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Practical
ACTION

CAN MARKET MECHANISMS FACILITATE ENERGY ACCESS FOR PEOPLE LIVING IN EXTREME POVERTY?

Findings and Recommendations

REPORT

Acknowledgements

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Front cover: Daniya village in Nepal (Baglung District). Credit: Practical Action / Edoardo Santangelo

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UKaid from the British people

Transforming Energy Access

Contents

Abbreviations

CCA	Clean Cooking Alliance
ESMAP	Energy Sector Management Assistance Program
FAO	Food and Agriculture Organization of the United Nations
GOGLA	Global Off-Grid Lighting Association
GPA	Global Platform for Action
IRENA	International Renewable Energy Agency
LPG	Liquified petroleum gas
MECS	Modern Energy Cooking Services programme
MTF	Multi-Tier Framework for defining and measuring energy access (see Bhatia and Angelou, 2015)
PAYGo	Pay as you go
P-REC	Peace Renewable Energy Credit
PPP	Purchasing power parity
RBF	Results-based financing
SHS	Solar home system
T0, T1, T2, T3, T4 or T5	Tiers of energy access under the MTF
UNHCR	United Nations High Commissioner for Refugees
WHO	World Health Organization
WTP	Willingness to pay

Terminology

Clean cooking energy: Energy used for cooking (or heating) which produces low levels of fine particulate matter ($PM_{2.5}$) and carbon monoxide (CO) (WHO, 2021).

Clean cooking energy access: Access to energy for cooking which achieves Tier 4 or higher under the Multi-Tier Framework for defining and measuring energy access (MTF), and therefore can be expected to produce low levels of fine particulate matter ($PM_{2.5}$) and carbon monoxide (CO). For this review, where the tier of access has not been stated in the source, use of biogas, LPG, electricity, ethanol, natural gas or solar energy has been assumed to equate to clean cooking energy access.

Electricity access: Access to electricity which achieves Tier 1 or higher under the Multi-Tier Framework for defining and measuring energy access (MTF). This excludes electricity relying on dry cell batteries and grid or off-grid supplies which do not achieve Tier 1 (and so fall into Tier 0).

Extreme poverty: Living on less than US$2.15 per person per day in 2017 purchasing power parity (PPP) terms (World Bank, 2022).

Forcibly displaced persons: The United Nations High Commissioner for Refugees (UNHCR, 2018) defines forcibly displaced persons as 'those forced to move, within or across borders, due to armed conflict, persecution, terrorism, human rights violations and abuses, violence, the adverse effects of climate change, natural disasters, development projects or a combination of these factors'. This includes:

- Refugees: those who have been forced to flee their homes because of war, violence or persecution, often without warning, and who have rights to specific protections under international law once they obtain refugee status.
- Asylum-seekers: those who are seeking international protection from dangers in their own country, but whose claim for refugee status has not yet been determined.
- Internally displaced people: those who have been forced to flee their homes because of war, violence, human rights violations or disasters but that remain in their own country.

Fragile and conflict-affected countries: There is no universally accepted definition for this term. However, there is some consensus that fragile and conflict-affected countries are characterized by poor governance, disputed legitimacy, weak capacity and institutions, high risk of conflict and insecurity, and poverty (World Bank, 2009; OECD, 2015; Mercy Corps, 2019; Logan and Sacchetto, 2021). In this report the term is used to refer to those countries categorized by the World Bank as fragile and conflict affected (World Bank, 2023a).

Indo-Pacific: Those countries categorized by the UK Foreign, Commonwealth & Development Office as being part of the Indo-Pacific Region (see Appendix 7.3 of the report 'Part 1: Understanding the Relationship between Energy Access and Extreme Poverty').

Lack of electricity access: Access to electricity which does not achieve Tier 1 or higher.

Lack of clean cooking energy access: Use as the primary means of cooking of any form of energy which does not qualify as clean cooking energy (as defined above).

Market mechanisms: In this report, a market mechanism refers to a financial intervention that has an impact on the affordability of energy products and services. These may include:

a. mechanisms which form part of a company's business model and aim to spread the cost of a product over time, such as pay as you go (PAYGo);
b. interventions by donors and/or governments to support affordability (such as results-based finance, grants or beneficiary subsidies) which may be employed directly or used to support mechanisms described in (a).

Modern energy: electricity or clean cooking energy (see definitions above).

MTF Energy Access Diagnostic Reports: a series of reports, based on surveys undertaken by the Energy Sector Management Assistance Program (ESMAP) between 2016 and 2018, looking at energy access in individual countries, including Bangladesh, Cambodia, Ethiopia, Kenya, Liberia, Myanmar, Nepal, Niger, Nigeria, Rwanda, São Tomé and Príncipe, and Zambia (Brutinel et al., 2019, 2020; Dave et al., 2018; Dubey et al., 2020; Koo et al., 2018, 2019; Luzi et al., 2019, 2020; Padam et al., 2018; Pinto et al., 2019, 2020; Samad et al., 2019).

Sub-Saharan Africa: Those countries categorized by the UK Foreign, Commonwealth & Development Office as being part of the sub-Saharan Africa Region (see Appendix 7.3 of the report 'Part 1: Understanding the Relationship between Energy Access and Extreme Poverty').

Tier: Level of electricity or cooking energy access as defined under the Multi-Tier Framework for Defining and Measuring Energy Access.

Traditional energy: Energy produced by burning wood, charcoal or any other form of biomass (other than in a clean cookstove which achieves Tier 4 under the MTF), kerosene, coal, candles or non-biomass waste.

1. Introduction

At least 683 million people are living in extreme poverty in 2023, of whom around 454 million are in sub-Saharan Africa, South Asia, and the Indo-Pacific (World Bank, 2023b; 2023c).[1] At the same time, an estimated 675 million people around the world have no access to electricity and 2.3 billion no access to clean cooking, as of 2021 (IEA et al., 2023).

Lack of energy access is both a result of, and a contributing factor to, poverty. An ample body of evidence shows that energy access is vital to enable people to achieve better livelihoods and escape poverty (Practical Action, 2010, 2012, 2014, 2015). However, as yet, there has been little focus on people living in *extreme* poverty; their specific energy needs and challenges; and what may be needed to enable them to achieve energy access. Against this background, Practical Action, with partners Kuungana Advisory, has undertaken a study to better understand the energy access needs and challenges of people living in extreme poverty and to investigate the potential of different market mechanisms to improve their energy access.

The study is intended to support the Sustainable Energy and Leave No One Behind (SEaL) agenda within the Transforming Energy Access (TEA) platform. It has been funded by UK aid from the British people via the TEA; however, the views expressed do not necessarily reflect the UK Government's official policies. It aims to improve the targeting and design of future market mechanisms to support delivery of energy access to people living in extreme poverty by focusing on two overarching questions:

- Who and where are the people living in extreme poverty in sub-Saharan Africa and the Indo-Pacific and what are their energy needs and challenges?
- What market mechanisms could best serve the energy needs of people living in extreme poverty?

The study investigates the relationship between energy access and extreme poverty; the barriers to energy access faced by people living in extreme poverty; the effectiveness of different market mechanisms; and factors which may limit the reach of those mechanisms.

These questions are explored at regional and national levels across the sub-Saharan Africa and Indo-Pacific and in greater detail for six countries (Ethiopia, Kenya, Nepal, Nigeria, Rwanda, and Zambia) and six specific demographic groups (rural workers; residents of informal urban settlements; people in fragile and conflict-affected areas; displaced people; women and girls; and people with disabilities). These more detailed country- and group-specific reviews provide a more nuanced picture of how circumstances vary for people living in extreme poverty in different contexts, and how this affects their ability to access energy.

This report brings together findings from the various components of the study including:

1. A review of the literature around energy access and extreme poverty in sub-Saharan Africa and the Indo-Pacific, generally and for the six groups above, focused on the first of the key research questions above. More detailed findings from this component are available in the accompanying report '**Part 1: Understanding the Relationship Between Energy Access and Extreme Poverty**'. The findings of this literature review, particularly in relation to energy access barriers and factors limiting market mechanism reach, and how these apply to different groups of people living in extreme poverty, fed into the second, market mechanism review component of the study.

2. A review of available market mechanisms, including their properties and how these affect their ability to extend energy access to people living in extreme poverty, and development of an econometric model to estimate the extent to which specific mechanisms can extend energy access to this demographic under different circumstances. More detailed findings from this component are available in the accompanying report '**Part 2: The Role of Market Interventions and Business Models**'. The second component of the study also included the development of two accompanying tools which have been key in developing the findings presented here:
    - A **categorical matrix** to delineate different types of market mechanism. The matrix documents the properties of each type of mechanism and categorizes them in different ways, including based on the nature of the impact they have on affordability.
    - An **Excel-based market mechanism model**, designed to quantify the impact of mechanisms on households living in extreme poverty. The model distinguishes between the impact that a mechanism has on households' willingness to pay (WTP) for a product and the ability of a mechanism to reach different population groups. The model has been populated with data for the focus countries selected for this assignment: Ethiopia, Kenya, Nepal, Nigeria, Rwanda, and Zambia, but can also be adapted for other countries. (Examples in this report generally focus on Kenya.)

These components were supplemented by consultation with a range of stakeholders working in the energy access sector, including private sector companies, donors, and institutions with experience designing or implementing market mechanisms. Organizations with a particular focus on specific groups that are more likely to experience extreme poverty, such as Mercy Corps (focusing on humanitarian contexts) and the Global Distributors Collective (focusing on last-mile activities), were also included.

In addition, primary research was undertaken in Kenya and Nepal in September 2023 to capture the perspective of people living in extreme poverty on the relationships between extreme poverty and energy access and factors affecting market mechanism reach.[2] Research involved interviews and focus group discussions conducted in urban informal and rural settings.

2. Defining and categorizing market mechanisms

In this report, a market mechanism refers to a financial intervention that has an impact on the affordability of energy products and services. These may include:

a. *Business model interventions*: mechanisms which form part of a company's business model and aim to spread the cost of a product over time, such as PAYGo.
b. *External interventions*: interventions by donors and/or governments to support affordability through, for example, results-based financing (RBF), grants or beneficiary subsidies, which may be employed directly or used to support mechanisms described in (a).

Non-financial interventions have not been covered as part of this review. These include awareness raising, technical capacity building activities, and wider enabling policies. These activities are invaluable for the development of effective and sustainable markets, but they are not the focus of the analysis performed.

Mechanisms across the two broad groups highlighted above are often adopted in parallel to achieve energy access goals. Many of the populations lacking access to modern energy services reside in markets that are characterized as hard to reach, lack basic infrastructure, and have low levels of affordability. Furthermore, companies often require external intervention support in order to implement business model options which will enable low-income consumers to afford their products. To tackle these complex factors, multiple mechanisms are regularly combined.

Mechanisms can be grouped by type. This captures whether a mechanism is some form of subsidy, a payment model, or an additional revenue source.

- *Supply-side subsidy* – funding to offset the costs faced by service providers (e.g. upfront company grant).
- *Demand-side subsidy* – funding to lower the price of a product or service to end consumers (e.g. end-user subsidy).
- *Cross-subsidy* – recovering part of the cost of serving a consumer group from another consumer group (e.g. regulatory cross-subsidies).
- *Additional revenue source* – revenue stream for product or service sales, in addition to revenue from energy consumers.
- *Payment model* – alternative payment options to upfront cash payments (e.g. PAYGo).

Mechanisms can also be categorized according to the nature of their impact. This captures whether the market mechanism is increasing affordability or availability through actions such as injecting new funds, spreading costs, or unlocking new funds.

- *Injection of funds* – injection of new funds that would otherwise not have flowed to the sector (e.g. RBF).
- *Shifting cost* – recovering service costs from other consumers (e.g. regulatory cross-subsidy).
- *Unlocking new funds* – catalysing funding flows from finance (e.g. financier protection).
- *Spreading cost* – spreading the upfront cost of a product to match consumer ability to pay (e.g. PAYGo).
- *Non-monetary payment* – accepted non-monetary forms of payment (e.g. barter payment model).

A full list of the market mechanisms considered by the analysis is presented in Table 1.

Table 1. Categories of market mechanism

Group	Market mechanism	Mechanism type	Nature of impact
External interventions	End-user subsidies	Demand-side subsidy	Injection of funds
	Product/tariff subsidy		
	Incubator RBF	Supply-side subsidy	
	Import RBF		
	Sales RBF		
	Tax exemption		
	Upfront company grant		
	Concessional finance		
	Impact funding	Additional revenue source	
	Regulatory cross-subsidies	Cross-subsidy	Shifting cost
	Bulk procurement	Supply-side subsidy	Unlocking new funds
	Financier protection		
Business models	Customer finance	Payment model	Spreading cost
	Concessional consumer finance		
	Third-party financing partnerships		
	PAYGo (mobile-enabled)		
	Energy as a service – capacity or availability-based charging		
	Energy as a service – consumption-based charging		
	Utility-managed financing		
	Small purchase sizes		
	Flexible repayments		
	Barter payments	Payment model	Non-monetary payment
	Cross-subsidy between customer groups	Cross-subsidy	Shifting cost
	Tool and fuel cross-subsidy		
	Remittance-based models	Payment model	Unlocking new funds
	Community savings schemes		
	Customer insurance		

The categories of market mechanism identified can be differentiated by their distinct properties. The properties of each mechanism have been defined in the categorical matrix that accompanies this report. Properties that have been analysed include:

- *Impact on the price of a product*. The impact that a mechanism has on upfront and regular payments made by customers, and the impact on total cash cost.
- *Longevity*. Whether a mechanism provides a one-off benefit, is available for a fixed term, or is permanent.
- *Direct recipient of support*. Whether support is, in the first instance, administered directly to the customer or to the service provider.
- *Timing of disbursements*. The point in the sales cycle at which the benefit from any mechanism is disbursed.
- *Customer eligibility*. Whether the customer requires evidence that they meet eligibility criteria, such as proof of address, social security registration, identification, mobile phone number, or credit related data.

3. Description of market model

An Excel-based tool has been developed to estimate in quantitative terms the extent to which different market mechanisms can support energy access, especially for households living in extreme poverty (shown schematically in Figure 1). In broad terms, the model has three steps to estimating the impact of market mechanisms on household energy access:

1. The model analyses the impact of selected mechanisms on the upfront and monthly price of energy access products and services.
2. Data on household WTP is compared against the resulting prices to determine the proportion of households willing to pay for the product or service.
3. The proportion of households that can be reached by mechanisms is evaluated and then multiplied by the proportion of households willing to pay, to obtain the final number of households able to achieve energy access.

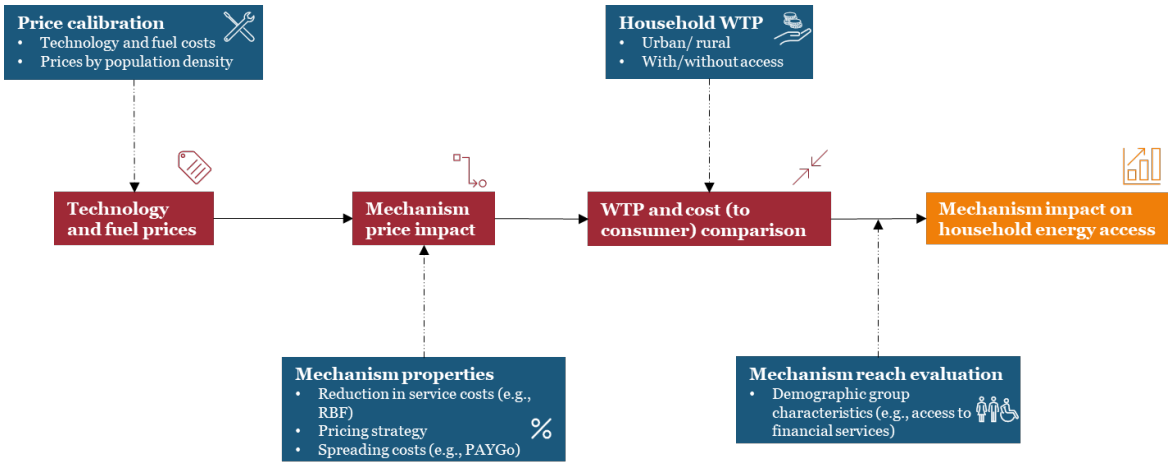

Figure 1: Market mechanism modelling framework

The analysis is performed for a given energy product or service. That is, the combined access to the technology and, where relevant, fuel. For example, an assessment of access to a biomass gasifier stove analyses the upfront and monthly costs faced by a household for the gasifier stove as well as the biomass pellets. Fuel costs are modelled as a monthly cost to consumers. When purchased on a cash basis, technology costs are entirely upfront, but can also consist of both an upfront and a monthly cost when mechanisms such as consumer finance are deployed.

The model is populated for a selection of technologies most likely to be appropriate in meeting the needs of households living in extreme poverty. These selections have been informed by work undertaken through the literature review component of this project that assessed the energy needs of people living in extreme poverty. Selections were also based on recognized thresholds for different levels of energy access, such as those provided by the Multi-Tier Framework. The model is also populated with demographic data to allow the impact of mechanisms on different groups to be analysed. The model allows for the following groups to be disaggregated:

- urban versus rural populations;
- households currently with and without energy access;
- households living in extreme poverty versus the whole population;
- specific population groups: women and girls, people with disabilities, rural, urban informal, displaced people, and people in fragile and conflict zones.

The model leverages WTP data that is specific to the product and payment model being deployed. The inputs to the model are informed by a detailed analysis of the underlying data used for the World Bank's Multi-Tier Framework (MTF) surveys. This has allowed for the model to distinguish between the WTP, depending on:

- *Product*. For example the data clearly shows that households are willing to pay a lower share of their monthly income for cookstoves compared to solar home systems (SHS).
- *Payment terms*. The amount that households are willing to pay depends on whether they are making a single, upfront payment, or paying a regular amount over a longer period of time. The MTF data allows for this impact to be quantitatively estimated.
- *Household income*. WTP is lower, even in terms of share of monthly income, for households in extreme poverty, for whom access to energy is just one of many priorities competing for limited cash.

The model also assesses the extent to which a market mechanism is able to reach a target population. The net impact of a mechanism's ability to reach households is made up of the two components (Figure 2):

1. Does a market mechanism have the potential to overcome barriers to energy access, and particularly those barriers which most impede energy access for people living in extreme poverty?
2. Are there factors ('characteristics') in the circumstances of people living in extreme poverty (and specific groups of people) which are likely to restrict the ability of a market mechanism to reach them?

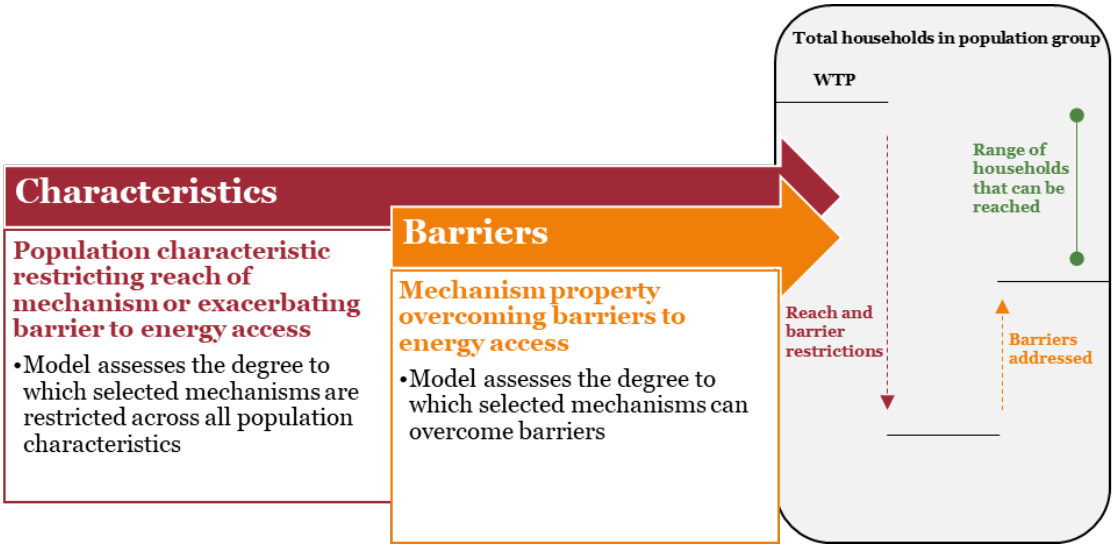

Figure 2: Assessment of market mechanism reach

4. Findings and recommendations

4.1 People living in extreme poverty without energy access

An estimated 312 million people living in extreme poverty in the Indo-Pacific and sub-Saharan Africa are without access to electricity, and 430 million have no access to clean cooking energy. More than 90% live in sub-Saharan Africa and over half of each group in just six countries (see Table 2).

Table 2. Who and where are the people living in extreme poverty without access to energy[3]

Area or group	Total population (millions, 2023)	People living in extreme poverty (millions, 2023)	People without electricity (millions, 2021)	People without clean cooking energy (millions, 2021)	People living in extreme poverty without electricity (millions, 2023)	People living in extreme poverty without clean cooking energy (millions, 2023)
Sub-Saharan Africa	1,183	424	578	949	310	406
Indo-Pacific	1,204	30	48	473	2	25
Top 6 countries (highest at the top to lowest at bottom)	Indonesia Pakistan Nigeria Bangladesh Ethiopia Philippines	Nigeria DRC Ethiopia Tanzania Madagascar Mozambique	Nigeria DRC Ethiopia Tanzania Uganda Mozambique	Nigeria Bangladesh Pakistan Ethiopia DRC Philippines	DRC Nigeria Tanzania Ethiopia Madagascar Mozambique	Nigeria DRC Ethiopia Tanzania Madagascar Uganda
% in top 6 countries	49%	49%	48%	48%	53%	50%
Rural	1,372	349	530	1,010	278	339
Urban informal	415	?	?	?	?	?
Fragile and conflict affected	843	267	403	668	201	255
Displaced people	41	?	?	?	?	?
Women and girls	1,195	231	314	745	158	219
People with disabilities	278	54–74	86	182	?	?

Note: DRC, Democratic Republic of the Congo

Most people living in extreme poverty are in rural areas and/or conflict-affected countries (validating the long-standing focus of energy access support for these groups). People living in urban informal settlements and forcibly displaced people in camp settings are significantly smaller groups but face distinct energy access challenges.

Women and girls make up just over half of people living in extreme poverty who lack energy access. Poverty and energy access rates among women and girls may be slightly higher than for men and boys, but it is the differences in their energy needs, and the barriers to addressing these needs, which are most significant. People with disabilities form a smaller group, but also have distinctive energy needs and barriers, largely relating to social exclusion and household power dynamics.

People living in extreme poverty have significantly lower levels of energy access than the rest of the population. However, while there is considerable overlap between people living in extreme poverty and people who lack energy access, they are by no means identical – **it is not only people living in extreme poverty who lack energy access, and some of those in extreme poverty *do* have access**.

Relationships between lack of electricity and clean cooking energy access among people living in extreme poverty and among populations as a whole, appear reasonably consistent (see Figure 3(a) and (b)).

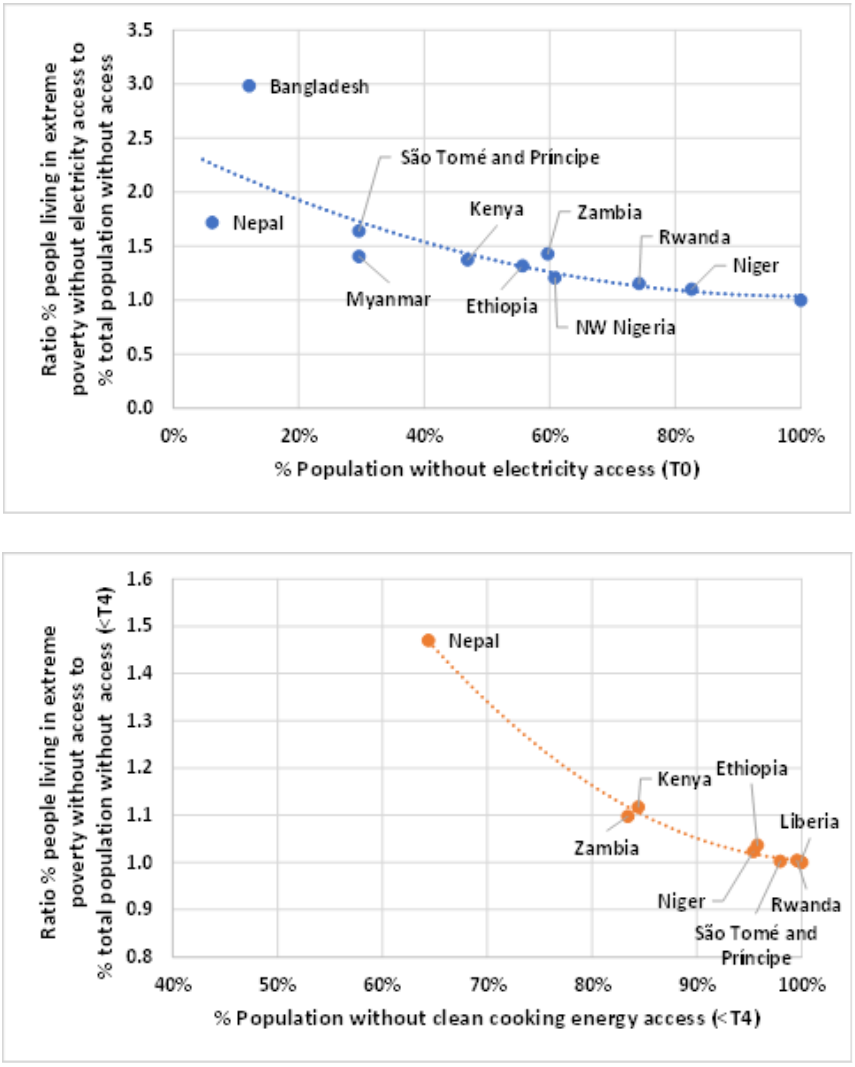

Figure 3: Relationship between (a) lack of electricity access and (b) lack of clean cooking energy access among people living in extreme poverty and wider populations
Source: based on data from Brutinel et al., 2019, 2020; Dubey et al., 2020; Koo et al., 2018, 2019; Luzi et al., 2019, 2020; Padam et al., 2018; Pinto et al., 2019, 2020; Samad et al., 2019 and associated datasets.

These relationships may be used to:

a. Estimate numbers of people living in extreme poverty who are without energy access in countries where direct data is not available.
b. Identify countries where energy access among people living in extreme poverty relative to the wider population is higher or lower than would be expected. An understanding of the factors which have led to these differences will inform the design of policies and interventions which better support energy access for people living in extreme poverty.

4.2 Implications for focus of market mechanism support

Increasing support for market mechanisms in just seven countries has the potential to benefit over half of all people living in extreme poverty without energy access in sub-Saharan Africa and the Indo-Pacific. Over half of those living in extreme poverty without access to either electricity or clean cooking energy live in the Democratic Republic of the Congo (DRC), Nigeria, Tanzania, Ethiopia, Madagascar, Mozambique, and Uganda, suggesting prioritization of market mechanism support in these countries.

Evidence supports increased use of market mechanisms to improve access to productive uses of energy in rural areas and toward climate change adaptation. The majority of those affected by extreme poverty live in rural areas (World Bank, 2020a) where supporting agricultural livelihoods is key to poverty reduction and adapting to climate change (FAO and IRENA, 2021). Market mechanisms to improve access to productive energy uses in agriculture, particularly off-grid, can make an important contribution to these goals. Furthermore, worsening climate change suggests that market mechanisms should support access to energy uses with adaptation benefits (GOGLA, 2023).

> Survey and focus group participants in Mogotio, a rural town in Baringo County, Kenya identified affordability as a key barrier to the productive use of energy in farming. Community members who could use irrigation lack funds to install solar powered water pumps and so cannot produce crops during adverse weather conditions.

Young people are more likely to be affected by extreme poverty than older people (World Bank, 2020a). To reach large numbers of people living in extreme poverty, **market mechanisms will need to be prioritized and adapted for households with young children or headed by youths**. Given a strong association between extreme poverty and lack of education (ibid.), market mechanisms should improve energy access for education, including energy for schools, home lighting, and labour-saving devices, enabling children to attend school and study for longer.

People living in urban informal settlements and displaced people can benefit from both tailored market mechanisms and greater inclusion in mechanisms targeted at the wider public. Displaced people and people living in urban informal settlements have distinct energy access needs and challenges (Singh, 2014, Practical Action, 2020b). For displaced people, needs and challenges vary depending on whether they live in formal camps or among host communities (GPA, 2022). Those living in camps with restrictions on economic activities often require specialized support while those living

outside camps (Lukuyu and Kersey, 2022) can benefit from greater inclusion in market mechanisms for host communities.

More tailored and inclusive market mechanisms are needed for women and girls and people with disabilities both within households and living alone. Market mechanisms prioritizing uptake of clean cooking are especially important for women and girls (Energia, 2019a; World Bank, 2020b). However, mechanisms should also support uptake of energy uses contributing to greater women's empowerment including inclusive use of productive energy appliances (Energia, 2019b). In addition, more specialized market mechanisms are needed to meet the unique energy needs of people with disabilities such as access to assisted living technologies (UNDESA, 2019).

> Survey and focus group participants in Kenya identified additional energy needs and challenges for people with disabilities. For one participant, in particular, access to electricity to enable use of an electric mattress, required by their child's medical condition, was a high priority. However additional accommodation and other costs made it difficult for the family to afford the electricity needed.

4.3 Is affordability the main barrier to energy access?

Cost is unequivocally the greatest single barrier to energy access for people living in extreme poverty. About 30% of people asked as part of the MTF Energy Access Diagnostic Surveys carried out in 12 countries between 2016 and 2018 put costs as the greatest barrier to grid connection, and this rose to 36% for people living in extreme poverty. Furthermore, the solar appliance sector continues to predominantly serve customers living above the US$3.20 per day poverty line, reflecting significant affordability challenges for those living below this line (Efficiency for Access, 2022).

> Survey results from Kenya and Nepal support findings that cost is the primary barrier to energy access for people living in extreme poverty. In both urban informal and rural sites in the two countries, the majority of those surveyed identified upfront cost as the primary barrier to both electricity and clean cooking energy access.

All groups reviewed in this study are affected by low incomes, due to combinations of low education and skills, social exclusion and prejudice in labour markets, restrictions on economic activity, and poor access to markets. For some groups energy affordability is affected by higher living costs. At the same time, **providing energy access to people living in extreme poverty carries additional costs**, particularly in areas which are remote or difficult to access, or where population densities (and hence energy demand) are low (Sacchetto et al., 2020; Logan and Saccheto, 2021).

Uncertainty and variable earnings exacerbate affordability challenges, particularly for those working in agriculture or the informal economy or living in fragile and conflict-affected or displacement settings, making people more cautious about spending on energy (Mercy Corps, 2019; NORCAP, 2020; Practical Action, 2020b; Singh, 2014).

Access to, and control over, resources also influence whether people can access energy. Displaced people, for example, are often subject to restrictions on employment and use of natural resources (Practical Action, 2020b; Patel and Gross, 2019; Corbyn and Vianello, 2018; Butorac, 2019; Vianello, 2016). For women and girls and people with disabilities, limited control over household finances and decision-making power within households can mean that energy needs are not addressed (Energia, 2019a).

Affordability challenges are reflected in WTP for energy access, which is significantly lower among those living in extreme poverty than among the rest of the population. Across the countries analysed in the model, and in the absence of any market mechanisms, 37–93% of urban households are estimated to be willing to pay the cost of a Tier 1 multi-light solar home system; for rural households this drops to 17–61%. For clean cooking solutions WTP is even lower: 5–36% of urban households and 3–21% of rural households are estimated to be willing to pay the cost of a biomass gasifier cooking service. WTP varies within and between countries because of differences in income and differences in end-user pricing (e.g. because of tax exemptions).

Households have lower WTP for clean cooking solutions than electricity. The MTF survey data reveal that on average households are willing to commit less of their income to purchasing clean cookstoves compared to electricity. This suggests a lower perceived need for this technology. The data also indicates that households are less willing to pay for SHS than grid connections, indicating that they place greater value on the higher level of access provided by a grid connection.

Analysis indicates that, in the absence of market mechanisms, no households living in extreme poverty are willing to pay the cost of Tier 4 cooking in any of the selected countries. The model also suggests low WTP for Tier 1 lighting technologies for households living in extreme poverty. However, the literature review found that some households in extreme poverty are willing to pay for such technologies.[4]

4.4. Can market mechanisms improve affordability and by how much?

There is clear evidence that the option to pay for energy products and services in instalments clearly increases WTP for all forms of energy access. Willingness to pay is generally further increased by subsidies which reduce prices. This supports the proposition that market mechanisms, and specifically mechanisms which spread payment over time, have the potential to support significant increases in energy access among people living in extreme poverty.

> A majority of survey participants in Kenya and Nepal selected a reduction in upfront cost of electricity and clean stoves as their first-choice option to make energy more affordable. Participants also supported mechanisms which spread upfront costs over time, or removed them entirely, and those which reduced the ongoing cost of energy use or allowed flexible payment.

PAYGo can improve the affordability of a Tier 1 multi-light SHS, bringing such a system within reach of some households in extreme poverty. For example, modelling suggests that PAYGo has the potential to bring access to such a system to over 1 million households living in extreme poverty in Kenya (Figure 4). The use of PAYGo to

spread the upfront cost of the Tier 1 SHS over 12 months makes the product affordable to 27% of Kenyan households living in extreme poverty (benefiting ~ 4.1 million people). This includes any households in extreme poverty that already have SHS, although recent reports suggest PAYGo is not yet reaching many households living in extreme poverty (Lighting Global et al., 2022). The number of households able to afford a system increases further if lending is on concessional terms (lower interest rates, longer tenors).

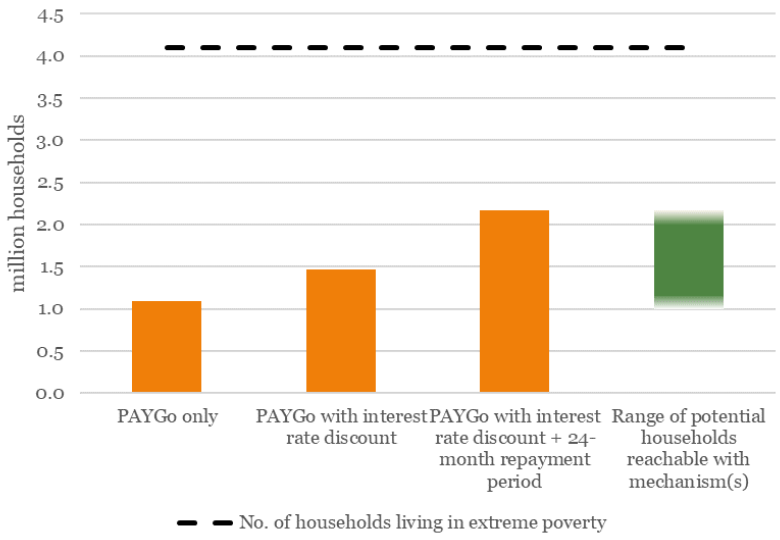

Figure 4: WTP for Tier 1 multi-light system among households living in extreme poverty, via PAYGo
Note: 'Range of potential households reachable with mechanism(s)' indicates the net number of households with characteristics that restrict the reach of mechanisms. Thus, actual reach will be somewhere within the indicated range.

Additional support or intervention is required to further extend energy access. This could be through the use of external subsidy, for example, or other mechanisms highlighted earlier in this report, such as those that do not rely on households being able to make cash payments.

4.5 Non-financial barriers to energy access

Addressing affordability alone is insufficient to provide households living in extreme poverty with energy access. Significant minorities of people living in extreme poverty remain unwilling to pay for energy access, even at a reduced price and in instalments. This reflects the existence of non-financial barriers which either reduce WTP or prevent people living in extreme poverty from achieving access even if they are willing to pay.

Unavailability of suitable energy products and services hinders energy access for people living in extreme poverty. This includes both the limited quality and extent of grid coverage and inadequate distribution networks for off-grid appliances, clean fuels, and maintenance services (Efficiency for Access, 2022). In fragile and conflict-affected states, low availability is worsened by attacks on infrastructure and supply chain disruption (Logan et al., 2021). Even **where appliances are available, they may not meet local needs.** Often clean cookstoves do not match households' cooking requirements and productive use appliances are poorly adapted to farming contexts (Practical Action, 2020a; 2020b).

'There have been instances where the village did not have electricity for up to 2 days. Our village is far from the city area where Nepal Electricity Authority (NEA) office is located and they, most of the time, do not come immediately when there is need for repair and maintenance in the electrical system' – Focus group participant in Jyamire village, Manahari Rural Municipality, Nepal.

Physical, financial, and legal restrictions on movement and engagement between energy suppliers and customers can also hamper energy access. Long distances to markets, due to poor road networks and transport services, especially impact rural areas and people living with disabilities that affect mobility (WHO, 2022). Energy suppliers' access to refugee camps and urban informal settlements may also be restricted by governments or managing agencies (Singh, 2014; Practical Action, 2020a), and displaced people often have limited freedom of movement (Vianello, 2016).

Lack of formal identification and recognition hinder energy access for certain groups. For example, informal and temporary housing means that residents of urban informal settlements are often unable to provide documents such as proof of residence required for electrification (World Bank, 2012) or purchase of LPG (Singh et al., 2014). Without formal services, electricians and landlords often act as de-facto energy suppliers setting tariffs and restricting energy uses for residents (Lukuyu and Kersey, 2022).

Lack of land tenure and formal documents were identified as key obstacles to grid connection by urban informal residents of the Hetauda sub-Metropolitan City, Nepal.

Social obstacles form at least as great a barrier to energy access as physical or legal restrictions. Discriminatory social norms around the division of household labour and mobility hinder women and girls' access to places where energy products and services are sold and their ability to benefit from them within households (Energia, 2019a). Furthermore, social exclusion and stigma mean that people with disabilities are often confined to the home (UNDESA, 2019), hampering their ability to access energy products.

The availability of alternative energy sources can reduce the priority given to modern energy. Willingness to pay for clean cooking options in rural areas is often low where traditional biomass fuel is freely available (interview with H. Adair-Rohani, World Health Organization, 8 May 2023) and urban informal residents often connect to the grid illegally rather than pay for formal connections (Singh et al., 2014). **Prioritizing energy access is likely to be harder for those with higher household costs.** For instance, people with disabilities may place a lower priority on energy if they have higher accommodation, transport or care costs (Mont and Cuong, 2011).

Prioritization is also affected by awareness of energy options and their benefits. Low awareness is a particular issue for increasing access to clean cooking which often requires awareness raising and behaviour change interventions (Vianello, 2016).

Low prioritization of energy was reported among focus group participants in both Nepal and Kenya. In Nepal, female participants saw access to electricity as less urgent than paying for daily meals and children's education. Male and female participants in Kenya ranked LPG and electricity below food for their families, paying rent, and taking children to school.

People living in extreme poverty face additional barriers to information needed to access energy. Common across all groups is limited access to education (World Bank, 2020a; Castañeda et al., 2016). In rural areas, indigenous and ethnic minority groups tend to lack access to education in a language they understand, and technologies are often imported without local language manuals, making them difficult to operate and maintain (FAO and IRENA, 2021). Similarly, information may not be tailored to people with disabilities, for example, written in braille for those affected by blindness (WHO, 2022). More broadly, access to information is hindered by low phone ownership, network coverage, and access to the internet.[5] Informal routes to information may also be affected by social exclusion, particularly affecting women and girls and people with disabilities (Banks et al., 2017; NCAPD, 2008).

4.6 Factors that affect market mechanism reach

Not only are people living in extreme poverty faced by barriers to energy access, there are also a number of factors which can impact the extent to which a market mechanism is able to reach them:

- **Low incomes and financial resilience hinder the capacity of people living in extreme poverty to take up financial support.** Income variability and low financial resilience are likely to reduce people's ability and willingness to engage with business models requiring regular fixed payments such as PAYGo. Income variability may also hinder eligibility for market mechanisms and reduce providers' willingness to extend support due to the risk of payment default.
- **Low experience with and high aversion to financial services**, including as a result of poor coverage by financial institutions and the telecommunications infrastructure that mobile money services depend on, can result in difficulties accessing and apprehension about engaging with market mechanisms. In particular, households can be hesitant in taking on inflexible financial commitments, which are often required to bring down the upfront cost of an energy access product or service.
- **High cost to serve.** Many people living in extreme poverty live in places or under circumstances that increase the cost of a market mechanism provider reaching them. Rural and remote communities are the most obvious, but not the only, example. Population density is often low, and infrastructure is poor, making it costly to serve these regions.
- **Informality and social exclusion.** Populations living in informal areas and excluded groups often lack the documentation that enables them to take up market mechanisms, or are excluded from social security registers. For populations living in refugee camps, lack of documentation can be further compounded by legal restrictions on movement.

- **Low awareness and prioritization.** This can be the result of some of the social exclusion issues discussed above, but also of low levels of education and literacy and lack of access to information. As a result, people may not be aware of market mechanism support opportunities or may not understand their benefits.

At least some factors that restrict the reach of market mechanisms affect most people who live in extreme poverty. As noted above, some factors will impact specific population groups. However, most households will be impacted by at least one factor that restricts the reach of market mechanisms.

4.7 Implications for market mechanism selection and design

Market mechanism selection and design should consider both non-financial barriers to energy access and the impact of factors that can restrict their reach. Some mechanism properties are particularly well suited to avoiding specific factors restricting reach. Sometimes, mechanisms can be designed to adopt these properties.

Consumer finance by itself is insufficient to reach people living in extreme poverty. Customer finance at market rates remains out of reach of the poorest. However, mechanisms which combine elements such as flexible repayments, concessional consumer financing, and service-based models (energy as a service) may have the potential to reach at least some of those living in extreme poverty.

Mechanisms with properties that subsidize the cost of a product to a consumer are also important for addressing income poverty. Demand-side subsidies are an example of this. End-user subsidies are better able to reach people living in extreme poverty than product or tariff subsidies, as the customer is the direct recipient of funding with end-user subsidies. This means they can be targeted at the poorest and are less distorting of markets since advertised market prices are maintained. However, targeting itself can be costly, and the complexity of administering targeting could hamper the reach of a market mechanism. The barter payment model can also address income poverty if the customer can offer something (such as feedstock) that is of greater value to the company than to the customer as it effectively reduces the cash price to consumers.

Mechanisms that do not rely on fixed repayments can better address people's aversion to taking on financial commitments. Consumption-based charging can address this barrier because consumers have more control over when they choose to pay for energy access. Consumption-based energy-as-a-service business models are an example. The tool and fuel business model for clean cooking can also address this barrier, reaching 50% of households on average across the modelled countries, compared to 11% reached by PAYGo.

Mechanisms that provide a lasting funding injection are important for addressing the high cost to serve barrier. Time-limited injection of funds can be counter-productive if there remains a gap between cost to serve and ability to pay when an external intervention, such as a supply-side subsidy, is withdrawn. Mechanisms such as tax exemptions and regulatory cross-subsidies can provide companies with the longer-term and more sustainable source of additional funding required to serve the higher-cost locations where many people who live in extreme poverty reside.

Funding injections that target specific groups of people living in extreme poverty are important for reaching socially excluded populations and those hardest to reach. Most of the market-based mechanisms reviewed can be designed with some form of targeting. Some mechanisms have been implemented with specific social objectives, such as enabling energy access for:

- *Women and girls* – for example, C-Quest's Health and Gender RBFs targeting health benefits to women and girls from clean cooking, through avoided pollution and reduced fuelwood collection (CCA/MECS, 2022).
- *People with disabilities* – for example, R&D for inclusivity grants from Efficiency for Access, which includes projects enabling the development of technology for people with disabilities.
- *People living in displacement, and those living in fragile and conflict-affected areas* – for example, targeted impact funds, such as Peace and Renewable Energy Credits (P-RECs),[6] which are available to renewable energy developers in fragile, energy-poor countries.

Market mechanisms will need to be complemented by awareness-raising programmes to reach many communities. Market mechanisms alone are unlikely to be sufficient in addressing low awareness of the benefits of energy access among many of those living in extreme poverty.

4.8 Data gaps and how they can be filled

This review has revealed a **number of gaps in the data around extreme poverty and energy access**. These hamper estimation of the size of some groups living in extreme poverty who lack energy access. In particular:

- Neither extreme poverty nor energy access rates are published for *informal* urban areas.
- Income data (and hence poverty rates) are not available for forcibly displaced people. Nor is comprehensive data on energy access in displacement settings available (GPA, 2022).
- Data on extreme poverty rates and energy access among people with disabilities is limited.

To improve understanding of the relationship between energy access and extreme poverty so that market mechanisms can be most effectively focused, we would suggest the following:

- Encourage the Energy Sector Management Assistance Programme (ESMAP) in any future MTF Energy Access Diagnostic Surveys, to:
  a. categorize locations surveyed as rural, formal urban, and informal urban;
  b. include a separate question on whether households include any people with disabilities;
  c. analyse data gathered through the lens of extreme poverty.
- Work with the Global Platform for Action (GPA), United Nations High Commissioner for Refugees (UNHCR), and other humanitarian agencies to develop more systematic and comprehensive data on extreme poverty and energy access among displaced people.
- Engage with the Disability Data Initiative to discuss how better and wider data on extreme poverty and energy access among people with disabilities can be secured.[7]

This research has helped to identify groups of people living in extreme poverty that are particularly hard to reach. Better data on where these groups are and the extent to which they overlap would help both to improve the data inputs to the analysis presented and to

inform the future design of market mechanisms. In particular, the data available on energy access levels, needs, and WTP among people living in extreme poverty is limited, and somewhat ambiguous. Better data, which looked more deeply and systematically at the relationships between income, access, and both willingness and ability to pay for energy, would enable the sector to develop strategies which avoid leaving this vulnerable group behind.

5. Conclusion

This study looked at evidence on energy access among people living in extreme poverty in sub-Saharan Africa and the Indo-Pacific. **It has identified who and where are the people living in extreme poverty without energy access** and revealed the concentration of both extreme poverty and lack of energy access in rural and fragile and conflict-affected areas of sub-Saharan Africa and in a relatively small number of countries. The study has also explored the **relationship between poverty and lack of energy access among specific demographic groups** and looked at the commonalities and differences in their energy needs, and the challenges they face in accessing energy.

Findings **confirm that affordability is the greatest barrier to energy access** for people living in extreme poverty, but also **that market mechanisms which spread cost over time and/or reduce prices have the potential to enable energy access for a significant number of people living in extreme poverty**. However, the study has also confirmed the part played by other, non-financial barriers and the need to take these, and factors limiting mechanism reach, into account if market mechanisms are to be effective.

A categorical matrix of market mechanisms has been developed (classifying mechanisms by type, nature of impact, and properties) to enable selection of the most suitable mechanism(s) for a given group and context. In addition, the study has developed a **model to quantify the impact of mechanisms and estimate the number of households living in extreme poverty that could gain access to a given energy product or service through different mechanisms**. The model incorporates the WTP impact of a mechanism and its ability to reach different population groups, allowing its effectiveness for different groups of people living in extreme poverty to be assessed.

These findings should, together, inform the selection, targeting, design, and implementation of market mechanisms to enable energy access for people living in extreme poverty and ensure that vulnerable demographic groups are not left behind.

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7. Endnotes

[1] For the remainder of this report, 'sub-Saharan Africa and the Indo-Pacific' is used to refer to the countries listed in Appendix 7.3 of Part 1: Understanding the Relationship between Energy Access and Extreme Poverty (which do not include India).
[2] For each country, research consisted of 30 interviews (15 in the rural setting and 15 in the urban informal setting) with a mix of people living above and below the extreme poverty line. This was complemented by two focus group discussions involving 20 people (10 in each location and, again, a mix of people living above and some below the extreme poverty line). The mix of participants in each reflected a focus on conditions for specific groups: women and girls in Nepal and people with disabilities in Kenya.
[3] See Appendix 7.1 of 'Part 1: Understanding the Relationship Between Energy Access and Extreme Poverty' for data sources and how figures were arrived at. Total population numbers and numbers of people who lack energy access *include* Afghanistan, Cambodia, Equatorial Guinea, Eritrea, and Papua New Guinea. Numbers of people living in extreme poverty, or who are living in extreme poverty *and* lack energy access exclude these countries (for which poverty data is unavailable). The figures for the individual groups do not sum to the total for the two regions because the various groups overlap.
[4] It is not clear whether this reflects unreliability in income and expenditure data (i.e. that households expressing this WTP were not in reality extremely poor) and/or in expressions of WTP (i.e. that some of those who said they would be willing to pay for energy would not, in reality, do so) or whether it indicates genuine variations in the value placed on energy, and hence WTP, even among households with very low incomes.
[5] Interviews with S.M. Leitner and N. Hzami, GIZ – Energizing Development, 2 May 2023; and F. Hinrichs and B. Koo, World Bank – ESMAP, 27 April 2023.
[6] Renewable energy developers developing projects in fragile, energy-poor countries can receive P-RECs for each unit of electricity generated. The P-RECs are then sold to outcome buyers seeking to meet sustainability goals (EPP, 2019)
[7] The Disability Data Initiative (https://disabilitydata.ace.fordham.edu/), based at Fordham University, provides analyses of disability data (including poverty and energy access data) to help advance the rights of persons with disabilities and sustainable human development for all (Mitra and Yap, 2021, 2022).

CAN MARKET MECHANISMS FACILITATE ENERGY ACCESS FOR PEOPLE LIVING IN EXTREME POVERTY?

Findings and Recommendations

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