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Multidimensional Energy Poverty for Botswana: Does gender matter?

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ABSTRACT

The energy-gender nexus is a topical issue that has gained traction among researchers and policymakers. Access to clean energy and gender equality are two of the most crucial sustainable development goals (SDGs) that affect households directly. Notwithstanding this, the gendered analysis of multidimensional energy poverty has been minimal in the empirical literature. Using the 2015/16 Botswana multi-topic household survey, this study investigates the gendered dimensions of energy poverty in Botswana, emphasising the disparities in energy access and affordability between male and female-headed households. We employed the Alkire-Foster (AF) methodology to compute our aggregate multidimensional energy poverty index (MEPI). Overall, we find that in Botswana, the gender gaps in multidimensional energy poverty levels are more than 10% for the poverty incidence and adjusted headcount ratio. This suggests that energy poverty in Botswana seems to be feminised. However, the gender gap in the intensity of multidimensional energy poverty is lower than 3% in favour of female-headed households. Finally, substantial gender gaps exist across household demographic characteristics, human capital, economic variables, and geography. The findings suggest that while Botswana has made significant progress in promoting renewable energy access through initiatives such as the Photovoltaic Rural Electrification Programme, gender-specific barriers remain. The study recommends enhanced policies that integrate gender considerations to foster equitable energy solutions, ensuring that all households, irrespective of the gender of the household head, can thrive in a sustainable and energy-secure environment.

Keywords: Multidimensional energy poverty; Gender gaps; Energy-gender nexus; Leave no one behind; SDG 5; Botswana.

1. INTRODUCTION

The 2030 Agenda for Sustainable Development emphasises the importance of energy and gender in achieving sustainable development (UN, 2015). Goal 7 of the Sustainable Development Goals (SDGs) (SDG 7) aims to ensure universal access to affordable, reliable, sustainable, and modern energy by the year 2030 (UN, 2015). Gender equality is at the core of sustainable development, and this is clearly captured by Goal 5 of the SDGs (SDG 5), which aims at achieving gender equality and empowering all women and girls by the year 2030 (UN, 2015). According to SDG 7, the adoption of energy policies and interventions should consider linkages across other SDGs, especially SDG 1 (poverty eradication) and SDG 5 (gender equality) (Buchy & Shakya, 2023). Access to clean energy and gender equality are two of the most crucial SDGs that affect households directly. However, a vast disparity remains between the stated SDGs and the situation on the ground. Access to reliable and affordable energy is essential for socio-economic development, yet it remains a significant challenge in many parts of the world, particularly in sub-Saharan Africa. The majority of the population with no access to clean energy (600 million of the 730 million) live in Sub-Saharan Africa (SSA) (International Energy Agency [IEA], 2020) and are mostly found in rural areas and low-income households (Danielsson & Ekman, 2023).

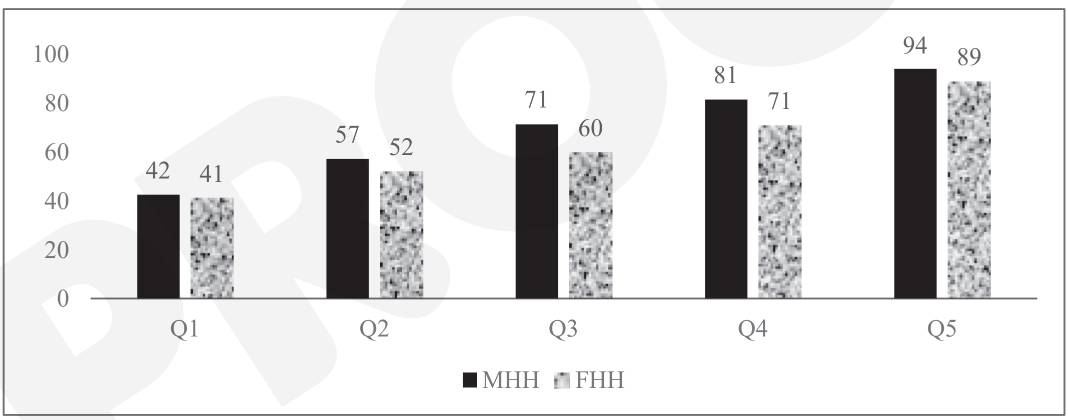
Like in other SSA countries, the Government of Botswana strives to expand access to sustainable renewable energy and has implemented several interventions to increase the adoption and use of modern and clean energy. The 2012 Energy Master Plan is committed to ensuring everyone has access to basic energy services, such as lighting, cooking, and heating, by integrating off-grid and grid technologies into its rural electrification initiative (Republic of Botswana, 2012). The Photovoltaic Rural Electrification Programme facilitates rural communities in Botswana to access the facility to purchase photovoltaic systems and repay the loan over four years. This move allows rural households to use solar renewable energy and complement other energy sources in water heating (IEG, 2023).

The 2021 National Energy Policy (NEP) recognises the different energy needs of men and women and calls for considering these gender differences in energy strategies and programmes during formulation and implementation. The policy stipulates that gender mainstreaming is key in policy design, formulation and implementation to achieve gender equality and women's empowerment (Republic of Botswana, 2021). Vision 2036 also recognises energy as essential to social and economic development and outlines availability, accessibility, safety, affordability and reliability as key factors for sustainable energy (Republic of Botswana, 2016). Even though Vision 2036 recognises gender equality, it does not explicitly mention gender equality regarding energy. The 2024 National Transformation Strategy aims at achieving national energy security by 2036 (Republic of Botswana, 2024). However, the strategy does not address gender equality in energy poverty.

Despite these initiatives, Botswana continues to experience energy shortages affecting many households. The use of renewable energy remains well below the country's potential. Botswana's electricity access is relatively low, particularly for female-headed households. Data show that most male-headed households (53.4%) are connected to the national grid compared to female-headed households (46.6%) (Statistics Botswana, 2018). The high cost of connections, frequently regarded as prohibitive, prevents many low-income households, especially female-headed households, from connecting to the national grid. Figure 1 shows that female-headed households are worse off compared to male-headed households across all wealth quintiles.

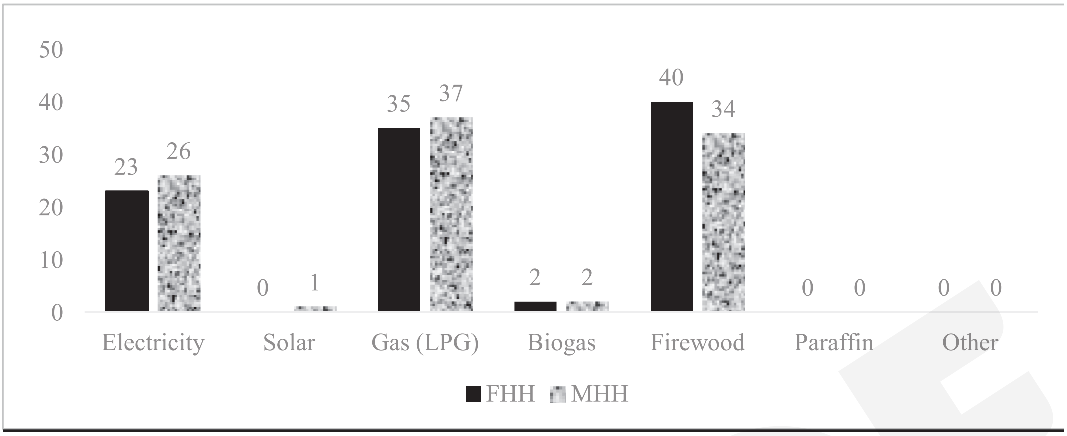
Concerning energy used for cooking, the primary fuel sources in Botswana are firewood, followed by petroleum gas (LPG), electricity and biogas. The remaining cooking fuels (solar, paraffin, coal) account for less than 1%. However, Figure 2 depicts gender gaps based on fuel used for cooking. Most female-headed households use dirty fuel for cooking (firewood, biogas, coal) compared to male-headed households. The opposite is true for clean cooking fuel, where male-headed households are better off than female-headed households.

Figure 1: Connectivity to the national grid across quintiles and gender of household head



Source: Authors' computation based on the 2015/16 BMTHS

Figure 2: Various fuels used for cooking by gender of household head



Source: Authors' computation based on the 2015/16 BMTHS

In Botswana, energy poverty is not merely a technical issue but one deeply intertwined with social dynamics, particularly gender. Women often bear the brunt of energy deprivation and face substantial hurdles in accessing clean and efficient energy sources. As the country pursues a transition towards renewable energy, it is imperative to investigate how these changes affect different households based on the gender of their heads. In view of the above and the absence of any study of this kind in Botswana, this research provides the first attempt to examine the possible gender inequalities in energy poverty. Therefore, this research aims to investigate whether gender gaps exist in energy poverty levels in Botswana. We use the 2015/16 Botswana multi-topic household survey (2015/16 BMTHS) to characterise different conditions of energy poverty across individual and household characteristics and across geographical distribution to assess whether there are gender gaps.

In doing so, this study seeks to illuminate the gendered aspects of energy poverty in Botswana by examining how energy access disparities manifest between male and female-headed households. By employing a multidimensional approach to assess energy poverty, we are making a novel contribution to the energy poverty-disparities literature in developing countries. Overall, this investigation aims to contribute to the discourse on energy policy by underscoring the importance of integrating gender considerations, thereby promoting equal opportunities for all households in Botswana's evolving energy landscape.

The next section provides a brief review of the literature. Section 3 presents the methodology and data sources. Section 4 presents empirical results, and Section 5 presents conclusions and policy implications.

2. REVIEW OF RELATED LITERATURE

2.1. CONCEPT OF ENERGY POVERTY

Understanding energy poverty is critical since it has a bearing on how it is defined and measured, which, in turn, influences interventions put in place to alleviate it (Pachauri & Spreng, 2011). The concept of energy poverty is multidimensional (Crentsil et al., 2019), so there is no single definition of energy poverty. Considering this, and due to differences in experiencing and understanding energy poverty, defining energy poverty has proved to be a challenge (Sokolowski et al., 2020). Boardman (1991) conceptualised the issue of energy poverty, defined it in terms of fuel poverty, and expressed it as "households whose fuel expenditure on all energy services exceeded 10% of their income". Since then, several definitions have been proposed in empirical literature. Bouzarovski and Petrova (2015) defined energy poverty as the inability to attain a socially and materially necessitated level of domestic energy services. Middlemiss and Gillard (2015) defined energy poverty as the inability of certain households to acquire the energy services required to live a decent and healthy life. Thomson et al. (2017) defined energy poverty as a situation when a household is unable to afford the energy needed to provide its members with adequate warmth, cooling, lighting, and appliance use.

Day et al. (2016) defined energy poverty as "an inability to realise essential capabilities as a direct or indirect result of insufficient access to affordable, reliable and safe energy services, and taking into account available reasonable alternative means of realising these capabilities" (p.260). They argue that defining energy poverty in terms of capabilities in this way draws attention to its impacts on multiple dimensions of well-being and human flourishing (Melin et al., 2021). The capability approach emphasises the role of access to energy services (or lack thereof) in achieving socio-economic well-being and sustaining quality of life (Sokolowski et al., 2020). In this case, energy poverty is conceptualised as a multidimensional concept, encompassing both availability (access) and affordability issues (Lekobane, 2025).

2.2. ENERGY-GENDER NEXUS

The relationship between gender and energy poverty has attracted some attention of researchers in recent years (Clancy et al., 2007; González-Eguino, 2015), and the conclusion is that energy poverty is also considered a gendered phenomenon (Aristondo & Onaindia, 2018; Moniruzzaman & Day, 2020; Sánchez et al., 2020). Most studies dealing with gender and energy poverty concluded that women may be negatively impacted by energy poverty more than men (Tsekane et al., 2024; Moniruzzaman & Day, 2020; Robinson, 2019). For example, Robinson (2019) indicates that spatial patterning of energy poverty is associated with economic activities and health in the UK. Aristondo and Onaindia (2018) find that energy poverty appears to be higher for women than men in Spain. Moniruzzaman and Day (2020) found varying energy poverty levels between women and men in rural Bangladesh, with women experiencing more energy poverty.

Energy poverty in sub-Saharan Africa continues to have a disproportionately adverse effect on women, who are primarily responsible for collecting and utilizing traditional biomass and other unclean energy sources for domestic tasks (Clancy et al., 2002). Gender dynamics in electricity access and household energy decision-making reveal entrenched inequalities, with women often having limited agency and influence over decisions related to energy use and investments (Tsekane et al., 2024). These dynamics reflect broader socio-material power imbalances, where women's contributions to financing electricity and their ownership of energy appliances are frequently contested (Winther et al., 2020). While several studies have found a positive association between electricity access and improvements in women's welfare (Njoh et al., 2022), the broader developmental impacts of energy access remain uneven, with considerable regional variation across the continent (Acheampong et al., 2022). Importantly, recent evidence suggests that access to clean fuels and technologies for cooking is positively associated with women's life expectancy in the region (Tsekane et al., 2024), underscoring the critical role of gender-responsive energy policies in advancing human development outcomes.

González-Eguino (2015) maintains that most people experiencing energy poverty rely on traditional biomass as their energy source for cooking. However, biomass use has many adverse effects on the impoverished, particularly women who are responsible for cooking. The fuel is of low quality and produces large amounts of smoke and pollutants known to be harmful to human health when burned (Robinson, 2019). The use of dirty fuel for cooking is associated with indoor air pollution, and this has adverse effects on individuals' health and might increase the risk of many diseases and death (Kaplan, 2010; Balakrishnan et al., 2011), particularly for women and young children (Duflo et al., 2008). In addition, exposure to smoke has immediate and long-term adverse effects on one's health (Baruah, 2015).

Among households that use firewood for cooking, daily cooking responsibilities and firewood collection are primarily carried out by women and girls (Choudhuri & Desai, 2020). This means women spent several hours each day collecting firewood, leaving them with less time to spend on other productive activities (Chevalier & Ouédraogo, 2009; Robinson, 2019). In the same way, Heredia et al. (2022) show that gender roles and jobs like caregiving, which women typically perform, are linked to energy poverty in comparison to men. Furthermore, women are usually subjected to low earnings and precarious employment, particularly in the rural economy. This significantly impacts their energy decisions, particularly for households headed by women, who are already at a disadvantage due to income gaps with their male counterparts. For example, the amount left over after paying for electricity becomes increasingly insufficient for the household's needs (Robinson, 2019). Moniruzzaman and Day (2020) suggest that energy is 'women's business' in rural and low-income urban households, meaning that women provide the energy and use it for productive activities such as tilling land (farming) and household chores.

3. DATA AND METHODOLOGY

3.1. DATA

We utilised the 2015/16 Botswana Multi-Topic Household Survey (BMTHS) data. This is a cross-sectional and nationally representative survey conducted by Statistics Botswana. The survey collected socio-economic information on sixteen (16) topical modules covering a sample of 7,060 households across administrative districts (Statistics Botswana, 2018). The survey employed a two-stage stratified probability sample design. The first stage was the selection of primary sampling units (PSUs), enumeration areas (EAs), using Probability Proportional to Size (PPS), where the measure of size is the number of households in an EA as defined in the 2011 Population and Housing Census. The second stage was the selection of occupied households within the selected EAs. A list of identified occupied households formed the basis of secondary sampling units (SSUs). Thus, the number of occupied households in each selected EA served as a sampling frame for that EA. Stratification was made based on the twenty-six (26) census districts, which are heterogeneous and are aligned to administrative districts. The districts were further grouped into three strata: cities/ towns, urban villages, and rural areas (Statistics Botswana, 2018).

3.2. MEASURING MULTIDIMENSIONAL ENERGY POVERTY (MEPI)

Efforts to measure energy poverty have largely been based on unidimensional binary indicators such as modern or clean energy access (Mendoza et al., 2019). However, these binary indicators do not accurately represent the energy situation. Given the multidimensional nature of energy poverty, several composite indices have been proposed and developed. These composite indices aggregate different indicators of energy poverty into a single number that is easy to compare across time and nations (Nussbaumer et al., 2013). These include the Energy Development Index (EDI) (International Energy Agency [IEA], 2014); Multidimensional Energy Poverty Index (MEPI) (Nussbaumer et al., 2012), Energy Poverty Index (EPI) (Tirado-Herrero & Bouzarovski, 2014; Mirza & Szirmal, 2010) and Compound Energy Poverty Indicator (CEPI) (Maxim et al., 2016). The method that best measures multidimensional energy poverty is still being debated (Mendoza et al., 2019). Therefore, which method to use largely depends on the type of data and the conceptual framework adopted to define energy poverty.

Following other studies that examined multidimensional energy poverty (Nussbaumer et al., 2011; Okushima, 2017; Adusha-Poku & Takeuchi, 2019; Mendoza et al., 2019), we adopted the Alkire and Foster (AF) methodology (Alkire & Foster, 2011) for identification and aggregation.[1] We assume a population of n households $i\,(i = 1, \cdots, n)$ and $d \geq 2$ dimensions, $(j = 1, \cdots, d)$ summarised by an $n \times d$-dimensional matrix $\boldsymbol{Y} = [y_{ij}]_{n\times d}$, where y_{ij} is a set of achievements of household i in indicator j. The AF methodology uses a two-step 'dual cut-off' process to identify the poor (Alkire & Foster, 2011).

The first cut-off process is linked to deprivation cut-offs for each indicator, x_i and is denoted by z_j represented by a vector $\boldsymbol{z} = (z_1, z_2 \cdots, z_d)$ where d represents the number of indicators. A household i is deprived in any indicator j if its achievement falls below the deprivation cut-off z_j (or $y_{ij} < z_j$) for indicator j. From the $\boldsymbol{Y}$ matrix and vector, a matrix of deprivation $\mathbf{g}_{ij} = [\mathrm{g}_{ij}]_{n\times d}$ is obtained such that $\mathrm{g}_{ij} = 1$ when $y_{ij} < z_j$ and $\mathrm{g}_{ij} = 0$ otherwise. In other words, $\mathrm{g}_{ij} = 1$ means household i is poor (or deprived) in indicator j. Next, let $\boldsymbol{w} = (w_1, w_2 \cdots, w_d)$ be the vector of indicators' weights. The weight attached to indicator j is denoted by w_j such that $(w_j > 0)$. These weights sum to 1, that is, $\sum_{j=1}^{d} w_j = 1$ and $w_j \in [0,1]$. Then, the deprivation score c_i is computed for each household i, such that $c_i = \sum_{j=1}^{d} w_j \mathrm{g}_{ij}$. If a household is not deprived in any indicator $c_i = 0$, and if a household is deprived in all indicators $c_i = 1$. The vector of deprivations for all households is given by $\boldsymbol{c} = (c_1, c_2 \cdots, c_n)$.

The second step involves choosing the poverty cut-off point, k, using the deprivation profiles in all indicators to multidimensionally energy poor households. The choice of k is such that $1 \leq k \leq d$.[2] The poverty cut-off is implemented by using the method of identification ρ_k. A household i is identified as multidimensional energy poor if it satisfies the following condition: $\rho_k(x_i; z) = 1$ if $c_i \geq k$, otherwise household i is *not* in energy poverty if $\rho_k(y_i; z) = 0$. From the deprivation matrix $\mathbf{g}[\mathrm{g}_{ij}]_{n\times d}$, a censored deprivation matrix $\mathbf{g}(k)$ is constructed by multiplying each element in $\mathbf{g}$ by the identification function $\rho_k(y_i; z)$: $\mathrm{g}_{ij}(k) = \rho_k(y_i; z)$: $\mathrm{g}_{ij} \times \rho_k(y_i; z)$ for all i and all j. A censored deprivation score vector for all individuals is then obtained from the original deprivation score vector: $c(k) = c \times \rho_k(y_i; z)$. Let $c(k) = \sum_{j=1}^{d} w_j \mathrm{g}_{ij}(k)$ be the censored deprivation score of household i; by definition $c_i(k) = c_i$, if $c_i \geq k$, and $c_i(k) = 0$ if $c_i < k$ (Alkire & Santos, 2014).[2] Then, $c(k) = [c_1(k), c_2(k) \cdots, c_n(k)]$. Finally, we can now compute a multidimensional energy poverty index (MEPI) as:

$$M_0 = H \times A = \frac{q}{n} \times \frac{1}{q} \sum_{i=1}^{q} c_i\,(k) = \frac{1}{n} \sum_{i=1}^{n} c_i\,(k) \qquad (1)$$

1 This section draws heavily from Lekobane (2025).

2 The censoring step retains the deprivation scores of households identified as energy poor and replaces the deprivation scores of those who are not identified as energy poor ($c_i < k$) by 0 (Alkire et al., 2015).

where q is the number of multidimensionally energy poor households, n is the number of households in the population; $c(k)$ is the censored deprivation score of household i. M_0 is the adjusted energy headcount ratio, containing both multidimensional energy headcount ratios (H) and the average deprivation scores (A), capturing the intensity of multidimensional energy poverty (Alkire et al., 2015).

Table 1 presents the dimensions and indicators used to compute multidimensional energy poverty for Botswana, including their respective cut-offs and weights. The weights are distributed arbitrarily among the indicators, recognising their relative importance to the overall MEPI (Nussbaumer et al., 2012; Crentsil et al., 2019; Mendoza et al., 2019). Cooking fuel captures the source of fuel used by households for cooking. Using dirty fuel for cooking is associated with indoor air pollution, which has adverse effects on individuals' health and might increase the risk of many diseases and death (Kaplan, 2010; Balakrishnan et al., 2011). This captures the capability of good health (Day et al., 2016). Being unhealthy can also affect several other basic capabilities, such as an individual's ability to participate in social activities and undertake paid employment (Rippin, 2016). A household is deprived in cooking fuel if the main source of cooking is wood, cow dung, coal, charcoal, and crop waste or has no cooking fuel source. Our dataset does not have information to capture indoor air pollution, unlike similar studies (Crentsil et al., 2019; Mendoza et al., 2019).[3]

Access to electricity is vital for essential household services (Crentsil et al., 2019). Access to electricity can improve the living conditions of households by allowing them to be independent of sunlight for lighting and contribute to a clean environment (Santos, 2013). Access to electricity is also critical for other capabilities, such as information, education, entertainment, and communication (Day et al., 2016; Sadath & Acharya, 2017). For example, using electricity for lighting aids the use of modern technologies, enhancing children's learning. Also, the availability of lighting allows adults, especially women, to study during the night after completing their house chores (Wamukonya & Davis, 2001). A household is considered deprived if the primary source of lighting in the household is not electricity from the national grid.

In addition to access to electricity and improved cooking fuels, we included three indicators that capture what Day et al. (2016) termed secondary capabilities. Nussbaumer et al. (2012) argued that the MEPI should consist of other indicators that capture the issue of energy affordability by incorporating indicators that relate to the ownership of household appliances. We include three indicators. The first indicator captures services provided by means of household appliances defined in terms of household ownership

3 The omission of this variable does not have any significant impact, since the weight for the cooking dimension remains the same. The effect of air pollution is indirectly captured within the cooking fuel indicator. Household using dirty fuel for cooking have higher likelihood of being affected by indoor air pollution. And since this indicator captures health, it carries more weight. The robustness checks (not reported in this paper) revealed no changes in the main results and conclusions.

of fridge/freezer. A household is defined as deprived on this indicator if the household does not own a refrigerator or freezer. The second indicator relates to entertainment/education. A household is considered deprived in this indicator if it does not own a radio or television. The third indicator is communication; a household is deemed deprived in telecommunications if it does not own a fixed telephone or mobile phone. These indicators influence some basic capabilities, such as education and access to information.

Table 1: Dimensions, deprivation indicators, cut-offs and weights†

Dimension	Indicator	Indicator Definition	Deprivation cut-off (a household is deprived if …)	Weight
1. Lighting	Electricity access	Assess household connectivity to the national grid	The household is not connected to the national grid.	1/5
2. Cooking*	Modern cooking fuel	Captures the source of fuel for cooking used by households	The household uses the following fuel source: wood, cow-dung, coal, charcoal, and crop waste OR has no source of cooking fuel at all.	2/5
3. Services provided by means of household appliances	Household appliance ownership	Assess whether the household owns a fridge	The household does not own a fridge	2/15
4. Entertainment/ Education	Entertainment/ education appliances	Assesses whether the household owns a radio OR television	The household does not own a radio OR television.	2/15
5. Communication	Telecommunication means	Assesses ownership of communication appliances	The household does not own a landline OR mobile phone.	2/15

† Our dataset does not have information to capture indoor air pollution.

4. EMPIRICAL RESULTS

4.1. ENERGY DEPRIVATION INDICATORS BY GENDER OF HOUSEHOLD HEAD

We first examine gender gaps in the aggregate deprivation levels in each indicator. Table 2 shows the estimated proportion of male-headed households and female-headed households deprived in each indicator and the associated gender differences between female-headed households' and male-headed households' estimates in absolute and means both male-headed and female-headed households are almost equally likely to be deprived of electricity, refrigeration, and telecommunications. However, concerning fuel for cooking, the gender gaps are estimated at 16% in relative terms, in favour of male-headed households. The results also show that female-headed households are worse off in the entertainment indicator, with the gender gap estimated at 27%.

Table 2: Proportion (h%) of MHH and FHH deprived in various indicators

	MHH		FHH		Δ(FHH–MHH)	
	Mean	SD	Mean	SD	Absolute	Relative
Electricity	34.1	0.4739	34.2	0.4745	0.10	1.00
Cooking	34.8	0.4765	40.5	0.4908	5.70	1.16
Refrigerator	45.0	0.4975	45.0	0.4975	0.00	1.00
Telecommunication	16.5	0.3711	16.7	0.3725	0.20	1.01
Entertainment	26.6	0.4421	33.9	0.4733	7.30	1.27

Source: Authors' estimates based on the 2015/16 BMTHS data.
Notes: Survey weights applied. MHH: Male Headed households; FHH: Female Headed Households. Δ(FHH–MHH) means differences between female-headed and male-headed households estimates.

4.2. MULTIDIMENSIONAL ENERGY POVERTY INDEX (MEPI) BY GENDER

Overall results on the aggregate multidimensional energy poverty levels show substantial gender gaps in the incidence of multidimensional energy poverty (H) and the adjusted multidimensional headcount ratio (M_0). The estimated gaps in relative terms are more than 10%, and this may suggest that multidimensional energy poverty in Botswana is feminised. Female-headed households are worse off in poverty incidence (14%) and MEPI (12%) than male-headed households (Table 3). However, the opposite seems to be true in poverty intensity (2%).

4.2.1. Gender differences and demographic characteristics

Table 3 reveals mixed results concerning gender gaps across different age groups of household heads. Concerning multidimensional energy poverty incidence and MEPI, the gender differences observed for households headed by children and older persons are negative implying female-headed households are better off compared to male-headed households. The gender gaps are estimated at 25% and 18% for child-headed households and households headed by adults, respectively multidimensional energy poverty incidence. However, the reverse is true for households headed by the youth and adults. For MEPI, the highest gender gap is found in households headed by adults (15%). Except for households headed by children, both female and male-headed households are likely to suffer from the same intensity of multidimensional energy poverty (estimated at less than 4%).

Table 3: Multidimensional energy poverty estimates by age of HH and gender differences

Strata	MHH	FHH	Δ(FHH–MHH)	
	The incidence of multidimensional energy poverty (H)		Absolute	Relative
12–17 (Children)	76.9	57.5	-19.4	0.75
18–35 (Youth)	35.5	37.0	1.4	1.04
36–64 (Adults)	40.6	48.0	7.5	1.18
Above 65 (Elderly)	69.2	65.4	-3.8	0.94
Total	**42.3**	**48.0**	**5.8**	**1.14**
	The intensity of multidimensional energy poverty (A)		Absolute	Relative
12–17 (Children)	0.7793	0.9587	0.1795	1.23
18–35 (Youth)	0.6938	0.6955	0.0017	1.00
36–64 (Adults)	0.6989	0.6817	-0.0172	0.98
Above 65 (Elderly)	0.7357	0.7130	-0.0227	0.97
Total	**0.7050**	**0.6929**	**-0.0121**	**0.98**
	The adjusted multidimensional headcount ratio (M_0)		Absolute	Relative
12–17 (Children)	0.5997	0.5519	-0.0478	0.92
18–35 (Youth)	0.2472	0.2574	0.0102	1.04
36–64 (Adults)	0.2840	0.3277	0.0436	1.15
Above 65 (Elderly)	0.5098	0.4667	-0.0430	0.92
Total	**0.2988**	**0.3332**	**0.0344**	**1.12**

Source: Authors' estimates based on the 2015/16 BMTHS data.
Notes: Survey weights applied. MHH: Male Headed households; FHH: Female Headed Households. Δ(FHH–MHH) means differences between female-headed and male-headed households estimates. HH: Household head.

Table 4 presents gender differences across the marital status of the household heads. The results reveal substantial gender gaps in both incidence and MEPI. The highest gender gap in poverty incidence is in households whose heads are separated (24%) and households headed by widows/widowers (22%). The gender gaps for MEPI are estimated at more than 10%, except for households whose heads never married). For both poverty incidence and MEPI, the gender gaps are negative for households whose heads are married, living together, and divorced implying that female-headed households are better off compared to male-headed households for these groups. However, the opposite is true for households headed by divorced/widowed, separated and never married individuals. Concerning the intensity of multidimensional energy poverty, gender gaps are negative and estimated at less than 10% across all marital statuses of the household head. This means, overall, male-headed households across all marital status are more likely to suffer from the intensity of energy poverty than female-headed households.

Table 4: Multidimensional energy poverty estimates by marital status of HH

Strata	**MHH**	**FHH**		**Δ(FHH–MHH)**	
	The incidence of multidimensional energy poverty (H)			Absolute	Relative
Married	34.7	32.4		-2.2	0.94
Living together	48.3	44.1		-4.2	0.91
Separated	44.1	54.5		10.4	1.24
Divorced	48.5	43.1		-5.4	0.89
Widow/Widower	51.1	62.2		11.1	1.22
Never married	44.8	47.6		2.9	1.06
Total	**42.3**	**48.0**		**5.8**	**1.14**
	The intensity of multidimensional energy poverty (A)			Absolute	Relative
Married	0.6441	0.5967		-0.0473	0.93
Living together	0.7190	0.7077		-0.0113	0.98
Separated	0.6807	0.6415		-0.0392	0.94
Divorced	0.6961	0.6640		-0.0321	0.95
Widow/Widower	0.7314	0.6941		-0.0373	0.95
Never married	0.7514	0.7093		-0.0422	0.94
Total	**0.7050**	**0.6929**		**-0.0121**	**0.98**
	The adjusted multidimensional headcount ratio (M_0)			Absolute	Relative
Married	0.2238	0.1936		-0.0302	0.86
Living together	0.3486	0.3120		-0.0366	0.89
Separated	0.3000	0.3497		0.0498	1.17
Divorced	0.3377	0.2863		-0.0514	0.85
Widow/Widower	0.3736	0.4321		0.0586	1.16
Never married	0.3362	0.3383		0.0021	1.01
Total	**0.2988**	**0.3332**		**0.0344**	**1.12**

Source: Authors' estimates based on the 2015/16 BMTHS data.
Notes: Survey weights applied. MHH: Male Headed households; FHH: Female Headed Households. Δ(FHH–MHH) means differences between female-headed and male-headed households estimates. HH: Household head.

4.2.2. Gender differences and human capital

Table 5 depicts household heads' multidimensional energy poverty level and gender differences. Generally, multidimensional poverty levels decline with improvement in the educational level of the household heads. Overall, the results reveal no substantial gender differences in the multidimensional energy poverty incidence and MEPI across educational levels of household heads (less than 5%), except for households headed by individuals with secondary school qualifications with an estimated gender gap of 19%, implying female-headed households with secondary education are worse off than their male-headed households. Concerning the intensity of multidimensional poverty across the different levels of education, female-headed households are slightly better off than male-headed households with gender gaps are estimated at less than 5%, except for those with vocational training (estimated at 7%).

Table 5: Multidimensional energy poverty estimates by education level of HH

Strata	MHH	FHH		Δ(FHH–MHH)	
	The incidence of multidimensional energy poverty (H)			Absolute	Relative
None	75.8	78.1		2.2	1.03
Primary	64.0	63.4		-0.6	0.99
Secondary	33.9	40.2		6.3	1.19
Vocational	18.4	18.0		-0.4	0.98
University	9.9	10.0		0.1	1.01
Total	**42.3**	**48.0**		**5.8**	**1.14**
	The intensity of multidimensional energy poverty (A)			Absolute	Relative
None	0.7552	0.7538		-0.0014	1.00
Primary	0.7166	0.6821		-0.0345	0.95
Secondary	0.6676	0.6603		-0.0073	0.99
Vocational	0.5768	0.5391		-0.0377	0.93
University	0.5574	0.5352		-0.0222	0.96
Total	**0.7050**	**0.6929**		**-0.0121**	**0.98**
	The adjusted multidimensional headcount ratio (M_0)			Absolute	Relative
None	0.5726	0.5885		0.0159	1.03
Primary	0.4586	0.4321		-0.0264	0.94
Secondary	0.2261	0.2653		0.0391	1.17
Vocational	0.1060	0.0970		-0.0090	0.92
University	0.0552	0.0533		-0.0019	0.97
Total	**0.2988**	**0.3332**		**0.0344**	**1.12**

Source: Authors' estimates based on the 2015/16 BMTHS data.
Notes: Survey weights applied. MHH: Male Headed households; FHH: Female Headed Households. Δ(FHH–MHH) means differences between female-headed and male-headed households estimates. HH: Household head.

4.2.3. *Gender differences and economic variables*

Table 6 presents the key findings on multidimensional energy poverty by employment status of household heads and gender differences. The results highlight substantial gender gaps in the incidence of multidimensional energy poverty and MEPI. Except for households headed by family helpers, female-headed households are worse off compared to male-headed households. The most pronounced gender gaps are recorded in MEPI for households with heads engaged in self-employment, estimated at 45% and 38% for poverty incidence. This is followed by those involved in paid employment, estimated at 14% and 13% for MEPI and poverty incidence, respectively. Regarding the intensity of multidimensional energy poverty, the results reveal no substantial gender gaps across employment status of household heads (less than 5%), except for households headed by family helpers, recording a negative gender gap of 12%, implying female-headed households are better off than male-headed households regarding the intensity of energy poverty.

Table 6: Multidimensional energy poverty estimates by employment status of HH

Strata	**MHH**	**FHH**		**Δ(FHH–MHH)**	
	The incidence of multidimensional energy poverty (H)			Absolute	Relative
Unemployed	58.9	63.4		4.5	1.08
Paid employment	21.1	23.9		2.8	1.13
Self-employment	27.6	38.0		10.4	1.38
Own farm	75.5	81.0		5.5	1.07
Family helper	78.8	63.8		-15.0	0.81
Total	**42.3**	**48.0**		**5.8**	**1.14**
	The intensity of multidimensional energy poverty (A)			Absolute	Relative
Unemployed	0.7256	0.7216		-0.0040	0.99
Paid employment	0.5853	0.5884		0.0032	1.01
Self-employment	0.6054	0.6359		0.0304	1.05
Own farm	0.7640	0.7538		-0.0102	0.99
Family helper	0.7919	0.6936		-0.0984	0.88
Total	**0.7050**	**0.6929**		**-0.0121**	**0.98**
	The adjusted multidimensional headcount ratio (M_0)			Absolute	Relative
Unemployed	0.4276	0.4574		0.0298	1.07
Paid employment	0.1236	0.1408		0.0171	1.14
Self-employment	0.1668	0.2414		0.0745	1.45
Own farm	0.5770	0.6106		0.0336	1.06
Family helper	0.6242	0.4428		-0.1814	0.71
Total	**0.2988**	**0.3332**		**0.0344**	**1.12**

Source: Authors' estimates based on the 2015/16 BMTHS data.
Notes: Survey weights applied. MHH: Male Headed households; FHH: Female Headed Households. Δ(FHH–MHH) means differences between female-headed and male-headed households estimates. HH: Household head.

Overall, gender gaps in multidimensional energy poverty (incidence, intensity and MEPI) are evident across household welfare and they increase with improvement in household wealth (Table 7). The highest gender gaps are recorded in the wealthiest quintile (Q5), estimated at 43% and 33%, respectively, for the poverty incidence and MEPI. In contrast, the lowest gender gaps are estimated at 1% in households belonging to the bottom quintiles (Q1 and Q2) in the incidence of poverty and MEPI. The gender gaps in the intensity of poverty are estimated at 10% or less (except for Q4). The negative gaps implies that across wealth quintiles, male-headed households are worse off compared to female-headed households.

Table 7: Multidimensional energy poverty estimates by household wealth status

Strata	**MHH**	**FHH**		**Δ(FHH–MHH)**	
	The incidence of multidimensional energy poverty (H)			Absolute	Relative
Q1	80.8	80.3		-0.5	0.99
Q2	60.6	58.8		-1.8	0.97
Q3	45.2	40.6		-4.5	0.90
Q4	32.8	25.1		-7.7	0.77
Q5	13.6	8.5		-5.0	0.63
Total	**42.3**	**48.0**		**5.8**	**1.14**
	The intensity of multidimensional energy poverty (A)			Absolute	Relative
Q1	0.7202	0.7346		0.0143	1.02
Q2	0.7175	0.6940		-0.0235	0.97
Q3	0.7245	0.6554		-0.0691	0.90
Q4	0.6834	0.5917		-0.0917	0.87
Q5	0.6103	0.5515		-0.0588	0.90
Total	**0.7052**	**0.6927**		**-0.0126**	**0.98**
	The adjusted multidimensional headcount ratio (M_0)			Absolute	Relative
Q1	0.5819	0.5901		0.0082	1.01
Q2	0.4351	0.4082		-0.0270	0.94
Q3	0.3272	0.2663		-0.0609	0.81
Q4	0.2239	0.1483		-0.0756	0.66
Q5	0.0827	0.0470		-0.0357	0.57
Total	**0.2983**	**0.3328**		**0.0345**	**1.12**

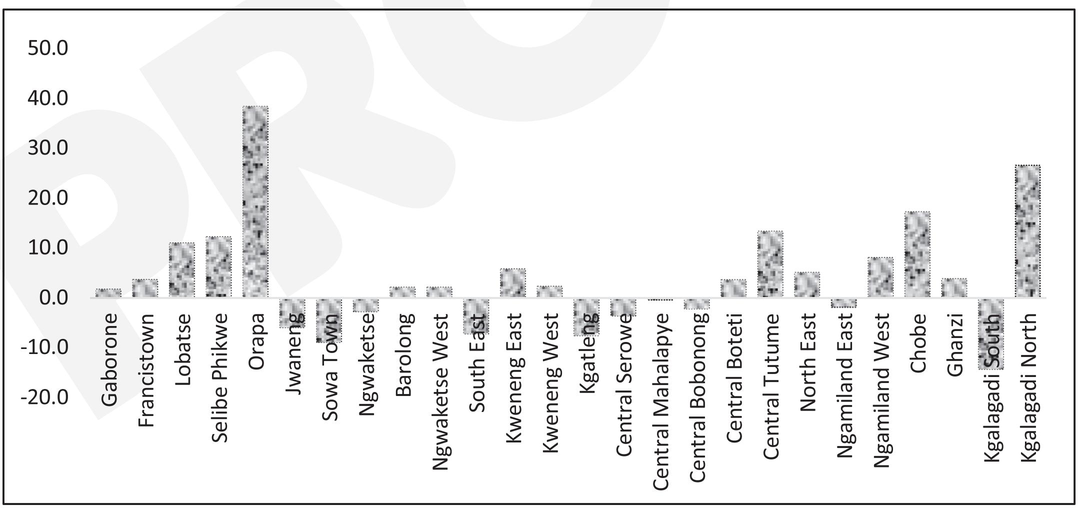
Source: Authors' estimates based on the 2015/16 BMTHS data.
Notes: Survey weights applied. MHH: Male Headed households; FHH: Female Headed Households. Δ(FHH–MHH) means differences between female-headed and male-headed households estimates.

4.2.4. GENDER DIFFERENCES AND GEOGRAPHY

Figure 3 illustrates the gender gaps in the incidence of multidimensional energy poverty in absolute terms across administrative districts. The figure highlights evidence of substantial gaps in the incidence of multidimensional energy poverty between female-headed and male-headed households, with female-headed households being worse off. However, the differentials vary substantially across districts. Results reveal that female-headed households experience higher multidimensional energy poverty in 16 out of the 26 administration districts. Orapa recorded the highest gender gaps in incidence and MEPI, followed by Kgalagadi North, Chobe and Central Tutume.

In contrast, Kgalagadi South, Sowa town, South East and Kgatleng revealed gender gaps, where male-headed households are worse off than female-headed households.[4] However, the results based on the intensity of multidimensional energy poverty reveal a contrasting picture. Figure 4 depicts the gender gaps in the intensity of multidimensional energy poverty. The figure highlights that the intensity of multidimensional energy poverty is higher for male-headed households than female headed households as evidenced by negative gender gaps in most administrative districts. The results for MEPI, depicted in Figure 5, mimic those of Figure 3, with female-headed households recording higher levels of MEPI compared to male-headed households.

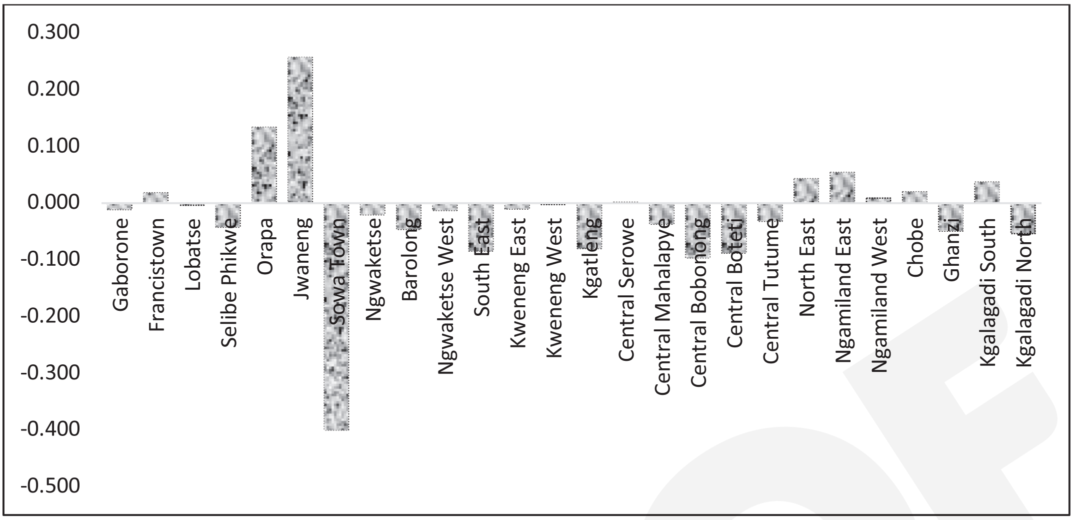
Figure 3: Gender gaps in the incidence of multidimensional energy poverty (*H*%)



Source: Authors' estimates from the 2015/16 BMTHS

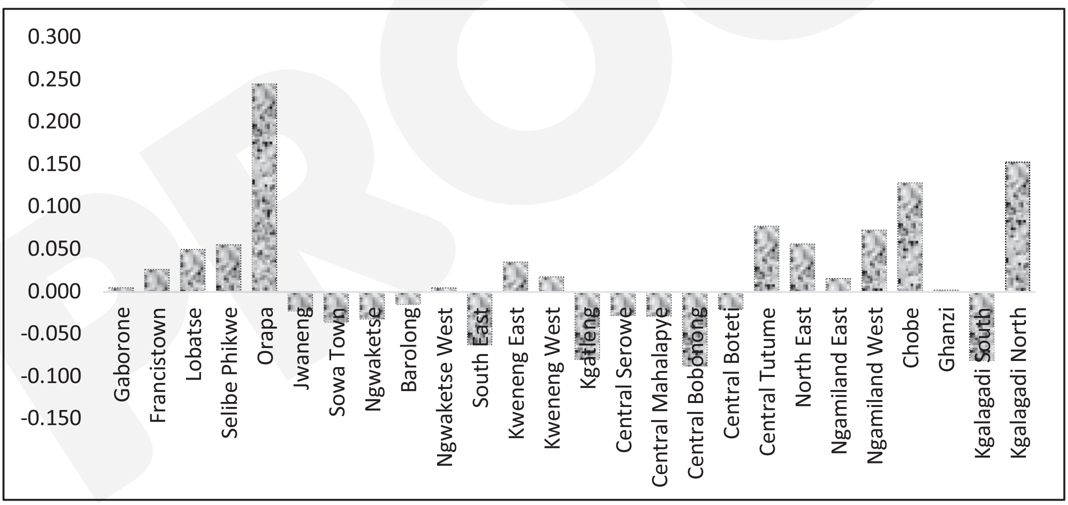
4 The results for Sowa should be treated with caution. Most households in Sowa are headed by males because it is a mining town. The few households headed by females recorded zero (0) incidence of energy poverty, hence the negative gender gaps in the three indicators (*H*, *A*, MEPI).

Figure 4: Gender gaps in the intensity of multidimensional energy poverty (*A*)



Source: Authors' estimates from the 2015/16 BMTHS

Figure 5: Gender gaps in the adjusted multidimensional energy headcount ratio (M_0)



Source: Authors' estimates from the 2015/16 BMTHS

In general, Table 8 reveals substantial differences in multidimensional energy poverty levels across strata, with rural areas recording the highest poverty levels. However, concerning gender differences, the highest gender gaps in poverty (incidence, intensity, and MEPI) are found in urban villages (30%) and cities/towns (24%) with female-headed households being worse off compared to male-headed households for the incidence of energy poverty. Similarly, urban villages recorded the highest gender gaps (39%) followed by cities and towns (22%) in MEPI. However, concerning the intensity of energy poverty, cities and towns showed no gender differentials while urban villages recorded 6%. In contrast, rural areas recorded no substantial gender gaps in multidimensional energy poverty levels, estimated at 2% with female-headed households being worse off than male-headed households. The gender gaps in the intensity (3%) and MEPI (1%) are negative, implying that in rural areas male-headed households are marginally worse off compared to female-headed households concerning the intensity of energy poverty and MEPI.

Table 8: Multidimensional energy poverty estimates by strata and gender differences

Strata	**MHH**	**FHH**		**Δ(FHH–MHH)**	
	The incidence of multidimensional energy poverty (H)			Absolute	Relative
Cities/Towns	18.9	23.4		4.5	1.24
Urban Villages	28.2	36.8		8.6	1.30
Rural areas	76.3	78.0		1.6	1.02
Total	**42.3**	**48.0**		**5.8**	**1.14**
	The intensity of multidimensional energy poverty (A)			Absolute	Relative
Cities/Towns	0.5256	0.5286		0.0031	1.01
Urban Villages	0.5988	0.6369		0.0381	1.06
Rural areas	0.7842	0.7576		-0.0266	0.97
Total	**0.7050**	**0.6929**		**-0.0121**	**0.98**
	The adjusted multidimensional headcount ratio (M_0)			Absolute	Relative
Cities/Towns	0.1010	0.1235		0.0225	1.22
Urban Villages	0.1691	0.2348		0.0657	1.39
Rural areas	0.5990	0.5910		-0.0079	0.99
Total	**0.2988**	**0.3332**		**0.0344**	**1.12**

Source: Authors' estimates based on the 2015/16 BMTHS data.
Notes: Survey weights applied. MHH: Male Headed households; FHH: Female Headed Households. Δ(FHH–MHH) means differences between female-headed and male-headed households estimates.

5. CONCLUSIONS AND POLICY IMPLICATIONS

Using the 2015/16 BMTHS, we analysed gender disparities in multidimensional energy poverty to shed light on the intersection of gender and energy poverty in Botswana. We employed the Alkire-Foster methodology to compute the multidimensional energy poverty index. The study provides a reliable foundation for concluding the gendered nature of energy access and its implications for policy and development in Botswana.

The findings reveal that there exists substantial gender gaps in multidimensional energy poverty levels in Botswana, with female-headed households experiencing higher levels of energy poverty compared to male-headed households. This is evident in the incidence and adjusted headcount ratio of energy poverty. Women are disproportionately affected by reliance on traditional, polluting cooking fuels like firewood. These challenges not only have adverse health and economic consequences but also hinder women's empowerment and their ability to participate fully in the development of their communities.

Gender gaps in energy poverty vary substantially across different demographic characteristics. For instance, child-headed and elderly-headed households show negative gender gaps, implying male-headed households are worse off compared to female-headed households among child- and elderly-headed households. In contrast the youth- and adult-headed households show the opposite trend. Economic variables and human capital also influence the gender gaps in energy poverty. Female-headed households with lower educational levels and those engaged in self-employment or unpaid family work are more likely to experience higher levels of energy poverty. There are substantial geographical variations in gender gaps in energy poverty. Urban villages and cities/towns show higher gender gaps, with female-headed households experiencing higher poverty levels than male-headed households. Rural areas show minimal gender differences.

The evidence from Botswana underscores the importance of adopting a gender-sensitive approach in energy policy and interventions. Despite ongoing efforts by the government, such as the integration of off-grid technologies and the promotion of renewable energy, considerable barriers to achieving equitable energy access remain. These barriers are compounded by social, economic, and geographical factors that perpetuate energy poverty, particularly for women. These conclusions highlight the need for multifaceted and inclusive policy approaches to address the intertwined issues of energy poverty and gender inequality in Botswana.

To address these disparities, this study recommends targeted interventions that improve access to clean energy for female-headed households, especially in rural and underserved areas. To effectively reduce energy poverty and bridge gender gaps, comprehensive strategies that consider the diverse needs of women and men, promote financial inclusion, and support women's economic empowerment are essential. Furthermore, policies that promote gender mainstreaming in energy planning and provide financial support and training for women are necessary to bridge the energy divide and foster sustainable development. Policies should focus on inclusive energy access, financial inclusion for women, gender-responsive energy technologies, and community-based approaches to energy planning. Ultimately, tackling energy poverty through a gender lens not only contributes to achieving SDG 7 (Affordable and Clean Energy) but also supports the broader goals of gender equality (SDG 5) and poverty eradication (SDG 1). By addressing the gendered nature of energy poverty, Botswana can create a more inclusive, equitable, and sustainable energy future, ensuring that all citizens, regardless of gender, have the opportunity to thrive in a modern, energy-secure environment.

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