaries that exist among energy professionals. Moreover country-specific policies and differing perceptions of varying stakeholder types have been published elsewhere (Chatterjee, Palit, & Dhar-Bhattacharjee, 2021; Edomah, Foulds, & Malo, 2021; Khalid & Wajahat Malik, 2021; Schiffer et al., 2022; Schiffer & Nkpeebo Yesutanbul, 2021).

Inspired by Nowell et al. (2017), we structured our analysis around five phases. First, *familiarisation*, whereby all available interview memos and transcripts were read by the lead analyst before any coding began. Second, *generating initial codes and themes*, whereby preliminary bottom-up codes and their overarching themes were produced together iteratively using NVivo, and documented in a codebook (Campbell et al., 2013; Saldana, 2015) and reflexive journal. Third, *reviewing and revising themes*, whereby the codebook was regularly circulated to two fellow authors for auditing, as well as formally reviewed via a wider team peer reviewer meeting. Team discussions helped in further critical review of the data and drawing out key themes around dominant narratives. Following feedback, the codebook was updated in terms of new, deleted, moved, merged and disaggregated codes/themes. Fourth, *finalising code and theme structures*, whereby the updated codebook was applied to the remaining analysis, during which it continued to be inductively updated and revised until agreement from the analysis team's two auditors was attained.

4. Findings

4.1. Introduction to two energy imaginaries

The analysis revealed a broad spectrum in how gender is imagined by energy professionals. These gendered energy imaginaries intersect with wider socio-technical imaginaries, as shown in Figure 1. Gendered energy imaginaries act as structuring future visions that emerge in relation to specific energy technologies and infrastructures (such as clean energy and on/off-grid supply

[3] Within each of the two regions, we selected two countries that are listed on the OECD Development Assistance Committee's List of Official Development Assistance Recipients (See: https://www.oecd.org/dac/financing-sustainable-development/development-finance-standards/daclist.htm). The countries that we selected have (1) the highest populations without electricity access – India (99m), Nigeria (87m); and (2) the highest access-deficit populations from the 20 countries with fastest-growing access rates for clean cooking fuels – Pakistan (109m); Ghana (22m). (Ghana was second highest, but highest (Sudan) was deemed unfeasible due to political instability, as indicated by UK Foreign and Commonwealth Office travel restrictions.).

[4] The SDG Gender Index measures the state of gender equality aligned to 14 of the 17 Sustainable Development Goals (SDGs) concerning issues related to health, gender-based violence, climate change, decent work, etc. Further details can be found at: https://data.em2030.org/2019-sdg-gender-index/explore-the-2019-index-data/.

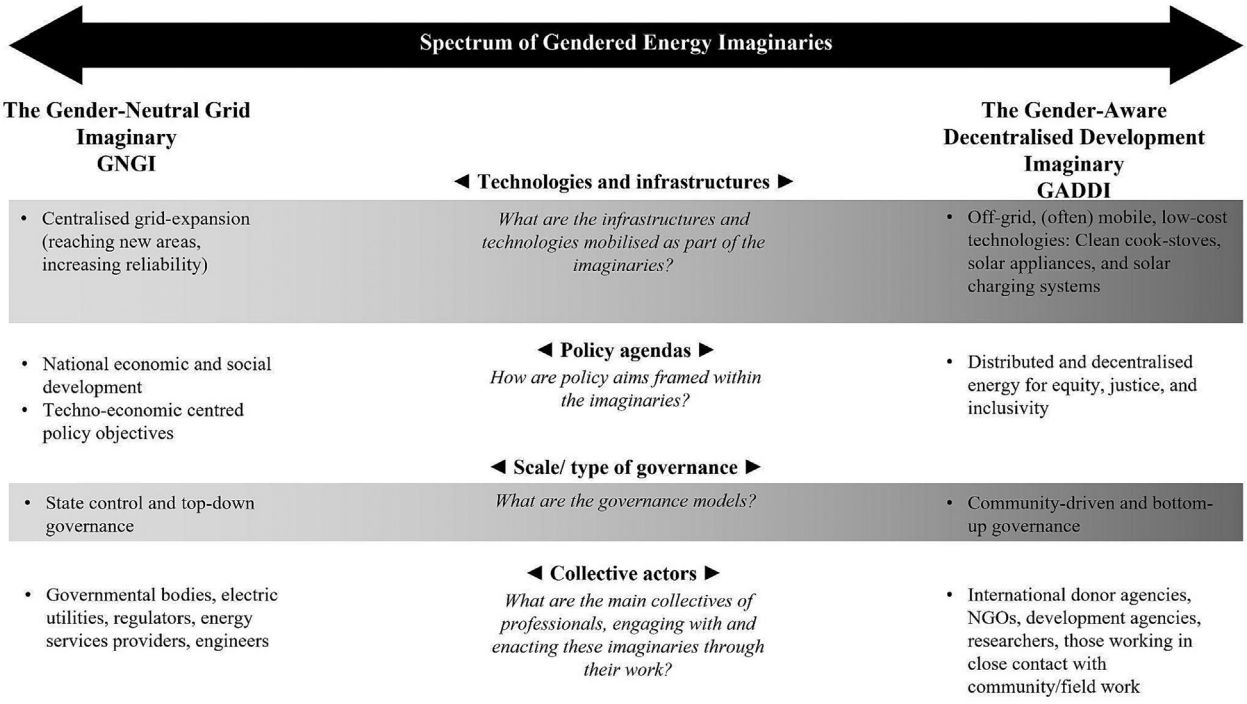

Fig. 1. Gendered socio-technical imaginaries of universal access to energy: The Gender-Neutral Grid Imaginary (GNGI) and The Gender-Aware Decentralised Development Imaginary (GADDI).

systems), in line with specific policy goals and intervention targets (such as economic growth or energy access for all) and become dominated by certain modes of governance (such as top-down or bottom-up). Further, particular actors may engage with and enact specific gendered imaginaries, and in the process, re-entrench or reformulate gendered access to energy. Gendered energy imaginaries can therefore take multiple forms through the varying intersections of actors, networks and socio-technical processes. A comprehensive description of the varying gendered imaginaries of energy professionals, with their inherent complexities, overlaps and country-specific contexts, is beyond the scope of this paper. Our aim in this paper is to draw attention to two dominant imaginaries that represent two extremes of a spectrum, in terms of how gender is understood within energy access. These can broadly be categorised into (1) the Gender-Neutral Grid Imaginary (GNGI) and (2) the Gender-Aware Decentralised Development Imaginary (GADDI) (Figure 1). Focusing on these two archetypes or extreme imaginaries can help visualise competing socio-technical pathways of energy access and their implications for energy policies and interventions. As emphasised earlier, these imaginaries, though representing extreme positions, were not necessarily framed by mutually-exclusive constructions (such as those of technologies and infrastructures, as explained below). Rather, they were fluid and found to coexist in different moments, spaces, and professional communities. As Jasanoff and Kim (2015) contend, multiple imaginaries can coexist within a society in tension, and be elevated by different powers and institutions for specific policy purposes. In the present case, these contrasting imaginaries reinforce specific patterns of technological and infrastructural development, project formation and evidence production that together define institutional cultures towards gender (Jasanoff, 2005).

Whilst we do not aim to provide a comprehensive, historical account of energy transitions and policy contexts for the four case-study countries (see Appendix A for a brief overview of energy sector and policies in the four case-study countries), we do endeavour herein to briefly provide an overarching trajectory to contextualise the two professional imaginaries that emerged.

A review of national energy policies in all four countries reveals their predominant focus on techno-economic processes for achieving visions of modernisation and economic growth. These techno-economic framings underpin ambitious plans for increasing electrification capacity and access to ensure energy security (e.g., MoE, 2010; MPDR, 2013), which are generally positioned as targeting the energy trilemma: delivering cost-effective energy for *economic growth*, while maintaining *environmental standards* (or climate commitments) and ensuring *energy security* (e.g., Bamgbopa et al., 2019; Mohan and Topp, 2018). The first socio-technical imaginary (GNGI) (Figure 1) centres around such narratives, in which centralised grid-expansion is envisioned as key to delivering national socio-economic development and, implicitly, gender equity. Dominating the policy space across the four cases, this imaginary emphasises state-control and top-down governance approaches, with an acute focus on increased generation via an optimal energy resource mix that still heavily relies on fossil fuels. In addition, such targets are mostly envisioned as extensions of existing centralised grids. For example, in India, the energy policy roadmap envisions increased capacity through coal power stations that will use 'supercritical' technology, i.e. having lower pollution levels and higher efficiency (Mohan and Topp, 2018). Most upcoming power projects in Pakistan are also utility-scale coal and gas projects (NEPRA, 2019) served by the national grid (IRENA, 2018). Both Pakistan and Ghana have shifted from hydro to thermal power as their main electricity source (65% in Pakistan (NEPRA, 2019) and 60% in Ghana (MoE, 2010)) for improved energy security, while in Nigeria, energy access targets are imagined through transmission expansion in the form of a 'supergrid' (Bamgbopa et al., 2019). The centralised grid framing persists even for policy reforms that target greater shares of renewable energy (such as 'big-solar' in India).

Centralised, state-controlled electricity generation and distribution has historically served as the prevailing governance model in

all four countries. Whilst this traditionally monopolistic framework is undergoing transformation through various stages of reform in all four countries (mainly through privatisation and market inclusion, e.g. see Bamgbopa et al., 2019; Kemausuor et al., 2011; Mohan and Topp, 2018; NEPRA, 2019), energy planning and implementation still remain top-down and focused on centralised grid-expansion. Further, state-level targets set by national economic development agendas and international commitments prevail over localised user needs and demands (e.g. Mohan and Topp, 2018). Explicit foci on gender considerations and other differential/intersectional social needs do not form any part of this imaginary.

The second imaginary (GADDI) is centred around the provision of energy access for egalitarian purposes, focused on human-centred visions of development, as opposed to the techno-centred visions (within the GNGI) particularly focusing on energy access for those most marginalised. Within the GADDI, electricity access is envisioned beyond the centralised grid system, reified through the proliferation of small- and medium-scale, generally rural, off-grid (stand-alone) projects that have gradually taken hold through decentralised and distributed energy systems. The narrative of decentralised energy is often aligned with that of energy justice and emphasises local governance and inclusive, bottom-up processes, in which the end-users are an agentive part of the system. Ideas about end-user needs are therefore central to this imaginary. Current trends show that the development of decentralised projects in the four case-study countries is linked with investment of private-sector actors with financial backing from international development finance institutions and donor agencies (SE4ALL, 2020). For example, in India, while government bodies, large corporates and NGOs have financed mini-grids, virtually all the associated developers have been local companies (SE4ALL, 2020) and bottom-up citizen initiatives (Mohan and Topp, 2018) - understood here as community-based, participatory groups involved in decision-making action (for a more comprehensive understanding of bottom-up initiatives, see Seebauer et al., 2019; for a post-colonial understanding of community, see Kumar et al., 2019). Recent involvement of democratic and civil institutions in decision-making and policy processes in Nigeria's energy sector have also been highlighted (Edomah et al., 2016a,b). Within this imaginary, decentralised markets supported through bilateral, non-hierarchical contracts between consumers and service providers (both public and private) and devolution of responsibilities to local communities, are envisioned as pathways to improved energy 'democratisation' (Adhekpukoli, 2018) and energy inclusivity (Katre and Tozzi, 2019). Gender-based narratives therefore form part of this imaginary, linked with visions articulated in the international sustainable development arena, in which a focus on gender is increasingly gaining momentum (as seen in the SDGs).

Here, it is important to emphasise the varying socio-political role of energy technologies and infrastructures mobilised within the contesting imaginaries, sometimes with the same technology in question. For example, greater shares of renewable energy (such as through solar) in the energy supply mix forms part of national policies across all four countries (Appendix A). Whilst renewable solar energy is often at the core of decentralised and egalitarian energy access in off-grid areas (e.g. Palit, 2013), which thereby helps drives the GADDI imaginary, growth in renewable energy is also part of the equation within the GNGI imaginary. In this case, it is envisioned by government actors through grid integration as part of the centralised utility supply (Mohan and Topp, 2018), grounded within existing techno-economic narratives of gender-neutrality. Similar is the case of LPG (Liquefied petroleum gas), which is often a centralised state-funded and implemented project, such as in India. In this case, it forms part of both the GNGI imaginary (as a cleaner source of energy to reduce economic dependence on fossil fuels through universal household subsidy) and the GADDI imaginary (to empower and improve the lives of women, provided there is democratic and shared community decision-making and understanding of latent contextual factors like social values and cultural norms (Herington et al., 2020; Maji et al., 2021)). Similar contestations are also evident in the case of energy infrastructures. For example, whilst mini/micro grid projects (either isolated or connected to the main grid) also form part of decentralised systems, their position as socio-technological infrastructures within the two gender imaginaries can vary depending on the national context, policy and regulatory mechanisms and stakeholders involved (e.g. see SE4ALL, 2020). Whilst top-down and government-led initiatives and financing for micro/mini grids can be commonly found, the degree of in/flexibility of the system and de/centralised planning (Kumar et al., 2019) and the participatory nature of institutionalised structures (Prakash and Kumar, 2016) can produce differing imaginaries in off-grid projects on a continuum of configurations, including those of gender. These examples contend to the socio-political construction of technologies and infrastructures: the same technology may form part of contesting narratives based on how it is conceived, defined and exploited within specific future visions. The teleological grounding of the socio-technical imaginary thus defines the technology itself. Such a conceptualisation also speaks to the overlapping nature of gendered energy imaginaries.

In the next subsections, we draw on interview data to explore how the two imaginaries understand and approach gender (in) equalities in energy access and the implications of this for practice (Subsection 4.2 for the GNGI; Subsection 4.3 for the GADDI). For each imaginary, we first consider how technologies and their role in gender equity are imagined, before considering how energy users and their gendered inequalities are imagined.

4.2. The Gender-Neutral grid imaginary (GNGI)

4.2.1. Imagined technologies and their role in gender equity: The grid as a gender-neutral and equalising technology

Within the GNGI, the grid was framed as a gender 'neutral' technology with potential to increase gender equity. Participants engaging with this imaginary emphasised the grid as a *"gender agnostic*" technology (P4, Man, Electric), i.e. one that does not discriminate based on social subjectivities or identities. The expectation, then, is that grid-expansion and new domestic connections would benefit women and men equally. This presumption was expressed by a participant from Ghana, according to whom, in the current national electrification scheme, the government aims for *"every Ghanaian… to get access to power (…) the criteria being used is not whether the person is a female or a male, in getting the access… the government's perception has always been that for electricity in particular, it serves both men… [and women]*" (G15, Woman, Policy).

This construction of the grid as a gender-neutral technology was also visible in the widespread belief that projects and policies related to grid-expansion do not need to incorporate gender considerations: *"As a distribution company we make plans on [the] need to go around relieving the overloaded feeders, overloaded lines. So those are the major considerations, not gender issues*" (N13, Man, Electric).

In recent years the four countries have gone through efforts to varying extents to embed gender as a 'mainstream' issue in national policies, ranging from Ghana where gender mainstreaming is an explicit part of energy policy and present in interventions: "*All energy interventions talk about mainstreaming gender, so that is a recognition that there is a missing link or gap there.*" (G21, Man, NGO) to Pakistan where participants highlighted that gender issues are mainly absent from policy: "*In terms of Pakistan, one, there is no pol-*

icy on access. There is nothing, no strategy on access, leave alone having any gender concerns on that policy" (P3, Woman, NGO) (for more information, see country-specific policy briefs for gender equity in energy access, published as part of the larger research project: Chatterjee, Palit, & Dhar-Bhattacharjee (2021); Edomah, Foulds, & Malo (2021); Khalid & Wajahat Malik (2021); Schiffer & Nkpeebo Yesutanbul (2021). Regardless of the level of recognition for gender mainstreaming in the national policy landscape, a common dynamic to the four countries is that there has only been very limited engagement with gender inequalities in policies and programmes that focus on a centralised grid. As a participant indicated: *"I have definitely not seen any gender policy on the grid side, which is very crucial for electricity access. It's just as important as [for] off-grid*" (N7, Woman, Planners).

Participants engaging with the GNGI were not oblivious to the differential impacts of energy poverty along gender and other axes of social differentiation. However, under this gendered energy imaginary, gendered energy inequalities manifested more saliently in rural or poverty-stricken areas than in urban or affluent regions, often because of limited or unreliable energy supply:

> *"Low-income areas have higher load shedding and power outages than urban areas and so the gender inequality there would probably be higher, because again, the tasks would always fall inequitably on women and children*" (P14, Woman, Engineers).

In contrast, in urban electrified spaces with greater energy availability and comparatively fewer challenges of affordability, participants claimed that *"energy access is genderless*" (P9, Woman, NGO), or as I7 contended, *"I don't see that gender dimension so much in urban areas, because there is affordability and there is plenty of energy available. There's no shortage of money or electricity*" (I7, Woman, Electric). As suggested in these quotes, the grid was imagined as an equaliser, a technology whose presence causes gender differences automatically to vanish.

4.2.2. Imagined energy users and their gendered inequalities: Different uses in harmonious households

Within the GNGI, households (i.e. not individual householders) were conceptualised as the end-users of the grid. This focus on households as the recipients of grid connections and electricity was illustrated by a participant from Pakistan who argued: *"when they're providing the electricity connection, they're providing it to a house not to some guy or some girl, it's an applicant, it could be anybody*" (P7, Man, Policy). In participants' framings, the household was presented as the main unit to be considered in the generation of data on energy access and consumption, disregarding other potential scales of data-disaggregation at the intra-household level: *"I consider the household as my criteria. I consider one connection, after I've given it, I don't even look at the gender of the user or whose name it has gone to*" (I17, Woman, Engineers).

In line with literature on gender and energy, the household remained an unscrutinised entity in professional imaginations (Clancy et al., 2020; Petrova and Simcock, 2021) – envisioned as a harmonious unit, where those co-habiting are considered able to benefit evenly from access to energy (e.g., a new connection to the grid or a new energy technology). In the words of a participant from Ghana: *"If a household is connected, all the gender groups, including even the vulnerable groups, also get the full benefit of that particular service*" (G15, Woman, Policy). This construction rendered invisible the intra-household power dynamics (gender and other) that demarcate different energy experiences of individual household members.

In professionals' imaginaries around gender issues and their relationship with energy consumption, we found a tendency to present a depoliticised understanding and binary construction of women's and men's uses of domestic energy. Most participants articulated gender differences in terms of prevailing gendered divisions of labour, without connecting these to structural power dynamics. Men were frequently associated with uses of energy-related entertainment, thermal comfort and lighting, while the focus for women was placed on housework activities and cooking. The following quote resonates with many others across the sample:

> *"women's need of energy and men's need of energy is quite different. Men's energy need is largely productive uses and for entertainment and a little bit for lighting, you know, and women's energy is more for cooking appliances and other drudgery removal issues*" (I7, Woman, Electric).

Furthermore, gender inequalities were conceptualised in terms of demand (i.e. uses; a cultural issue) and not of access (supply; a technological issue):

> *"For me it's not* access *to energy, maybe usage of energy could be different... maybe men are using more energy and that's very likely because they have access to modern equipment, and gadgets and technology and all of that, more so than women, but I wouldn't think that access to energy is particularly a problem. I mean, discussion of usage is very different from discussion of access*" (P5, Woman, Engineers).

Like P5, many participants considered energy demand as a separate sphere from energy supply. In the words of a participant from Nigeria, *"women are there, they can use it [energy]. Men are there, they can use it (...). Is it that energy has some restriction? No! It is the culture now that is affecting them [women]*" (N17, Man, Engineers). Interviews showed that this vision was more salient in countries such as Pakistan and Nigeria, where mostly gender-neutral policies and practices prevail. This vision that situated gender dynamics and other social processes as external to energy systems contributes to perpetuating the widespread assumption of gender neutrality in the sector (Clancy et al., 2007).

Most energy sector data takes the household as the unit of demand. As a result, the individual uses of household members are diluted in domestic consumption averages. This obscures the embedding of energy within daily practices and lived experiences, resulting in a lack of nuanced understanding of how different women use domestic energy and what their everyday challenges are: *"women and their needs are perceived to be very invisible. And I think a lot of it comes from this view of household as a ... single unit*" (I13, Woman, Other). Despite the lack of data on differential uses and experiences of energy, the underlying assumption within this imaginary was of the home-as-a-women's-domain, in which women were the primary end-users of domestic energy due to their housework responsibilities. For example, most discussion of women's involvement in centralised grid-based projects focused on their supposed role as household efficiency promotors and managers. The following extract represents the accounts of others across the sample:

> *"We consider women as the change agent for energy conservation in the building because traditionally we used to have women remaining in households, and she is the manager of the house, who, along with the other management, she also does the energy management of the home*" (I3, Man, Policy).

In contrast, men were portrayed as mainly absent from the home and dominating domestic energy financial decisions: *"Men will be the ones making the decision to purchase the appliance, men would be making payments for the utility*" (P2, Woman, Policy). While it is important to recognise the prevalent role of men in

domestic decision-making on energy issues, this construction, in situating women in the domestic sphere and men in the public and productive sphere, results in various inequitable energy outcomes.

For example, the invisibility of women's domestic role in energy-related tasks beyond housework means that most professionals tend to imagine men as being inevitably in charge of certain activities, such as paying for electricity bills or applying for an electricity connection. Consequently, professionals enacting this imaginary failed to consider the possibility of more active roles for women, including greater employment in the energy sector, particularly for fieldwork that involves household engagement. Some energy professionals observed that women customers and end-users can communicate their needs better when addressed by women fieldworkers or utility employees, due to prevalent cultural customs of gender segregation: *"females are able to perform better and they are able to connect better with the households and with the females who are the target*" (I17, Man, Engineers). Hence, they miss the opportunity to widen the diversity of the workforce and offer a more woman-friendly service. Furthermore, the gendering of roles within this imaginary fails to account for the numerous home-based income-generating activities that women are involved in for their financial independence or family livelihoods (Pueyo et al., 2020).

In summary, our analysis demonstrates that the top-down centralised model envisioned (i) the electricity system as gender-neutral and (ii) grid-expansion as an equalising force. Under this imaginary, intersectional differences and distributional impacts of energy access remained invisible under the guise of homogeneity and gender-neutrality. However, such 'gender-neutral' interventions result in 'gender-blindness' (Govindan et al., 2020) and risk reproducing gender inequalities in future energy transitions.

4.3. The Gender-Aware decentralised development imaginary (GADDI)

4.3.1. Imagined technologies and their role in gender equity: Decentralised energy to improve women's lives

Stakeholders that engage with and enact the GADDI mostly represented international donor agencies, local NGOs and private social enterprises working in the local energy sector and promoting the use of renewable sources and innovative decentralised technologies to alleviate energy poverty in remote and marginalised communities. Such organisations often had a more bottom-up, collective approach to energy interventions, emphasising field-level activities and close dialogue and engagement with beneficiaries: *"when you're planning for a decentralised solution, there is greater scope for everybody to take part (…) you can have everybody in the village coming together and talking and deciding*" (I4, Man, NGO). Such programmes and policies often included women's participation as an explicit criterion throughout the design and implementation of interventions: *"Our social safeguards group ensures that the consultations that are being done involve women as well, because they are generally left out*" (P3, Woman, NGO). This allows energy provision stakeholders to have a better understanding of the distributional impact of energy poverty on low-income and vulnerable women: *"we all know how lack of access to energy, whether it's electricity or clean cooking, affects women disproportionately, and the economic outcomes, the health impacts…*" (N7, Woman, Planners). The gendered understandings on which this imaginary was based recognises women's specific energy needs and challenges to energy access, thereby emphasising the great potential that access to energy has to improve the lives of women by easing their domestic hardships and promoting family wellbeing (for example, via clean cooking fuels such as Liquefied Petroleum Gas (LPG)):

> *"Women are the lifeline of a household… they are the ones who really carry… things forward and the primary users are them, whether it is electricity, or is cooking, or washing or things like that. I feel that they are a bigger benefactor [i.e. they benefit from energy access more]… …. By a single effort of providing the LPG cylinder, they can look after their children well, they can now devote more time towards... economic activities at home or otherwise, plus the health factor*" (I7, Woman, Electric).

Many of the interventions within this imaginary emphasised labour-saving domestic technologies that help women with housework, including clean cooking technologies (as in the previous quote) and solar portable devices: *"Solar lanterns may actually be more beneficial for women, a lantern a woman can move around, she can even afford to either pay for it or rent it*" (N2, Woman, NGO). Off-grid technologies such as solar lanterns referred to by the participant, but also cookstoves, were very often automatically framed as feminine and targeted towards women: *"if you're doing a cook-stove project, the default beneficiaries definitely will be women who are the majority users of that particular energy*" (G15, Woman, Policy). This strong emphasis on cooking and other housework-related technologies, rather than on other technologies, was evident in most off-grid projects, programmes and policies. This limited approach was highlighted by a participant from India in the following terms:

> *"When it's energy policies, they'll be for women, for cooking energy, I think that's the* default *thinking that happens, and then it stops there. So, you don't have policies at the intersection of energy and gender unless it's cooking energy*" (I13, Woman, Other).

However, policy programmes that target women without considering existing household power dynamics, can limit the success of interventions. For example, excluding men from marketing interventions for clean cooking stoves can limit their uptake because men dominate most household purchase decision-making, as highlighted by a participant from Pakistan:

> "*If you are orienting a product just to women, that might actually not work in favour* of *women because your customer is actually the men, they are the ones, who are going to make the decisions… if they are not being targeted too, that would be bad marketing*" (P01 Woman, Delivery services/solutions).

These examples highlight two issues of concern: 1) gender awareness on its own does not translate into transformative change towards gender equality; and 2) how policy gets translated into actionable interventions on ground determines its success.

4.3.2. Imagined energy users and their gendered inequalities: From energy deprived homemakers to prosumers in the energy supply chain.

Within the GADDI, the imagined end-user shifted from the household unit to individual women. As such, intra-household inequalities became more visible than in the GNGI imaginary. As many participants indicated, in most cases there is a stark imbalance in decision-making with men controlling domestic resources and dominating financial decisions on domestic energy:

> *"Women are marginalised when it comes to decision-making in energy. Normally before such* energy *decisions… [such as when] devices are acquired, most of them have to ask permission, because most of them do not have their own source of livelihood; their livelihood depends on the man's catch. If they had their own livelihood, their earning, they could take some decisions on their own.*" (G19, Man, Engineers).

This framing sat in contradiction with the fact that most interventions within this imaginary, as described above, targeted only women. Thus, without engaging other household members, they risk neglecting the role of men. Some participants reflected on this as counterproductive to the intended objective of improved equity.

Furthermore, it was highlighted that excluding men, who are often in positions of power and authority, from interventions could have adverse effects: *"If you were to go and market a solar home system and said, 'This is marketed to women, and we exclude the men from that conversation', that transaction is never going to happen*" (P1, Woman, NGO). Marketing interventions only to women may make accessing technologies even more difficult for women, as their needs are often not given priority in household budgets: *"[clean cooking] is pitched as a scheme only for women, which leads to other kinds of barriers, because who cares about a woman's health in a certain household context when you're struggling for resources?*" (I13, Woman, India). These comments resonate with previous studies that have shown that ignoring relational aspects of gender can strengthen inequalities (Clancy et al., 2020).

With regard to perceptions of the household within the GADDI imaginary, similar to previous findings (Clancy et al, 2020), our analysis revealed the nuclear family was imagined as the central model for household organisation, with only a few participants mentioning other forms of household organisation. This is despite significant diversity of household structures across the four countries; from intergenerational joint families, extended families, and polygamous marriages, to 'outside wives', and various types of women-headed households or non-marriage-based homes (e.g., Dommaraju, 2015; Karanja, 2018; Owusu and Baidoo, 2021). In all such examples, intra-household decision-making dynamics, including those related to energy, may be very different from those of a western nuclear family model.

Only a few exceptions of professionals commenting on the different dynamics of access associated to different family structures were observed during the interviews, mainly from Pakistan and India; for example, differences in access to energy in women-headed households and different family organisation models were highlighted. One such example was given by a participant from India, who noted that the adoption of LPG as a fuel was driven by cultural dynamics in the intergenerational joint family: *"it's the younger women who have driven the adoption of LPG [Liquefied Petroleum Gas]. In Bihar, particularly many villagers tell this: that now that we have a daughter-in-law coming in, we have to have a gas connection*" (I10, Woman, Policy). Similarly, the lack of tailor made policies that address specific cultural particularities (e.g. diversity of family organisation) was discussed by professionals from Pakistan and India who reflected on the problematic of adopting western policies: "*I see that these policies are very well drafted, very well written but the challenges for me to see, it's not tweaked and tailor made as per the Pakistan requirement you know*" (P6, Woman, NGO). Whilst some examples of contextual understandings of household access were found, for the most part, analysis of interviews revealed a lack of engagement by energy professionals with situated models of household organisation, particularly in Ghana and Nigeria. As a result, there was little recognition of diversity in household composition and how this may shape intra-household dynamics of energy use and access.

The GADDI also included constructions of gender roles and their relationship with domestic energy use. The GADDI emphasised the role of women in reproductive and homemaking uses of energy. Women's uses of energy are clearly distinguished from those of men, who were often presented as spending most of the time engaged in productive activities outside the home.

> *"Men and women use energy differently… cooking is an activity that women have to do. Men are thought to be a bread-winner and they are doing work outside of the home. So now it is the task of women, that they have to collect the firewood for cooking. Men are not helping them.*" (P20, Woman, NGO).

While this construction reflected the widespread unequal distribution of domestic labour, it overlooked its intersectional and contextual nature (see Listo, 2018). Many participants were able to describe how the burden of housework is harder for low-income or rural women, compared to urban or high-income women, due to uneven access to energy. As P9 described: *"For women in urban settings, they do have access to piped gas for example, so they don't have to chop fuel wood every time they want to make tea*" (P9, Woman, NGO). This general acknowledgment of how gender intersects with rurality or class to produce differentiated energy experiences for women contrasted with a lack of attention to diversity of experiences at the intra-household scale. Only a few participants reflected on how social categories of difference – such as women's age or family status (e.g., whether a woman is married or has children) – influenced how women living in the same dwelling may have different levels of engagement in energy-related household tasks, as exemplified by the following Indian participant's emphasis on inter-generational variation in household practice.

> *"Often the responsibility [of cooking] is transferred to the adolescent girls. In rural pockets, I mean, it's the adolescent girl who will be doing the cooking and not the mother, the mother might be working in the farm or somewhere else.*" (I10, Woman, Policy).

As this account suggests, assuming women as a homogenous category of end-users is problematic, because it does not reflect the diversity in how different women and men engage to different extents in household activities. Further emphasising the fluid, heterogeneous and changing character of gender roles, some participants even pointed to how conventional masculinities were being challenged, as more men are taking part in household tasks traditionally considered feminine, such as cooking: *"I can't give a sweeping statement that women are doing household chores and men are working outside the home, it is no more like that…*" (P15, Woman, Planners).

Homogenous framings thus risk reproducing conventional gender divisions and limit the opportunity to challenge or transform domestic gender roles. Similar concerns were highlighted by a participant from India who, when reflecting on the communication campaigns used to promote the adoption of clean cooking in India, suggested that these may have been more transformative had men been incorporated into the campaign:

> *"If it makes cooking easier, why are you not showing men in your billboards across the country? Why are you not putting both of them together? I think the* government *and that advertisement and approach could be a little more gender transformational.*" (I13, Woman, Other).

Contrary to the lack of consideration for women's productive work within the GNGI, many interventions in the decentralised energy space are increasingly recognising women's engagement in entrepreneurial activities. This has led to recent developments in addressing women's requirements for energy supply, including financing mechanisms to facilitate purchase of energy technologies related to such economic activities. An example of such an intervention was discussed by an Indian participant:

> *"What they're [a* local *solar food preservation company] doing is working with tribal women in Maharashtra, they're giving finance for these solar dryers… they give them the raw material, then……women process this raw material into dried [food] products which this company is then selling... giving these women a sustained flow of income... has then helped them repay the amount for that equipment loan... more and more companies are moving into this model.*" (I13, Woman, Other).

However, another Indian participant noted that such projects remain few and far between: *"They do look at it in the starting*

phases at a much smaller scale, but they're not really looked at as legitimate livelihoods or long-term livelihoods" (I6, Woman, NGO). Most entrepreneurial activities undertaken by women remain part of the informal economy and restricted to domestic spaces. As participants noted this may result from restricted access to mobility, public spaces, employment opportunities or difficulties juggling work with family care. The GADDI imaginary suggests that such considerations need to be accounted for in design and implementation of energy interventions (Clancy et al., 2007; ENERGIA, 2019).

Contrasting with the GNGI, the GADDI emphasised women as key actors and facilitators in the roll out of decentralised technologies. In this case, low-income and rural women were seen as change-agents and well-positioned field agents to reach customers: "*for a woman, if it gets to her, she will spread it across and let others know about the access to energy and the alternatives that they can use*" (G3, Woman, NGO). Women were targeted by interventions with the expectation that they could benefit from off-grid energy technologies, such as improved cook-stoves or solar devices, and also "*make a living from producing and selling these energy technologies*" (N6, Woman, NGO). In this way, end-users, in particular women, were envisioned as an integral part of the energy provision process, shifting their role as passive *consumers* to active *prosumers* in sustainable energy transitions. This can have implications for energy access policy, as improved engagement with women – not just as end-users but also as energy supply facilitators – can support the roll-out of access provision schemes to local areas and improve their uptake by communities.

5. Concluding discussion

We commenced this paper by arguing that socio-technical imaginaries, as collectively imagined forms and pathways of social life, play an important but under-explored role in shaping energy access practices and outcomes. We have addressed this gap by considering the gendered imaginaries of energy access amongst energy professionals, a particularly neglected topic, especially in contexts of the Global South. Adopting a novel conceptual integration of socio-technical imaginaries literature with feminist approaches to energy-and-development, we suggest several important insights concerning actors, practices, and outcomes of dominant gendered imaginaries of energy access in the Global South. In this concluding discussion, we now consider these contributions and their policy implications, as well as future research priorities.

Our findings on the gendered socio-technical imaginaries of energy professionals in the Global South resonate with previous studies that emphasise the significance of imaginaries in shaping future visions for energy transitions (e.g. Mohan and Topp, 2018; Simmet, 2018). We build on this to add insights into how such professional imaginaries result in particular developmental processes, policy implications and gendered outcomes for energy access. Specifically, we demonstrate that on the broad spectrum of imaginaries held by energy professionals, there are two dominant gendered imaginaries that correspond with two drastically differing epistemological and ideological standpoints and professional practices. The Gender-Neutral Grid Imaginary (GNDI) and the Gender-Aware Decentralised Development Imaginary (GADDI) reflect gendered imaginaries and constructions that are rooted in contrasting development paradigms, which centre 'neutral' techno-economic or critical human-centred perspectives on development respectively. The contrasting gendered imaginaries intersect with specific technologies and infrastructures, policies and modes of governance in fluid and sometimes overlapping ways and are reflected in the discourses and practices of the actors who engage with them, producing specific gendered visions and outcomes for energy transitions.

Our analysis has also revealed how the contrasting imaginaries are not necessarily mutually exclusive, but can overlap and coexist in different moments, spaces and professional communities. For example, narratives that link traditional masculine and feminine gendered roles with energy use were expressed within both the GNGI and GADDI. Furthermore, both imaginaries, while recognising inter-household differentiation (such as rural–urban inequalities) overlooked intra-household gendered differentiation and power dynamics. In this respect, neither imaginary fully recognises or addresses diversity in women's needs, though the GADDI does at least better recognise the importance of gender issues. Our analysis further shows how professional constructions of 'end-users' may work to perpetuate or alleviate tangible forms of gendered exclusion in energy access, such as reinforcing or addressing gendered exclusions in, for example, household decision-making, participation in employment (especially field projects), and access to financing. Building on these insights, we argue that studying socio-technical imaginaries of professional actors can enable better understandings of how different ideologies and issues are prioritised, contested, and/or overlooked in justifying development practices.

This mapping of gendered imaginaries can therefore inform energy practice and policy to better translate into tangible outcomes, based on their specific positionality on the spectrum of gendered energy imaginaries, and the specific goals for gender equity that are envisioned. To illustrate this, some of the key policy and practice recommendations that can be targeted towards each of the two dominant gendered imaginaries are presented in Figure 2. As the figure shows, in terms of gendered energy data, for policy contexts dominated by a GNGI imaginary, programmes should focus on collecting disaggregated intra-household data on men and women's specific energy access needs as the starting point (including for example on home-working energy needs). For contexts where gender-awareness of differential access may already exist (e.g. where GADDI imaginary is prevalent), an intersectional approach for better understanding of diversity within and between household types may be the next step, such as addressing the needs of women-led households, trans people's homes, migrant worker groups, informal 'blue tarp' settlements, or single parents in shared living, etc. Further, energy professionals should also be more aware of how the ways in which their understandings of the end-users can work to inadvertently perpetuate forms of gendered exclusion. On this topic, a key recommendation related to the GNGI imaginary arising from interviews is to promote women's participation as professionals across all parts of the energy sector. This could lead to wide-ranging benefits in shifting cultures, assumptions and practices within the field; however, this needs to be facilitated through sustained, proactive and holistic measures (including e.g. legislation, training, dedicated budgets, practical facilities). For the GADDI imaginary, a next step involves integrating energy policies with related *non-energy* policies for improved gender equity (as shown in Figure 2).

Whilst our mapping of energy professionals' gendered imaginaries serves to highlight key implications and suggestions for improved gender equity, particularly within the GNGI imaginary, it also demonstrates the existing shortfalls inherent in current 'gender-mainstreaming' approaches. Our findings reveal that gender-awareness in and of itself does not necessarily translate into transformative change and equitable outcomes. Such change requires careful consideration of socio-cultural norms, gender relations and power dynamics, throughout the design, targeting and implementation of interventions that address gender within a nexus of wider social and economic imbalances. Our study provides further evidence for the need to move beyond 'gender-main

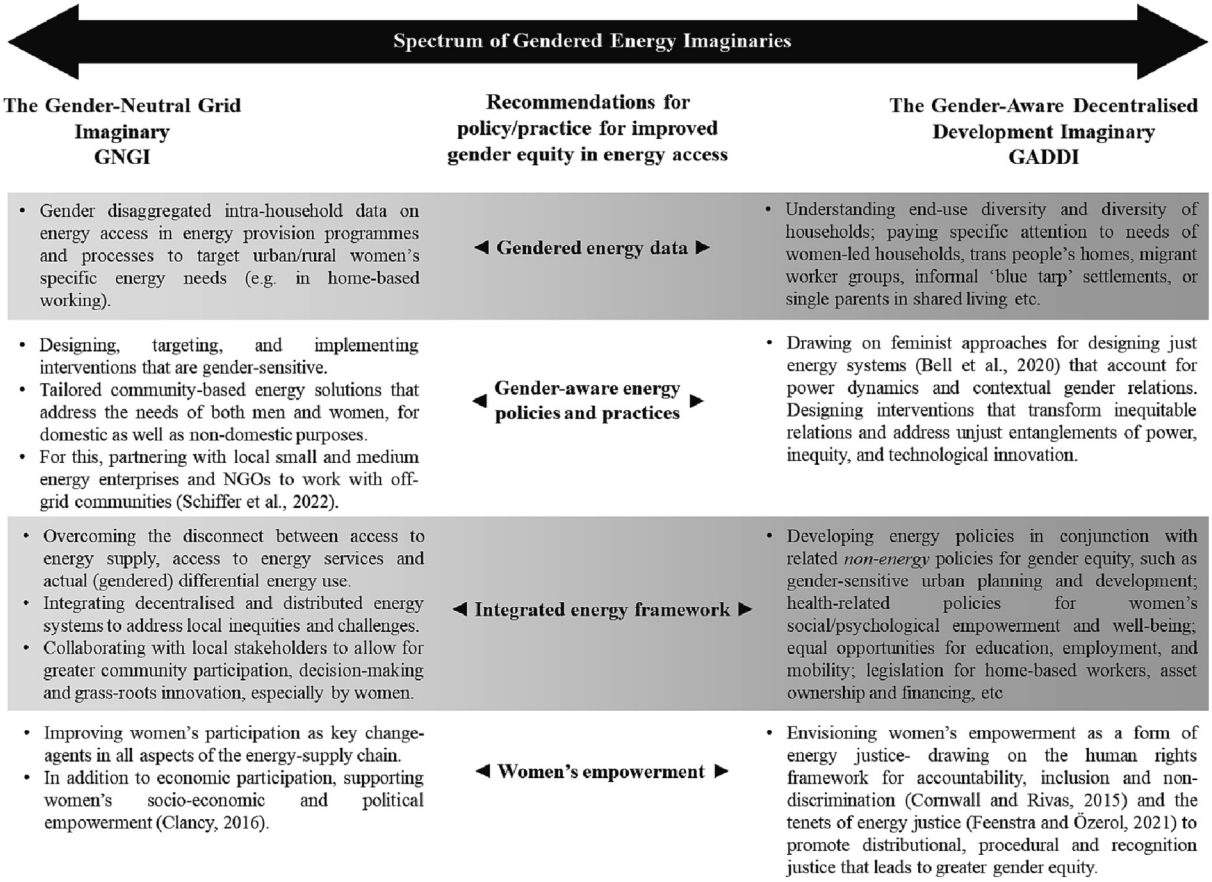

Fig. 2. Policy and practice recommendations for improved gender equity along the spectrum of gendered energy imaginaries.

streaming' towards intersectional conceptions of social equity and energy justice. Recent work by Feenstra and Özerol (2021) conceptualises an energy justice framework for engendering energy policy, which is supported by evidence from our findings. According to the authors, a gender just policy is seen as: acknowledging men and women's differential energy dynamics and creating access to energy technologies and services that match existing dynamics; recognising their rights in policy processes; and enabling equal participation. The empirical findings from our paper and the gendered energy imaginaries evidenced in our case-studies support the need for such a gender just policy. Here, our findings corroborate the need for more feminist approaches in designing just energy systems, as proposed by Bell et al. (2020). By addressing power more explicitly in the socio-ecological, economic, political, and technological dimensions of energy, such systems have greater capacity to address energy differentials, with implications for improved gender equity. Gendered disparities in energy access are recognised as being more than just a 'women's issue' (Cornwall and Rivas, 2015), rather a matter of human rights, social inclusion and justice, understood in its broader socio-economic, cultural and political dimensions. Our analysis contributes to the emerging nexus of literature on feminist energy systems by unpacking the pervasive visions of society, technology, and end-users that structure policies and interventions aimed at improving energy access in the Global South. In particular, we shine a light on the role of the various professionals who act as intermediaries in the design and implementation of socio-technical transitions - a crucial group of actors that has often been overlooked in past research on energy and gender.

Our paper draws its findings from policies, practices and interviews with energy professionals from four case-study contexts of the Global South; however, our framing of gendered energy imaginaries is likely to be of relevance to contexts beyond our case-study. Further research would be valuable to explore how gendered professional imaginaries play out in other contexts, as well as exploring how such visions translate into professional practices and development outcomes. We have initiated this latter effort in other publications from the research project, targeting country-specific policy insights and recommendations (Chatterjee, Palit, & Dhar-Bhattacharjee, 2021; Edomah, Foulds, & Malo, 2021; Khalid & Wajahat Malik, 2021; Schiffer & Nkpeebo Yesutanbul, 2021), in addition to a more comparative analysis (Schiffer et al., 2022). Our investigations have drawn attention to the important, but poorly understood, intersections of gendered imaginaries and energy access outcomes in the Global South. Further research is needed to address the multiple ways in which gender inequalities intersect with energy systems change, and to ensure that progress on sustainable energy transitions acts to support, rather than hinder, progress towards global gender equity and justice. These insights are of immense importance for informing efforts toward achieving equitable and sustainable development, and for realising the SDGs more broadly.

CRediT authorship contribution statement

Cecilia Alda-Vidal: Formal analysis, Conceptualization, Writing – original draft, Writing – review & editing. **Rihab Khalid:** Investigation, Conceptualization, Writing – original draft, Writing – review & editing. **Chris Foulds:** Methodology, Validation, Writing – original draft, Writing – review & editing, Supervision, Project administration, Funding acquisition, Data curation. **Sarah Royston:**

Methodology, Validation, Writing – original draft, Writing – review & editing, Project administration, Funding acquisition. **Mary Greene:** Methodology, Resources, Writing – original draft, Writing – review & editing.

Data availability

Anonymised data freely available at: https://doi.org/10.25411/aru.c.5505273.v1

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.

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Appendix A

Table 1
Energy and policy overview of the four case-study countries.

Pakistan	India	Nigeria	Ghana
Energy mix			
Pakistan's energy mix (HDIP, 2018): - Thermal fossil fuels (coal+ oil+ natural gas): 87.3%; - Hydropower: 9.7%; - Nuclear/Renewable: 2.9%; Approx. 66% of installed electricity generation capacity from thermal sources (NEPRA, 2019).	India's energy mix (IEA, 2021): - Thermal fossil fuels (coal+ oil+ natural gas): 76.5%; - Hydropower: 1.6%; - Nuclear/Renewable: 2.26%; - Biomass: 19.6%; Coal accounts for 55% of installed generation capacity, with policy foreseeing its increased use till 2030 and beyond (Ahluwalia, 2021; Government of India, 2006).	Nigeria's energy mix (SE4ALL, 2016): - Biomass: 81.25%; - Natural gas: 8.2%; - Petroleum 5.3%; - Crude oil: 4.8%; Over 50 million metric tons of fuel wood is also consumed annually, especially in rural areas. Local electric power generation mostly thermal and hydropower (Bamgbopa et al., 2019).	Ghana's electricity generation has seen a shift from hydropower to thermal sources (MoE, 2010): - Biomass (fuelwood+ charcoal): 65.6%; - Petroleum products: 26.0%; - Electricity: 8.4%; Renewable hydropower accounts for 43.2% of total installed electricity generation capacity (MoE, 2019).
Energy Policy			
- Main policy documents: National Power Policy 2013 and Alternate and Renewable Energy Policy (AREP) 2020. - Pakistan vision 2025 to elevate the country to upper-middle class status (MPDR, 2013). - Centralised control of the electricity generation and distribution system under DISCOs (Distribution Companies). - Federal government focused primarily on improving generation capacity and utility-scale projects in areas already served by the national grid (IRENA, 2018). - Although NTDC (National Transmission and Dispatch Company) has formulated a number of short and long-term grid expansion plans, these have been largely ignored in policy (NEPRA, 2019). - Efforts for partial privatisation and competitive market development underway (NEPRA, 2019).	- Main policy documents: Integrated Energy Policy Report 2006; National Electricity Policy 2005. - National energy policy focused on centralised grid expansion with integration of RE through utility scale, grid connected projects (Mohan and Topp, 2018). - Focus on energy trilemma: delivering cost effective energy for economic growth while maintaining climate commitments and ensuring energy security (Mohan and Topp, 2018). - Focus on increasing competitive market share and flexibility in system integration (IEA, 2020) - Reliance on 'clean coal' and 'supercritical' technology (Mohan and Topp, 2018).	- Main policy documents: National Energy Policy 2003 and National Renewable Energy and Energy Efficiency Policy 2015. - Targets for triad: economic, environmental and delivery impacts (Bamgbopa et al., 2019). - Nigerian electricity market traditionally designed to be monopolistic, until the Electricity Power Sector Reform Act 2005, which enabled private sector partnership (Edomah et al., 2016). - Focus on upgrade of grid capacity and increase in generation through expansion of 'super grid' (Bamgbopa et al., 2019) - Focus on development of more micro and mini hydropower schemes, reduction of bioenergy use and oil sector reforms to help revive oil production and expansion of gas network (Bamgbopa et al., 2019).	- Main policy documents: National energy policy 2010 and Renewable Energy Master Plan (REMP) 2019 - Envisions development of an 'energy economy' for securing reliable high-quality supply and for major export of oil and power, in line with Ghana's development agenda to achieve macro-economic stability and achieve middle-income status by 2020 (MoE, 2010). - Centralised, state-controlled generation, transmission, and distribution - Focus on regulation of the sector, mobilisation of investments, strengthening human capacity, research and development (MoE, 2010). - Gender mainstreaming explicit part of energy policy (MoE, 2010). - Power sector reforms initiated in 1995 allowed increased private sector investment and participation (MoE, 2010).
Energy challenges			
- Current electricity shortfall of ~5000MW (MWP, 2013). - More than 144 million people do not have reliable access to electricity due to a lack of connection to the national electricity grid (44%)	- Lack of reliable electricity supply; continued reliance on solid biomass (firewood) for cooking for 660 million people; financially ailing electricity distribution companies (IEA,	- Regular encountered power outages and below-par energy infrastructure (Bamgbopa et al., 2019).	- About 16.5% of Ghana's population stills lacks access to electricity with large disparities between urban (93.8%) and rural (70%) areas (World Bank, 2019).

Table 1 (*continued*)

Pakistan	India	Nigeria	Ghana
or due to blackouts that can last over 12 hours per day (PGREF, 2019). - Inefficiencies, theft, and high cost of generation result in debilitating levels of subsidies and circular debt. - Lack of integrated policy mechanisms at the federal or provincial level for off-grid electrification (IRENA, 2018). - Key factors limiting micro/mini-grid solutions for rural electrification include lack of technical expertise, limited data and knowledge of market potential and lack of financing and government support (PGREF, 2019).	2021). Heavy reliance on coal mining and coal-based power generation. - Common supply interruptions and voltage fluctuations. Inefficiencies of existing DISCOMs with high losses and outstanding debts (Ahluwalia, 2021). - Off grid solutions seen as only 'backup' or 'short term' measures (Mohan and Topp, 2018). - Lack of systemic thinking, and an undue focus on targets for political expediency instead of frameworks resulting in incoherent energy policymaking (Mohan and Topp, 2018).	- Over 85 million Nigerians (43% of the population), in over 15 million households, still lack access to electricity (World Bank, 2021). - Poor management of energy resources and absence of quality check for potency of policy implementation. Poor, slow, or ineffective implementation (Bamgbopa et al., 2019). - Lack of incentives for increased grid transmission and financial/pricing hurdles in renewable and non-grid operation (Adewuyi et al., 2020).	- Power outages are common due to unreliable supply (Eshun and Amoako-Tuffour, 2016). - Key challenges identified as inadequate and outdated infrastructure, inefficiencies in energy provision and inadequate regulatory mechanisms (MoE, 2010). - Renewable energy currently constitutes less than 1% of the electrical energy mix (MoE, 2019). - Slow uptake of mini-grids due to policy backlogs e.g., legal and financial binding constraints on developments of mini-grids (Bukari et al., 2021).
Energy targets			
- AREP targets for 20% renewables by 2025 (currently at 6%) and 30% by 2030 (AEDB, 2020). - To increase generation by 25,000MW by 2025, mostly from hydel and coal projects (MPDR, 2013).	- NDC Commitment to install low carbon energy capacity upto 40% of total installed electrical capacity by 2030 (Mohan and Topp, 2018). - 100% electrification of all households. 'Saubhagya' scheme intended to tackle last mile grid connectivity. - Targets to quadruple RE capacity to 450GW by 2030 (IEA, 2021). - Targets for 450 GW of renewable capacity by 2030 (IEA, 2021).	- To increase electricity access to 85% of population by 2040 (IEA, 2013). - The Renewable Energy Master Plan 2005 set goal for renewables to account for over 30% of energy mix by 2030 (IEA, 2013).	- REMP 2019 targets for increasing RE from 42.5 MW in 2015 to 1,363.63 MW by 2030, i.e. 10% renewable energy by 2030. - To ensure decentralized electrification in 1,000 off-grid communities (MoE, 2019).

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