

PRODUCTIVE USE OF
ENERGY SOLUTIONS
FOR MICROENTERPRISES

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ABBREVIATIONS

AC	Alternating current	NABARD	National Bank for Agriculture and Rural Development
AECF	Africa Enterprise Challenge Fund	NBFC(s)	Non-banking financial companies
CAPEX	Capital expenditure	NGO(s)	Non-governmental organisation(s)
CEEW	Council on Energy, Environment and Water	NGN	Nigerian Naira
CGST	Central Goods and Services Tax	NSS	National Sample Survey
CGTMSE	Credit Guarantee Fund Trust for Micro and Small Enterprises	NSSO	National Sample Survey Office
CLASP	Collaborative Labeling and Appliance Standards Program	OECD	Organisation for Economic Co-operation and Development
CInI	Collectives for Integrated Livelihood Initiatives	PAYGO	Pay-as-you-go
CRM	Customer Relationship Management	PMEGP	Prime Minister's Employment Generation Programme
DADA	Dare to Aspire, Dare to Achieve	PUE	Productive uses of energy
DFI(s)	Development finance institution(s)	R&D	Research & development
E4I	Energy 4 Impact	RRB(s)	Regional rural bank(s)
ECLGS	Emergency Credit Line Guarantee Scheme	REDP	Rural Electrification Densification Project
EEP	Energy and Environment Partnership	SACCO(s)	Savings and Credit Cooperative(s)
GDP	Gross Domestic Product	SFB(s)	Small Finance Bank(s)
GNP	Gross National Product	SFURTI	Scheme of Fund for Regeneration of Traditional Industries
GSTN	Goods and Service Tax Network	SGST	State Goods and Services Tax
ICT	Information and communication technology	SHG(s)	Self-help group(s)
IDEC(s)	Import Duty Exemption Certificate(s)	SIDBI	Small Industries Development Bank of India
IGST	Integrated Goods and Services Tax	SME(s)	Small and medium-sized enterprise(s)
ILO	International Labour Organization	SMEDAN	Small and Medium Enterprise Development Agency of Nigeria
IPFF	India Pure Finance Facility	SMME(s)	Small, medium and microenterprise(s)
KCIC	Kenya Climate Innovation Centre	TVET	Technical vocational education training
KES	Kenyan Shilling	UNECA	United Nations Economic Commission for Africa
K-OSAP	Kenya Off-Grid Solar Access Project	USSD	Unstructured Supplementary Service Data
LPG	Liquefied petroleum gas	VAT	Value added tax
ME(s)	Microenterprise(s)	WEP	Women Entrepreneurship Platform
MFI(s)	Microfinance institution(s)	WHO	World Health Organisation
MRV	Monitoring, reporting & verification		
MSE-CDP	Micro and Small Enterprises Cluster Development Programme		
MSME(s)	Micro, small and medium enterprise(s)		
MTF	Multi-Tier Framework		

GLOSSARY

Term	Description	Notes
Micro enterprises (MEs)	Sole proprietorships/self-employed entrepreneurs including up to two employees. Joint ownership models e.g. cooperatives or where multiple entrepreneurs own a single larger energy asset are also considered. Under both ownership models, the microentrepreneur earns below a living income.	<p>This definition deviates from how the term is used by the statistics bureaus of India, Kenya and Nigeria:¹</p> <ul style="list-style-type: none"> • MEs are officially defined in Kenya as licensed and unlicensed businesses with less than 10 employees. • In Nigeria, MEs are defined as businesses employing 3-9 people with turnover between ₦3 million and ₦25 million. Nano enterprises are defined separately from MEs, as businesses employing up to 2 people with turnover of less than ₦3 million per year. • In India, MEs are defined as enterprises with up to Rs. 5 Crore of turnover in a year. Nanoenterprises are defined separately with annual revenue ranging from Rs 10 lakhs to Rs 1 crore. Number of employees is not used as a criterion in India.
Productive uses of energy (PUE)	Energy consumed for the purpose of performing agricultural, commercial and industrial activities, typically to generate income. When possible, this energy is generated from renewable sources.	In this assignment, we only consider energy consumption that has a direct energy link with microenterprises. Energy use further up or down the value chain is not considered.
Productive energy solution suppliers	Any business manufacturing, importing, aggregating, wholesaling, distributing or retailing PUE technologies (in this case to microenterprises in India, Kenya or Nigeria).	We consider both early-stage suppliers as well as more established, larger suppliers.

¹ Most quantitative data pertaining to microenterprises reported in this study was sourced from the statistics bureaus of India, Kenya and Nigeria. In light of the different definitions listed here, we have reported nanoenterprise data from Nigeria, as it correlates closely with Shell Foundation's definition for microenterprises. In India and Kenya, where data for microenterprises as it is specifically defined by Shell Foundation is not available, but available in different forms nonetheless, we have used data for microenterprises as it is defined by the statistics bureaus in these countries. This approach only applies to quantitative data. Qualitative discussions of the status of microenterprises in each PUE use case follows Shell Foundation's definition to the extent possible, thus disaggregating data representing microenterprises living below a living income with less than two employees as much as possible from overall MSME data.

EXECUTIVE SUMMARY

Productive uses of energy (PUE) have become a focal point for energy access practitioners, governments, investors and donors in recent times as stakeholders seek to address the gaps that exist between energy access and economic activity in underserved populations. Stimulating productive uses requires targeted interventions to overcome barriers like high upfront costs and limited financing, especially in low-income areas. Much has been written about PUE strategies as it relates to irrigation and agro-processing, but a variety of other PUE activities should also be focused on as more attempts are made to ensure that energy translates into economic activity. This report delves into the intricate landscape of less-documented PUE solutions, analysing their impact on microenterprises in India, Kenya, and Nigeria.

The findings of the report are based on a rigorous methodology that included both desk-based research and primary interviews. Our findings are based on a market database covering 153 suppliers across India, Kenya, and Nigeria and 31 in-depth supplier interviews. We mapped funding flows, identified technology innovation trends and investigated business models. In each country, we also covered the landscape of the intended users of PUE equipment; microenterprises.

The report identifies ten under-researched PUE applications, exploring the challenges faced by suppliers and highlighting how these challenges could be resolved to achieve an exponential increase in adoption of these technologies. The PUE applications studied include cooling (refrigeration and freezing), retail food and beverage preparation (cooking and juicing), animal husbandry (egg incubation and dairy milking), textiles, metalwork, carpentry, information and communication technology (ICT), cottage industries (e.g. household-based rope and cotton wick manufacturing) and hairdressing. We considered off-grid as well as grid-powered appliances. Some, such as improved cookstoves and hair clippers already enjoy high levels of market maturity, while others

such as electric cookstoves, dairy milking machines and carpentry machines are associated with lower market maturity levels.

We selected these applications because the associated technologies are more regularly used for income generation compared to household use. Importantly, large numbers of women-owned microenterprises engage in most of these activities. Women constitute the majority share of customers among suppliers we interviewed: Up to 90% among cooking, cooling and textiles PUE solution suppliers.

The PUE technologies covered in this report have a transformative impact on the livelihoods of microenterprises living below living incomes. In India, microenterprises report an increase of \$57 in monthly income after purchasing a refrigerator while the incomes of cold room customers in Kenya have been shown to increase by 25%.² Globally more than 4 out of 5 productive users experience an increase in their incomes after purchasing a PUE product.³

A key driving force for this research has been the slow uptake of PUE technologies. The challenges identified in the report are multifaceted and rooted in the realities faced by suppliers in each country. Market fragmentation, funding mismatches, high upfront costs, detrimental importation regulations, limited consumer awareness, and gender-specific barriers have all been highlighted as critical obstacles to the widespread adoption and impact of PUE solutions. In India, suppliers especially grapple with serving hard-to-reach customers, while Kenyan suppliers particularly struggle with low levels of consumer awareness. Nigerian suppliers see access to finance as a primary challenge. By offering specific, actionable resolutions – such as tailored financing models, enhanced last-mile connectivity, and targeted gender support – we offer a roadmap for stakeholders aiming to facilitate exponential increases in the adoption of PUE technologies by microenterprises in India, Kenya and Nigeria.

² GOGLA, *Powering lives and livelihoods: Scaling productive uses of renewable energy, 2023* ([link](#))

³ 60 Decibels, *Why off-grid energy matters, 2024* ([link](#))

Tackling market fragmentation through aggregation

One of the key challenges identified is the fragmentation in low-income markets. Small suppliers, often operating in isolation, face inefficiencies and high costs, which limit their ability to serve a dispersed customer base. To address this, the report suggests that financial institutions could play a crucial role by offering bulk purchasing and warehousing facilities. This would allow suppliers to pool resources, reduce procurement costs, and expand their reach.

Bridging the funding mismatch

Many quality suppliers struggle to meet the minimum investment requirements set by funders, leading to a concentration of funds among a small number of larger companies. To bridge this gap, the report calls for more tailored funding opportunities and associated risk assessment methodologies that align with the realities of smaller suppliers. Introducing smaller, quickly disbursable grants and debt instruments could have a transformative impact, enabling a broader range of suppliers to access capital tailored to their conditions. The average minimum ticket sizes for grants, debt, and equity investments are \$130,000, \$300,000, and \$630,000 respectively – often too large for many suppliers, highlighting the need for more accessible financial products. Suppliers too can help by bridging this gap. Improvements in financial reporting, data management practices and business model innovation leveraging digital technologies can assist in increasing investability.

Addressing the affordability challenge

High upfront costs and limited consumer financing options continue to be significant barriers to the adoption of PUE technologies. For many microenterprises, these costs are prohibitive, and without adequate financing, they remain out of reach. The report emphasises the need to expand subsidies and consumer financing mechanisms and deliver them in a way that achieves maximum impact. Collaboration between PUE suppliers and microfinance institutions (MFIs) is presented as a viable solution, though it requires overcoming barriers relating to misaligned incentives.

Building consumer awareness

Microenterprises are often unaware of how these

technologies can enhance their productivity and profitability. Building consumer awareness is critical to ensuring that PUE solutions are adopted by the microenterprises that need them most. Yet seeing as the use of PUE technologies is not the only predictor of microenterprise success, we advocate for education programs not only on the use and benefits of PUE solutions, but also how microentrepreneurs can grow their customer base, which is a precondition to fully reaping the benefits of PUE solutions. Pilot programmes have shown that targeted consumer awareness campaigns can significantly increase adoption rates, demonstrating the importance of such efforts in scaling PUE technologies. At the same time the sector as a whole, given its early stage, has the opportunity to build a positive reputation by ensuring that customers are protected through high quality service delivery and data safeguards.

Enhancing last-mile connectivity

The cost and logistical difficulties of serving hard-to-reach customers are prohibitive in Kenya, Nigeria and India. To address this, the report highlights the need for investments in last-mile infrastructure and partnerships with local distributors. Training of in-house technicians is key to ensure effective after-sales support, while outsourcing to external after-sales agents can also be useful.

Targeting gender-specific barriers

Tailored financial and non-financial support for female entrepreneurs is not just a matter of equity but a strategic necessity for unlocking the full potential of PUE solutions to drive inclusive economic growth. Female-owned microenterprises in the informal sector represent the largest share of microenterprises in Kenya, Nigeria, and India, indicating a vast potential for impact through gender-focused interventions. These businesses often struggle with limited access to finance, lower education levels, and restrictive gender norms, which hinder their ability to benefit from PUE solutions. The report calls for tailored financial and non-financial support to target these barriers. Challenges unique to female-owned suppliers of PUE equipment are also studied. Given the holistic nature of these challenges, the report advocates for an ecosystem approach instead of siloed attempts.

1

INTRODUCTION



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This study breaks new ground by detailing the landscape of productive energy solution suppliers for a wide range of lesser-known productive use of energy (PUE) activities, beyond the well-documented activities such as solar irrigation and agro-processing. As a recent report by EnDev notes: *“The focus of most PUE projects, as well as product development by manufacturers, is on applications in agriculture, agro-processing and water supply.”*⁴

There are, of course, countless manufacturers, wholesalers, distributors and retailers that sell less-documented PUE products. The difference, therefore, is more nuanced: Most *formal PUE projects that have an intentional development focus, often financed by development finance institutions and impact investors*, concern agriculture, agro-processing and water supply. Agriculture and water related interventions are popular among development-funded PUE projects given the many cross cutting impacts between energy and agriculture. Agriculture (in the form of food) and water constitute basic human needs. It follows that when DFIs support PUE projects targeting these activities, they are supporting energy access as well as the eradication of hunger and the drive towards clean water and sanitation. DFIs also have a preference to support clean energy technologies and off-grid solar is typically the best-suited technology to power up agricultural activities for communities without energy access.

As more industry focus is being placed on strengthening the contribution of energy access to socio-economic development, there is a strong rationale for generating knowledge on PUE use cases that are currently largely overlooked. For this reason, this study outlines and deep dives into ten of these applications. These are presented in Table 1. We cover these applications in India, Kenya and Nigeria. The report sheds light on the landscape of companies supplying PUE solutions to microenterprises engaged in these lesser-known PUE activities, the challenges that the suppliers face and their financing needs and aspirations.

The outputs presented in this report depended extensively on findings emanating from interviews with these suppliers as most of them are, naturally, less documented in desk-based sources than suppliers operating in the well-documented irrigation and agro-processing sub-sectors. The difficulty of finding published desk-based research on PUE applications beyond agricultural activities illustrates the novelty and importance of this study.

Companies that supply PUE solutions in these sub-sectors can loosely be subdivided into two types, with the main differences being the ability to pay of their targeted customers and how they fund themselves:

1. Donor funded impact-first suppliers:

These suppliers have a *raison d'être* tightly linked to impact and development. Impact-first suppliers are therefore typically funded by international donors and impact investors. They specifically target customers at the bottom of the pyramid, making their products and services tailored to the needs of microenterprises earning below a living income. Whilst these suppliers have ambitions to become financially sustainable, serving bottom of pyramid customers – who typically have limited ability to pay – makes this difficult. This points to the high prevalence of grant funding among these suppliers. The majority of these suppliers offer off-grid products that can be used for household as well as income-generating purposes. These include solar refrigerators and clean cookstoves for example.

2. Conventional suppliers: Suppliers in this category sell to any willing buyer instead of explicitly targeting bottom of pyramid customers. Given that they do not offer extensive consumer finance such as PAYGO, their target markets tend to include customers with a slightly higher ability to pay. The nature of their operations are not extensively covered in international development publications and they do not raise external development finance, typically being self-funded. Most offer standard products

⁴ Havinga, M. & Tuele, R., *Productive use of energy: Moving to scalable business models*, 2020 ([link](#))

requiring an external AC grid-based power source such as inverter welding machines, sewing machines and hairdressing equipment.

1.1 The value proposition of productive uses of energy

The positive socio-economic benefits of energy access have been consistently recognised by a wide range of publications over the last decade. Yet, despite considerable efforts to improve access rates in the Global South (Kenya now has an electrification rate of 75% and India has recently reached universal access⁵), socio-economic development is lagging. This is certainly the case in Nigeria, where 86 million people lack access to electricity.⁶ We recognise that in all three of these countries (as well as further afield), energy access does not necessarily translate into localised economic activity organically. Energy access interventions are more likely to result in economic activity if consideration is given to the utility of this energy, in other words what it can most **productively** be used for, and to promoting market access among productive users. The second consideration is how to best stimulate these **productive uses of energy**. **Productive use equipment is key to achieving this objective.**

PUE can facilitate the transformation of the economies of rural, peri-urban and urban communities from subsistence to economically vibrant. This is a key step towards ensuring that energy access translates successfully into localised socio-economic development. The longer-term implications of this are well understood, but include increased community resilience to climate shocks, improved gender indicators and a reduction in conflict over scarce resources.

Productive use activities do not, however, emerge organically alongside the introduction of energy

access. In many cases, particularly in low-income contexts, they need to be stimulated. This requires interventions that both directly and indirectly address the key deployment and adoption barriers (e.g. high upfront cost for the end-user and lack of finance for distributors), identifying locally appropriate productive use activities that would be financially feasible to electrify and capacity building and awareness raising with microenterprises to increase adoption rates.

Despite irrefutable evidence of their role in catalysing socio-economic development^{7,8} and extensive efforts to expand access,^{9,10} deployment and adoption of productive use equipment has, however, been slow. Compared to household energy solutions, PUE solutions require a more holistic business model. The necessary ingredients for a successful business model in the supply of PUE solutions include a variety of ancillary services such as in-depth customer training, market linkages, affordable end-user financing and specialist after sales support. This relative complexity inherent in the supply of PUE solutions facilitates the emergence of a host of challenges that ultimately constrains end-user adoption. An understanding of the challenges faced by suppliers of this equipment (especially under-documented PUE equipment such as non-agri equipment) is thus of vital importance if the sector is to increase and tailor its support for energy-enabled economic development.

1.2 Introduction to microenterprises

PUE is defined as the consumption of energy to perform income generating activities. It follows that businesses are the main users of PUE equipment. This study covers the supply of PUE products and services to small businesses in India, Kenya and Nigeria, which we refer to as **microenterprises**. This includes self-employed microentrepreneurs

⁵ International Energy Agency, *Access to electricity, 2022* ([link](#))

⁶ International Energy Agency, *Tracking SDG 7: The Energy Progress Report, 2023* ([link](#))

⁷ Gaur, D., Yasaswi, P. & Jain, A., *How decentralised renewable energy-powered technologies impact livelihoods, 2023* ([link](#))

⁸ Powering Renewable Energy Opportunities (PREO), *Powering Prosperity: The socio-economic benefits of PURE in Africa, 2023* ([link](#))

⁹ World Bank, *Accelerating the productive use of electricity, 2023* ([link](#))

¹⁰ NEFCO, *Scaling productive use of energy solutions in Sub-Saharan Africa, 2023* ([link](#))

and microenterprises with up to two employees. 'Microenterprises' as it is defined in the context of this study only considers those that earn below a living income. This study also assesses the extent to which productive energy solution suppliers serve cooperatives of microenterprises.

1.2.1 PUE and its impact on female-owned microenterprises

As microentrepreneurs, women in Kenya, Nigeria and India face similar challenges:

- **High informality:** 88% of women-owned micro, small and medium enterprises (MSMEs) in Kenya are unlicensed, while in India 95.6% are regarded as informal.^{11,12} Data from Nigeria is unclear, but it is likely that the 12.2 million women-owned informal businesses constitute the majority share of all women-owned businesses in the country.¹³
- **Limited access to finance:** Cultural norms and lack of collateral make it difficult for women to secure loans.
- **Lower education levels:** Women often have less education than men, hindering their ability to access networks, technology, and data.
- **Gender norms:** Societal expectations restrict women's control over assets, mobility, and participation in male-dominated sectors.
- **Geographic disparity:** Access to resources and opportunities varies depending on location (urban vs rural, regional).
- **Weak legal enforcement:** Laws supporting women's economic rights often lack strong implementation.

The presence of these structural barriers suggests that it is more difficult to ensure that PUE solutions reach female-owned microenterprises, as compared to male-owned ones. On the other

hand, given that these structural barriers limit women's entrepreneurial growth and potential, the potential impact of PUE solutions on women-owned microenterprises is pronounced.¹⁴ The practical implication is that if women empowerment is to be achieved through PUE solution ownership, focus should be placed on sectors where women-owned microenterprises are well represented. [Section 2](#) explores these sectors.

1.3 Study methodology

1. We began this study with a literature review, which involved a stock take of the limited published information concerning the PUE use cases covered in this study.¹⁵
2. This was followed by the creation of a market database consisting of companies supplying products and services for the PUE use cases covered by this study. While this database is by no means exhaustive of all operational suppliers in each country, it does offer a useful indication of the extent of the supply of different PUE solutions in each country. The database covers 153 suppliers operating across India, Kenya and Nigeria. We also conducted desk-based research to compile a database of financiers and funding programmes available to productive energy solution suppliers in the countries of interest. Our funding database serves as a data backbone for our country-specific funding flows maps presented in this report.
3. We conducted a total of 31 interviews with suppliers of all sizes across all countries and sectors. These are listed in [Appendix A](#). Given the limited published studies on the PUE applications covered in this report, insights emanating from these interviews have been instrumental in developing an understanding of these under-researched topics.

¹¹ Analysis based on data from: Kenya National Bureau of Statistics, MSME Basic Report, 2016 ([link](#))

¹² Microsave Consulting, Decoding Government Support to Women Entrepreneurs in India- The anatomy of entrepreneurship schemes, 2022 ([Link](#))

¹³ National Bureau of Statistics of Nigeria, MSME Survey Report, 2021 ([link](#))

¹⁴ The impact of energy access on women in the household context is well-researched, with authors agreeing that the time savings experienced by women in households create opportunities for using this time for productive/income generating purposes. The impact of energy access and PUE solutions on women-owned enterprises (along the lines of, for example, increased revenues) is however under-researched in the literature.

¹⁵ 33 relevant industry reports were identified, published by a wide range of institutions including SELCO, Efficiency for Access, GDC, NEFCO, PREO, CLASP, ESMAP, EnDev, Verasol, 60decibels and CEEW. This excludes academic publications also perused during this research.

2

EXPLORING PUE SECTORS



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The PUE applications studied in this report include cooling (refrigeration and freezing), retail food and beverage preparation (cooking and juicing), animal husbandry (egg incubation and dairy milking), textiles, metalwork, carpentry, information and communication technology (ICT), cottage industries (e.g. household-based rope and cotton wick manufacturing) and hairdressing. These applications were studied in the context of all three countries, except for cottage industries, which was studied in the context of India only, and hairdressing, which was only deemed relevant to Kenya and Nigeria. Table 1 presents these applications.

The PUE space is best described as a convergence of a variety of markets. Off-grid solar PUE products for retail applications (e.g. solar fridges), light industrial AC-powered machinery (e.g. inverter welding machines), standard electric cookers, computers and printers and traditional electric

sewing machines are all regarded as PUE equipment despite their clear differences. It is not the technical design of a technology that qualifies it as a PUE solution, but **rather how it is used**; usually this is defined by whether the activity is income generating.¹⁶ All technologies covered in this assignment can also be used for non-PUE purposes. It is however the understanding that they are more regularly used for income generating purposes that qualifies them as PUE solutions. **It also constituted the first decision making criterion for selecting deep dive PUE applications for this study.** Solar-powered televisions, a common addition to off-grid solar systems, are for example excluded from this study as it has recently been found by a sample study that solar TVs are used for income generating purposes in only 2% of cases.¹⁷ Conversely, in approximately 88% of cases solar fridges are used to generate income. Our research also indicated high levels of productive use of the other products and services covered in this report.

Box 1: PUE technologies assessed as part of this study

In this assignment we consider standalone (off-grid) solar PUE technologies, which constitutes an integrated solar PV electricity source. Solar fridges and freezers fit this category.¹⁸ These technologies are especially relevant to Kenya and Nigeria as these countries have a comparatively lower electrification rate than India, necessitating off-grid technologies. We also consider technologies requiring an external power source (grid or mini grid). These typically include larger wattage technologies such as inverter welding machines and woodworking machines, but also include lower wattage technologies that are not available in solar form, such as most sewing machines, computers and printers. We also consider technologies using energy forms other than electricity, e.g. improved cookstoves or liquefied petroleum gas (LPG)-based cookstoves. In all cases, technologies studied would ideally be energy efficient and powered by renewable sources.

While an obvious point, it is nevertheless important to note the following: The links between the energy access sector and the sectors of the respective PUE technologies are understandably strong in off-grid solar, given that the power source and the technology are integrated into a standalone system. It means there is no split between the companies selling the PUE technology and those selling the system that powers the technology. In the case of technologies using an external power source, these links are naturally weak or non-existent.

¹⁶ In addition to income generation, technologies could also be regarded as productive if they lead to outcomes such as reduced drudgery, reduced waste and improved efficiency.

¹⁷ 60 Decibels, *Why off-grid energy matters*, 2024 ([link](#))

¹⁸ Given Shell Foundation's existing work on agriculture in a separate portfolio, solar water pumps and agro-processing machines are excluded from this study.

Gender disaggregated impact was a secondary decision-making criterion for selecting PUE applications to study. We ensured that at least the majority of applications are specifically relevant to female-owned microenterprises. This was done

by prioritising microenterprise industries that have large numbers of female-owned microenterprises¹⁹ and those in which products are used extensively by female-owned microenterprises.



Cooling (refrigeration and freezing)²⁰



Retail food and beverage preparation²¹



Egg incubation²²



Dairy milking²³



¹⁹ Data on the estimated number of female-owned microenterprises in each industry is presented in the country-specific sections.

²⁰ Photo credit: Morgana Wingard/USAID U.S Agency for International Development (Creative Commons)

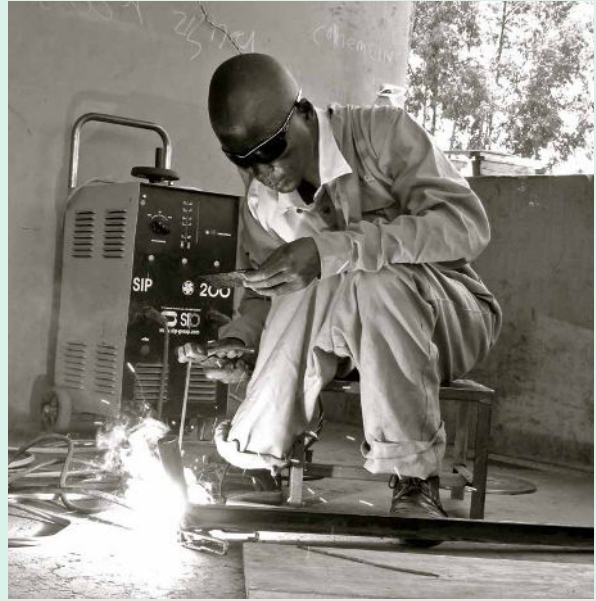
²¹ Photo credit: Saikat Gosh, Pexels

²² Photo credit: Gyeongbuk Kim, Pexels

²³ Photo credit: Ouça e Relaxa, Pexels



Textiles²⁴



Metalwork²⁵



Carpentry²⁶



ICT²⁷



²⁴ Seamstress tailoring clothes in Bambani village, Nigeria. Photo credit: Sam Duby.

²⁵ Welder working in workshop in Kisumu, Kenya. Photo credit: Sam Duby.

²⁶ Photo credit: Tope Asekere, Pexels

²⁷ Photo credit: Sushmita Nag, Unsplash



Cottage industries (rope, cotton wick and paper plate manufacturing)²⁸



Hairdressing²⁹

Table 1: PUE use cases covered by this report³⁰

Microenterprises in India, Kenya and Nigeria have adopted the products and services covered in this study to varying degrees. Figure 1 presents an outline of the market maturity of the products and services offered for each PUE use case mentioned in Table 1 above. We adopt an approach based on a combination of qualitative and quantitative data to assess the maturity of each product and service, similar to the methodology used by The World Bank³¹ and Efficiency for Access.³² While the standard approach places equal importance on technological maturity and market maturity, we emphasise the importance of **market maturity** in this study. Technological maturity is less of a concern as all products considered in this study are already technologically mature; this study does not only consider off-grid solar technologies but also standard grid-powered technologies. In PUE use cases where off-grid solar technologies are not yet technologically mature, mature grid-powered technologies are already available. Therefore we exclude technology maturity in the context of this study.

We acknowledge that this categorisation is based on sample quantitative datasets and anecdotal qualitative evidence, but maintain the utility of this exercise as it offers an overview of the penetration of these products and services among microenterprise customers. Quantitative metrics to assess market maturity include:

- Number of companies identified in supplier database;
- Average number of products sold by suppliers.

Qualitative inputs to assess market maturity include:

- Extent of challenges experienced by suppliers, for example: Are suppliers experiencing significant issues in an attempt to lower the product price for microenterprises? Do suppliers find it challenging to educate microenterprises on the value proposition of their products?

²⁸ Photo credit: SELCO Foundation

²⁹ Barbershop microenterprise powered by solar mini grid electricity in Remba Island, Kenya. Photo credit: Sam Duby.

³⁰ We also acknowledge the productive use potential of mobility, entertainment, pottery, vehicle repairs, electronic repairs and water treatment. These applications were however excluded from this study, along with the well-known irrigation and agro-processing use cases.

³¹ The World Bank, *Off-Grid Solar Market Trends Report, 2022* ([link](#))

³² Efficiency for Access, *Solar appliance technology briefs, 2021* ([link](#))


















	Concept	Horizon	Emerging	Growth	Mature
Market Maturity	Significant barriers in market penetration	Business model being piloted with microenterprises	Few suppliers, resolutions to challenges emerging	Growing sales and new entrants in the market	Products sold at volume by many players in a favourable environment
		 <p>Electric cookstoves</p>	 <p>Laptops and printers</p>	 <p>Fridges and freezers</p>	 <p>Improved cookstoves</p>
			 <p>Food heating carts</p>	 <p>Sewing machines</p>	 <p>Hair dryers (KE & NG)</p>
			 <p>Egg incubators</p>	 <p>Walk-in cold rooms</p>	 <p>Hair clippers (KE & NG)</p>
			 <p>Dairy milking machines</p>	 <p>Cold chain logistics</p>	 <p>Inverters</p>
			 <p>Welding machines</p>	 <p>LPG cookstoves</p>	
			 <p>Carpentry machines</p>	 <p>Indian cottage industries (paper plate machines, rope machines, cotton wick machines)</p>	

Figure 1: Market maturity of PUE products and services in microenterprise market³³

³³ TFE & pManifold analysis. LPG cookstoves enjoy higher market maturity in India and are thus regarded as mature, compared to its growing status in Kenya and Nigeria. Note that this classification of electric cookstoves includes electric pressure cookstoves and induction cookstoves.

Responses from suppliers in all three countries suggest that the products sold in the respective PUE value chains are highly relevant to female-owned microenterprises. We noted convergence among suppliers pertaining to the penetration of

female customers in their overall customer base. Table 2 presents these results. Most suppliers do not experience differences in how male and female customers use their products or in how male and female customers engage with them.³⁴

PUE sector	Company	Country	% of customers that are female
Cooking	Mukuru Stoves	Kenya	90%
	Burn Manufacturing	Kenya	70%
	Sosai Renewable Energies	Nigeria	70%
	Blue Star Auto Machinery	India	95%
Cooling	DD Solar	India	90%
	Eja Ice	Nigeria	70%
	Sosai Renewable Energies	Nigeria	70%
	Energy Excell	Nigeria	70%
Cottage industries	Nithya Enterprises	India	70%
Textiles	S.Y Opayemi Enterprises	Nigeria	95%
	Zinsutech	Nigeria	70%
Animal husbandry (Dairy)	Savanna Circuit Tech	Kenya	35%
	Magnum Innovations	India	40%
Metalwork	Energy Excell	Nigeria	5%
Hairdressing	Energy Excell (hair dryers and straighteners only)	Nigeria	90%
ICT	HiSpecs Innovation	Kenya	50%
	SmartBuy	Kenya	50%

Table 2: Percentage end-customers that are female³⁵

³⁴ Some notable exceptions include the case of Kenya-based Savanna Circuit Tech, who expressed that, on average, female customers tend to only use their milk chillers for its intended use, while male customers often use their chillers to chill other products as well.

³⁵ Customer refers to the user of the appliance. Depending on format of data reported by respective suppliers, this is in some cases also the buyer.

2.1 Cooling (refrigeration and freezing)

Cooling is the PUE category with the largest concentration of productive energy solution suppliers. In our market database, 49 out of the 153 productive energy solution suppliers identified during this study offer cooling products and services to microenterprises across India, Kenya and Nigeria. Our research shows the prevalence of both off-grid solar powered cooling solutions as well as grid-powered, AC solutions. While some overlap does exist, impact-first suppliers tend to focus more on off-grid solar solutions, while conventional ones tend to gravitate more towards standard grid-powered AC solutions. Off-grid solar solutions in particular tend to be tailored to the realities of microenterprises in terms of sizing, pricing and payment plans.³⁶ It is also an indication of the utility and value of the cooling business proposition. In India for example, a sample study has shown that 70% of microenterprises that acquired a refrigerator reported an average monthly profit increase of \$57.³⁷ The market opportunity for cooling solutions in India alone is worth \$3.7 billion.³⁸ This has led to

an influx of suppliers and growing sales numbers, placing cooling applications in the growth stage.

Microenterprises targeted by cooling suppliers include vendors of fish, meat, milk, horticultural crops and beverages. These can be grocers, restaurants, canteens, bars and even smallholder farmers. Some suppliers, such as Drop Access in Kenya, specifically supply refrigerators to clinics, to ensure cooling of vaccines and other medical supplies. While we note that most cooling suppliers serve a combination of microenterprises and households, we learned through this research that the majority of customers serviced by suppliers in this sector are microenterprises.

Box 2: Microenterprises as customers of cooling suppliers

In Nigeria, companies such as Eja Ice offer walk-in cold rooms in marketplaces where the only target customers are microenterprises selling fresh produce, while providers of standalone fridges such as Solaristique and Sosai in Nigeria have a productive user penetration rate of 70% and 95% respectively in their overall customer base.

In Kenya, Savanna Circuit Tech, a supplier of milk chillers, offer their services only to customers who use it for income generating purposes, mainly smallholder farmers and cooperatives.³⁹ In India, DD Solar's cold storage services are only sold to enterprises involved in the vending of groceries, fish and milk.

³⁶ While there are suppliers that have managed to achieve the correct product-market fit when serving microenterprises, many still struggle to achieve the correct fit. Pricing is one of the major challenges. More on these challenges in [Section 6](#).

³⁷ Blair, H., Ileri, M. & Maina, M.M., Solar-powered refrigerators on the frontlines of off-grid COVID-19 response, 2022 ([link](#))

³⁸ GOGLA, Powering lives and livelihoods: Scaling productive uses of renewable energy, 2023 ([link](#))

³⁹ According to Savanna Circuit Tech, a typical dairy smallholder farmer in Kenya produces 3-6 litres of milk per day. Savanna's customers pay KES 8 (\$0.06) per litre per kilometre. Farmers typically generate KES 44 (\$0.33) in revenue per litre. Many dairy smallholder farmers are also involved in cottage industries, such as the production of yoghurt.

Table 3 showcases the different cooling products and services on offer by suppliers. These companies

are engaged with one, two or a combination of these offerings.

Cooling type	Description	Supplier examples
Walk-in cold rooms	<ul style="list-style-type: none"> Customers pay for the duration of time that they make use of the cold room and the weight being cooled. Suppliers have varying rates depending on the type of goods being cooled. Cold rooms are either solar powered or grid powered with power ratings ranging from less than 5kW to about 30kW. 	ColdHubs (Nigeria), Eja Ice (Nigeria), EcoZen (India)
Standalone refrigerators and freezers	<ul style="list-style-type: none"> Suppliers offer fridges and freezers either on pay-as-you-go (PAYGO) or outright sales The duration of PAYGO contracts can reach a maximum of 4 years. 	DD Solar (India), Solaristique (Nigeria), Eja Ice (Nigeria), Energy Excell (Nigeria), Sosai Renewable Energies (Nigeria), Drop Access (Kenya)
Cold chain logistics	<ul style="list-style-type: none"> Customers pay for the weight of produce that they transport, per kilometre. Vehicles range from small scooters with cold boxes of 20 litres offered by Savanna Circuit Tech to large cold chain trucks used by Eja Ice. 	Savanna Circuit Tech (Kenya), Eja Ice (Nigeria)

Table 3: Product and service offerings in the cooling PUE sector

2.1.1 Future directions of cooling technologies for microenterprises

The cooling PUE subsector is experiencing constant technological innovation. As this new field continues to develop, suppliers are learning more and more about the needs of microenterprises. **We identified the following technological trends among suppliers as they continue to serve emerging microenterprise needs:**

- Cold rooms are expanding in capacity:** Cold room suppliers are finding that larger cold rooms provide economies of scale, while also meeting the demand for more cooling space, especially in crowded open-air markets. Nigeria-based ColdHubs’ first-generation cold room has a 6kW capacity. The company’s second-generation system has been increased significantly to 25kW fitted with energy storage for back-up energy provision. Detailed resources on technical designs and operations are available from Efficiency for Access.⁴⁰
- Ice making machines are emerging as a valuable bolt-on service:** Based on demand from fish and meat microenterprise customers, suppliers are expanding into the setup of ice points. These ice making machines tend to be powered by generation units of about 20kW.
- Rationalising offerings towards “no frills” solutions:** In order to increase the affordability of products, cooling providers are increasingly looking to disaggregate the value offerings of their products into separate smaller, “no frills” products to cover a more discrete, narrow need. For example, Savanna Circuit Tech in Kenya is aiming to separate their insulated containers from their power and cooling components. This way a customer can buy the insulated container and other cheaper cooling options such as glycol water cooled to -10°C without the refrigeration equipment. This greatly reduces the cost of cooling a litre of milk.

⁴⁰ Efficiency for Access, *Walk-in cold rooms – A practitioner’s technical guide, 2023* ([link](#))

2.2 Food and beverage preparation

In our market database, 38 out of the 153 productive energy solution suppliers identified offer food and beverage preparation products and services to microenterprises across India, Kenya and Nigeria. We see a large concentration of impact-first suppliers in this category, which suggests that products and services offered are tailored to the realities of microenterprises in terms of sizing, pricing and payment plans.

The types of microenterprises targeted in this category include mobile street food and/or juice vendors, restaurants and canteens. Suppliers target a combination of permanent and semi-permanent restaurants and canteens. Cookstoves sold to mobile street food vendors are smaller, with capacities of about 10 litres, while institutional cookstoves sold to larger restaurants and canteens can increase to 200 litres. In the cooking sector, there is high variability in the extent to which suppliers sell their products to microenterprises compared to households. In Kenya, Nairobi-based Zuhura Solutions' and Mombasa-based Kuza Ecoheat's food heating carts are specifically designed to meet the needs of street food vendors, while the percentage of microenterprises in the overall customer base of cookstove suppliers Burn and Mukuru Stoves is only 15% and 21% respectively.

Improved cookstoves

Costing between \$10 and \$40 in Kenya and Nigeria⁴¹ and between \$25-\$40 in India,⁴² these low-cost stoves are designed to burn biomass

more efficiently than traditional Tier 1 stoves. Improved cookstoves are typically regarded as Tier 3 cookstoves on the World Bank's Multi-Tier Framework (MTF) for cooking solutions.⁴³ The thermal efficiency of these stoves range between 50% and 60%. Improved cookstoves are now commonplace: Burn has, for example, sold 4.5 million products across the 20 countries in which it operates, while Mukuru Clean Stoves have already sold 420,000 stoves in Kenya alone since its inception in 2017. This, in addition to the large number of suppliers in this value chain suggests that improved cookstoves can be regarded as mature.

LPG cookstoves

LPG cookstoves are more efficient and cleaner than improved biomass stoves as they replace biomass for gas and also burn more efficiently. Therefore they are regarded as Tier 4 or 5 stoves on the MTF. Naturally prices of these stoves vary widely, but in Nigeria prices average in the \$19 - \$60 range for dual burners,⁴⁴ compared to a \$15 - \$30 range in Kenya.⁴⁵ In Nigeria the average cost of 1kg LPG fuel is ₦1,000 (\$0.67),⁴⁶ yet only 15% of the Nigerian population has access to LPG fuel⁴⁷ due to affordability constraints.⁴⁸ In Kenya the per capita consumption of LPG increased from 2.3kg in 2012 to 7.5kg in 2022,⁴⁹ although all-time high prices reached in March 2024 have hindered the prevalence of LPG cooking.⁵⁰ For these reasons LPG cookstoves are not yet regarded as a mature market in Kenya and Nigeria. In India LPG cookstoves are fully commoditised, with more than 60% of the population having access to LPG stoves and fuels.⁵¹ For this reason LPG is mature in India.

⁴¹ Interview data

⁴² Indiamart, Improved Cook Stove, 2024 ([link](#))

⁴³ The World Bank, Multi-Tier Framework for Measuring Access to Cooking Solutions, 2015 ([link](#))

⁴⁴ Jumia, Gas cookers, 2024 ([link](#))

⁴⁵ Jiji, Gas cooktops in Kenya, 2024 ([link](#))

⁴⁶ Olawin, D., Cooking gas price may drop, 2024 ([link](#))

⁴⁷ Obaniyi, F., Addressing Nigeria's Cooking Energy Crisis and Possible Measures for Change, 2023 ([link](#))

⁴⁸ Ajala, S., Rising cooking gas prices spur rethink of Nigerian household fuels, 2024 ([link](#))

⁴⁹ Ministry of Energy and Petroleum of Kenya, Kenya National Cooking Strategy Transition, 2024 ([link](#))

⁵⁰ Mwangi, K., Consumer pain as cooking gas prices up to record high, 2024 ([link](#))

⁵¹ Dharamji, D., How many Indian households use clean fuel for cooking? 2023 ([link](#))

Electric cookstoves

Electric cookstoves include single induction cookers and pressure cookers. Due to the higher wattage of these technologies, their usage is typically reserved to microenterprises that have access to a stable, grid quality electricity connection. Electric cookstoves are typically Tier 5 stoves. They are yet to find traction among microenterprises, mainly due to their high cost and the need for a stable electricity connection. Burn's ECOA induction cooker retails for approximately \$140, while its ECOA pressure cooker retails for about \$135.⁵² These products are offered in Kenya as well as Nigeria. Our interviews show that in India, despite the widespread electrification of other food processing stages such as roti rolling and chip slicing, the adoption of electric cookstoves among microenterprises remains low.

Food heating carts

Offered by Zuhura Solutions and Kuza EcoHeat in Kenya, these solar-powered carts are not designed for cooking purposes, but rather to keep cooked food heated while the vendor sells their meals and snacks throughout the day. The cart is also fitted with mobile charging compartments and lighting. This is an underdeveloped segment – we only identified



Figure 2: Zuhura Solutions' food heating cart used by a food vendor in Nairobi⁵³

⁵² Burn, *Buy a Jiko/stove*, 2024 ([link](#))

⁵³ Photo credit: Zuhura Solutions

⁵⁴ Photo credit: Aswhini Chaudhary Monty, Unsplash

nine suppliers offering these products across India, Nigeria and Kenya. Therefore we categorise these products in the emerging stage of market maturity.

Juice making machines

Electric-powered sugarcane juice makers, offered by companies like SELCO and Penguin Engineering in India, serve as efficient and eco-friendly alternatives to traditional diesel-based machines. These machines not only enhance operational efficiency but also significantly reduce emissions. Additionally, they can be solar-powered in off-grid areas, further minimising environmental impact.

Food processing equipment

Offered by suppliers such as India-based Blue Star Auto Machinery, these include roti makers, papad makers, banana chip making and vermicelli making machines. These technologies are commonly used by female entrepreneurs and self-help groups (SHGs) in India. They are used as an intermediate stage in food preparation to automate certain tasks while the majority of cooking happens through LPG or improved cookstoves. Roti rolling and papad making machines retail at about \$375 in India, while banana chip cutter and vermicelli machines retail at about \$600.



Figure 3: Typical dual burner LPG cookstove used by a food vendor in India⁵⁴

2.2.1 Future directions of food and beverage preparation technologies for microenterprises

Similar to cooling, the food and beverage preparation PUE sub-sector also experiences ongoing technological innovation as suppliers in this category look to develop offerings tailored to the needs of mobile street food and/or juice vendors, restaurants and canteens. **The following future-looking technological trends are emerging:**

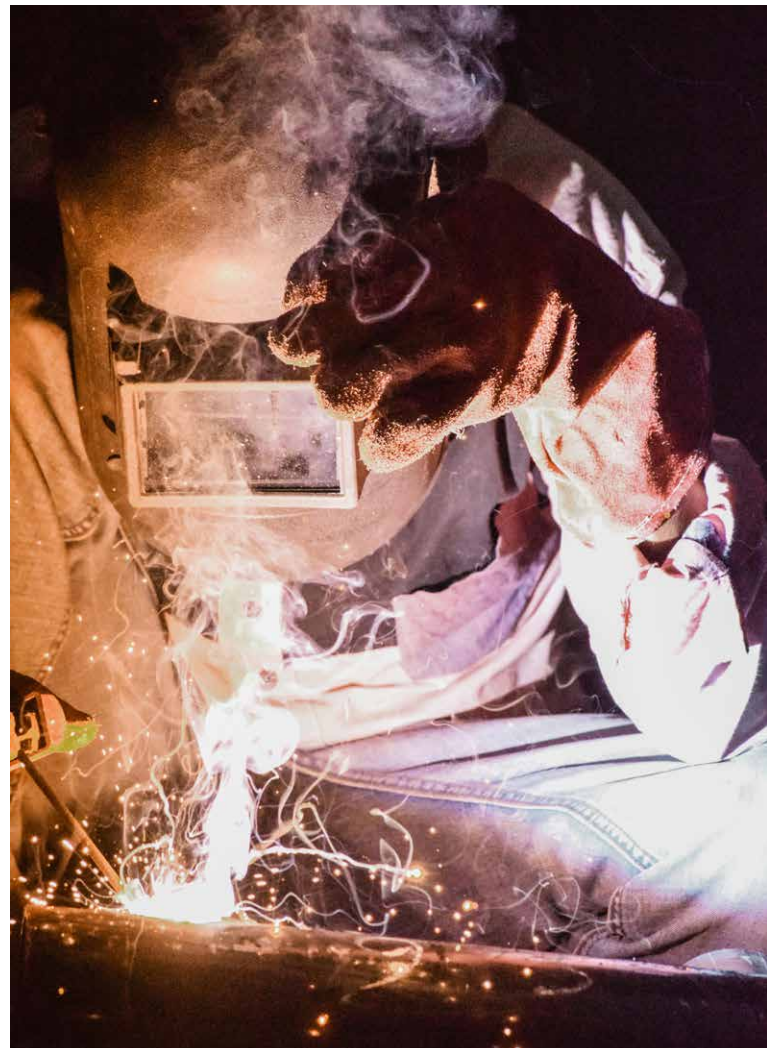
- **Increasing the capacities of electric stoves cost-effectively:** Given the relatively high cost of electric cooking, suppliers had to limit the capacities of these stoves to date in order to remain affordable for microenterprises living below a living income. These tend to average at around 8 litres, but suppliers are assessing ways to increase this to 12 litres and upwards without increasing costs substantially.
- **Bolt-on of complementary products and services:** Suppliers are increasingly recognising that their cookstoves serve as a type of “anchor product” on top of which additional services relevant to microenterprises could be added. For example, almost all of the electric cooking providers interviewed are adding lighting and mobile device charging services. Others, like Mukuru Stoves in Kenya, are venturing into the development of fuels. Mukuru is developing a mosquito repellent fuel to address the challenge of malaria. Similarly, Zuhura Solutions is currently piloting a hybrid heating and cooking trolley, which will enable food vendors to simultaneously cook food (with bioethanol) and keep the meals heated while waiting for buyers.

2.3 Metalwork

Despite the significance of metalwork as an economic activity in all the markets investigated, across the three countries we identified only 20 companies supplying one or a combination of metalwork machines. These include welding

machines, fan blowers, power hammers and angle grinders. Despite this, welding machines are widely used by microenterprises. Low value added tax (VAT) rates and import duties applied to these products suggests that governments are in support of growing local manufacturing industries. In Kenya, welding machines are exempted from VAT and import duties while in Nigeria a 0% VAT rate and 5% import duty applies.⁵⁵ Standard rates apply in India.

Suppliers in this category typically operate in a dual capacity as wholesalers and retailers. Insights from supplier interviews seem to suggest that metalwork microenterprises are concentrated in urban areas. Energy Excell, a Nigerian supplier of welding



⁵⁵ See Table 9 for a full outline of tax and duty rates applicable to each PUE product in India, Kenya and Nigeria.

machines to mini grid operators and directly to microenterprises note, for example, that it is rare for two or more welding entrepreneurs to be based in the same rural village.

Small inverter-based welding machines are most appropriate for microenterprises, compared to high-capacity gas fuelled machines. Among identified suppliers, these smaller systems start off at around \$30. High-capacity welding machines can cost hundreds and even thousands of dollars. Angle grinders are a well-used and versatile metal working tool. Those offered by suppliers identified in our database across the three countries have power ratings ranging from 750W to 1500W. Prices range from \$50 on the lower end to \$140 for higher capacity machines.

2.3.1 Future directions of metalwork technologies for microenterprises

While there are locally made, crude metalworking machines in all three countries, none of the suppliers interviewed are engaged in the manufacturing of metalwork machines. Most machines traded in India, Kenya and Nigeria are mass produced

in China and South Korea.⁵⁶ Therefore local suppliers have limited involvement in future technological innovation trends when it comes to metalwork machines. A trend we do see emerging is the need among local suppliers to deliver cost effective, quality-verified small capacity electrically powered machines to meet the small-scale needs of microenterprises.

2.4 Carpentry

Carpentry machines applicable to microenterprises include side planers, power drills and wood lathe machines. All types of small-scale carpenters can be regarded as relevant microenterprises for the purchase of these products. The carpentry machines mentioned here would typically be used by microenterprises to manufacture furniture such as chairs, tables, beds, windows and doors. From a supplier perspective, carpentry is closely linked to metalwork, as we see the same suppliers operational in both categories. The main type of suppliers is large, conventional companies that offer their products on a wholesale basis as well as on retail. Many of these suppliers also offer large, industrial woodworking machines which are not relevant to microenterprises.

Product type	Description	Supplier examples
Side planers	Power ratings of side planers usually range between 650W and 850W. Prices among identified suppliers range between \$20 and \$100, with upper end products offering high surface quality.	C. Woermann (Nigeria), GZ Industrial Supplies (Nigeria), Metro Tools (Kenya), Mikasa Trading (Kenya), Padmavati Engineering Works (India), SELCO (India), Macire (Kenya)
Power drills	Power drills used by most woodworking microenterprises are smaller capacity machines typically ranging between 450W and 750W. Prices among identified suppliers range between \$65 and \$115.	
Wood lathe machines	Wood lathe machines are high-capacity machines and prices are accordingly high in all countries studied. Contrary to other woodworking machines, lathe machines are not as readily available. Prices tend to range between \$330 and \$550.	

Table 4: Typical woodworking machines offered by identified suppliers

⁵⁶ Local manufacturing of welding machines is performed in India by companies such as Ador Welding Ltd, Weldfast Electrodes, Sai Arc India and Electra Welding Machines.

Similar to the metalwork PUE sub-sector, carpentry suppliers interviewed are not engaged in the manufacturing of machines. Most machines traded in India, Kenya and Nigeria are mass produced in China. This means that, again, local suppliers have limited involvement in future technological innovation trends when it comes to these machines.

2.5 Textiles

Microenterprises are integral to the cotton and silk sectors of the textile industry, handling everything from raw material procurement to garment sewing. These businesses are crucial for preserving traditional crafts without depending on large-scale machinery. In the cotton value chain, microenterprises perform ginning, separating cotton fibres from seeds, while both cotton and silk chains involve spinning, weaving, dyeing and sewing. These processes are essential for transforming raw materials into finished products. However, these activities can be physically demanding and impact artisan health due to the drudgery and demanding nature of the work.

To alleviate this, PUE technologies like cotton spinning machines, power looms, and sewing machines are employed. Sewing machines have been electrified for decades, representing a mature technology. Trade in sewing machines is in general well supported by the governments of India, Kenya and Nigeria. In India, these machines attract reduced 6% central goods and services tax (CGST), 6% state goods and services tax (SGST) and 12% integrated goods and services tax (IGST) rates while in Nigeria a reduced import duty of 5% applies. In Kenya, sewing machines are fully exempt from both import duties and VAT. Table 9 presents all tax and duty rates applied to sewing machines and other PUE products covered by this study.

In contrast to sewing machines, the electrification of spinning machines and power looms is still evolving for products relevant to microenterprises. These are issues which emerging companies are actively addressing.

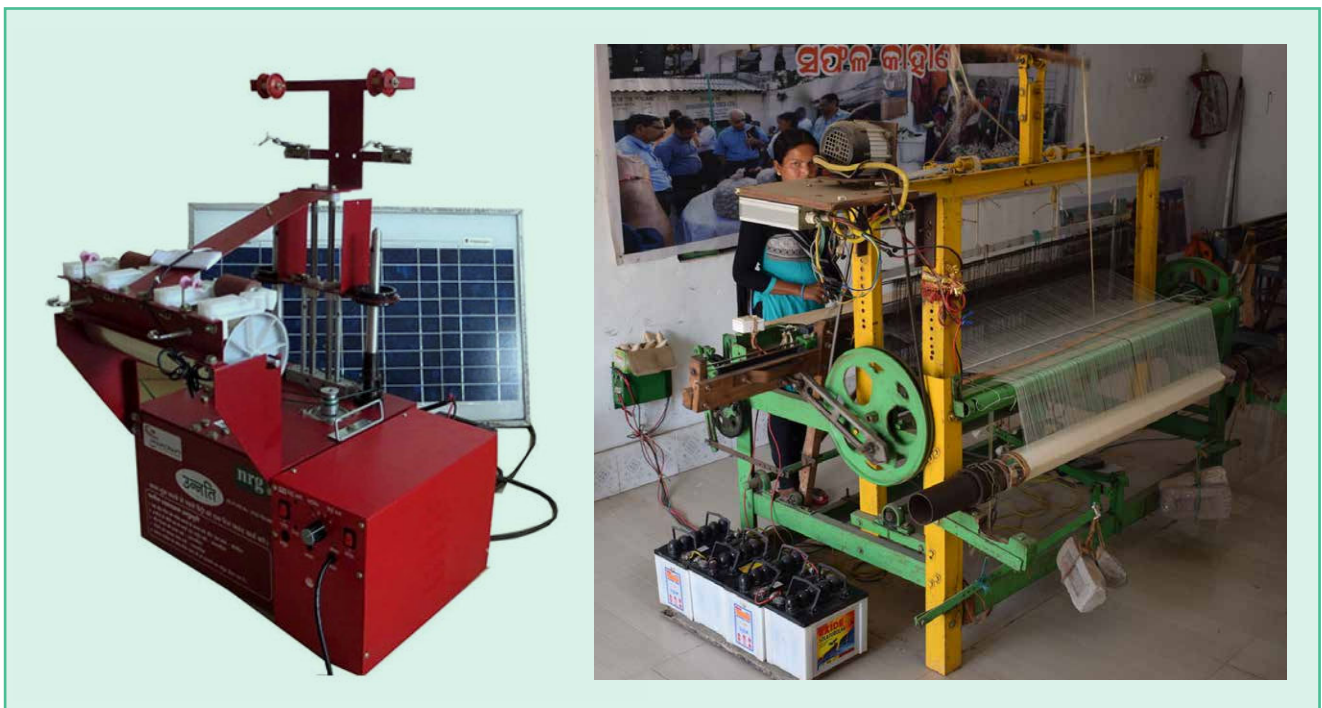


Figure 4: Spinning machine (left) and weaving machine (right)⁵⁷

⁵⁷ Photo credits: Resham Sutra

Our database includes 20 suppliers with the majority of the companies from Kenya and Nigeria supplying sewing machines, while in case of India, some suppliers focus on spinning and weaving machines (looms). Our interviews with suppliers such as Zinsutech and S.Y Opayemi Enterprises, as well as an analysis of the product catalogues of various other suppliers reflect that prices of small sewing machines relevant to microenterprises (50W-100W) start off at \$40, while high-tech premium sewing machines are sold for approximately \$200. In India, spinning and weaving machines are generally expensive. 2-spindle solar powered spinning machines retail for \$500 on average, while solar-powered semi-automatic weaving machines cost \$2,000 on average.

Going forward, interviewed suppliers will be looking to ramp up their offerings of spare parts as they have noted a significant emerging need for repairs and maintenance of these machines. In a similar vein, we also note an uptick in maintenance services offered to customers. In the case of the latter, the supplier does not sell spare parts, but rather offers a fully-fledged maintenance service to customers that initially bought their products.

2.6 ICT

The ICT category is dominated by conventional suppliers. We did not identify any donor funded impact-first suppliers offering ICT equipment (laptops, desktop computers and printers). Internet cafés and general businesses offering digital services are the typical microenterprise customers in this PUE category. ICT equipment is however relevant to all types of microenterprises as the use of these devices can help microentrepreneurs run their businesses more efficiently. It follows that increased adoption rates of such equipment can have a substantial impact on the livelihoods of microentrepreneurs across PUE sub-sectors in all countries. The governments of the three countries seem to acknowledge this fact. As Table 9 shows, all ICT equipment covered in this study attracts a 0% import duty in India.⁵⁸ In Kenya, laptops and desktop computers attract a 0% import

duty. In Nigeria, laptops and desktop computers attract a 5% import duty, but in contrast to India and Kenya, they are exempt from VAT.

Interviewed ICT suppliers indicated that there has been an increase in the number of women purchasing ICT equipment. Nairobi-based Hi-Specs Innovative Solutions noted for example that female business owners purchasing ICT products use it for setting up point of sale systems and printing services alongside their day-to-day businesses such as hairdressing. It notes, however, that the share of microenterprises in its overall customer base is rather low, at only 20%. The remaining customer base is divided into larger businesses and private individuals.

ICT companies operating in the retail space would typically partner with courier service companies to deliver to microenterprises in remote locations. Given limited consumer awareness of the technical specifications of the machines, the ICT companies interviewed pointed out that they offer consultancy and training services to help their customers get the best value for their money and establish trust in service and product delivery.



Figure 5: Hi-Specs Innovative Solutions owner Peter Ngugi at his business premises⁵⁹

⁵⁸ 9% CGST, 9% SGST and 18% IGST rates do however apply. See Table 9 for more details.

⁵⁹ Photo credit: Kelvin Kamande

2.6.1 Future directions of ICT technologies for microenterprises

As with metalwork and carpentry, interviewed ICT suppliers are only engaged in the importation, wholesale and retail of laptops, desktop computers and printers. In India, Lenovo and HP have local manufacturing facilities. We note minimal emerging technological trends among these global manufacturers towards the specific needs of bottom-of-the-pyramid microenterprises. Instead, smaller ICT manufacturers serving a specific need tend to develop products more geared for the needs of microenterprises living below a living income. The ICT suppliers interviewed mentioned that they experience an increase in microenterprises buying point of sale solutions. These suppliers are increasingly looking to stock more of these products in order to serve this growing demand.

Further afield, Madagascar-based Jirogasy developed a solar-powered desktop computer for off-grid areas. Their Jirodesk 2 system runs on a 12V/24Ah battery powered by a 100W PV panel. The computer can run for 5 hours without electricity.⁶⁰ Given limited grid access in Kenya and Nigeria and power reliability issues on the national grids of all three countries, solutions like the Jirodesk 2 can support microenterprises to run their businesses in off-grid areas and during blackouts in grid-connected areas.

2.7 Animal husbandry

Animal husbandry activities studied in this report include dairy milking and egg incubation. Capacities of egg incubation machines relevant to microenterprises include 48, 64 and 96 eggs. Suppliers that we consulted with do also offer larger capacity incubation machines, ranging from incubators with 528 egg capacity to incubators that can incubate 10,000 eggs. Starting prices for the smallest capacity incubators (48 eggs) do not vary

widely across the countries, ranging between \$85 and \$110. These incubators typically require an external power source.

Microenterprises targeted by dairy milking machine and dairy chiller suppliers are typically smallholder farmers. **Small capacity mobile milking machines are most relevant to smallholders:**

- These machines typically have a capacity of milking eight cows per hour equating to a recommended herd size not exceeding 16 cows;
- They tend to be fitted with one bucket (reservoir for milk) and one cluster;
- Given that milking machines can create an affordability issue for smallholder farmers living below a living income, suppliers also sell to dairy cooperatives, who avail the machine to their members.

Milking machines identified in this study typically require an external grid power source, but examples of solar-powered machines exist, such as those offered by India-based Ksheera Enterprises. Machines on offer vary in capacity, but a 12V DC-powered 150W milking machine would include a 35Ah battery.⁶¹ The company notes that the milking time ranges between 4 and 7 minutes per cow. Prices range between 15,000 and 48,000 INR (\$180 - \$570) depending on capacity. A study conducted by Efficiency for Access from 2021 to 2022 noted that the use of these machines reduced milking time by 4 minutes per cow and drudgery by a minimum of 70% among 25 dairy farmer respondents in Karnataka State.⁶²

⁶⁰ Jirogasy, Jirodesk 2, 2024 ([link](#))

⁶¹ Ksheera Enterprises, Battery operated milking machine, 2024 ([link](#))

⁶² Efficiency for Access, Evaluating appliance performance in the field – Results from milking machine testing, 2023 ([link](#))



Figure 6: A women's SHG assessing milk quality in Latur District, Maharashtra, India⁶³

Given the importance placed on animal husbandry sectors by the governments of Kenya and Nigeria, dairy milking machines and egg incubators enjoy relatively low VAT rates and import duties. In Kenya both of these products have no VAT or import duties applied to them, while in Nigeria they attract a 5% import duty rate and 0% VAT rate.⁶⁴

Interviews with suppliers of egg incubators have shown that while these machines add considerable value to the operations of smallholder poultry farmers, many are starting to show interest in buying chicks from suppliers instead of hatching eggs themselves. Going forward, suppliers are aiming to expand their offerings to include this service.

2.8 Cottage industries (India focus)

Indian cottage industries play a crucial role in empowering women by enabling income generation directly from their homes. Specialised equipment like paper plate making machines, cotton wick making machines and rope making machines have transformed traditional crafts into viable businesses. These technologies provide women microentrepreneurs with the means to produce goods efficiently, enhancing their economic independence and contributing to household income. Suppliers in this category are typically conventional types, often in a dual capacity as

⁶³ Photo credit: Prashanth Vishwanathan/Ashden

⁶⁴ See Table 9

wholesalers and retailers. It is also commonly seen that the suppliers offering cottage industry technologies supply multiple technologies along with cooking technologies. This ensures steady revenues throughout the year for these suppliers. The insights from supplier interviews suggest that these technologies are in a growth stage with

suppliers identifying growing demand for these products and new entrants entering the market. The cost of the paper plate making machine starts from \$750, reaching up to \$2,500. The cost of cotton wick making machines is about \$275, while solar-powered rope making machines retail for \$650 (including the solar generation system).



Figure 7: Plate making machine⁶⁵



Figure 8: Cotton wick machine⁶⁶

⁶⁵ Photo credit: Nithya Enterprises

⁶⁶ Photo credit: SaiDhan Enterprises

2.9 Hairdressing and barbershops (Kenya and Nigeria focus)

In even the smallest villages across Kenya and Nigeria it is usually possible to find the ubiquitous barbershop, usually a man, trimming the hair of other men using electric clippers for a small fee. Our conversations with barbers across Africa indicate that it is a good business, with relatively low start up capital costs and regular customers. In our experience, equipment is distributed into rural areas through very informal supply chains; village market stalls and small, regional wholesalers.

Female hairdressing in these contexts usually consists of hair braiding and other non-mechanised,

manual processes. Occasionally, where electricity is available, equipment like hair dryers and straighteners (2,000W and 1,000W respectively, on average) are used although this is less common than the clipper-equipped barbershop. Once again, the supply chains that feed these markets are largely informal and in the case of larger hairdressing equipment, often dealing in second-hand equipment.

Suppliers such as Solibrium Solar and Sunami Solar include hairdressing equipment (typically shavers and clippers) in their solar product offerings, which otherwise includes solar lights, chargers, TVs and fans.⁶⁷ Hairdressing equipment are also on offer by generalist stores and online retailers, who sell these products in combination with a host of other commoditised products.



Figure 9: A barbershop on a remote island in Lake Victoria, Kenya⁶⁸

⁶⁷ For example, Sunami Solar's hairdressing product comes with a 2x15W solar panel, 14AH battery, 2 charging points, 6 bulbs and 1 portable hair shaver. The product is available on a lease-to-own basis, requiring a customer deposit of KES 4,000 and a daily lease instalment of KES 95. The tenor period is 600 days.

⁶⁸ Photo credit: Sam Duby

3

INDIA PUE LANDSCAPE



3.1 Introduction to microenterprises in India

Table 5 presents key indicators on the microenterprise landscape in India. The largest concentration of

microenterprises is found in the animal husbandry sector followed by cooling. Within animal husbandry, 8.4 million microenterprises operate in the poultry sector, while 1.8 million operate in the dairy sector.

		Data	Notes and data sources ⁶⁹
Total number of MEs		63 million (unincorporated)	Unincorporated enterprises ^{70,71} in India constitute the informal sector, as estimated by the National Sample Survey (NSS) Office of India. Of the 63 million enterprises, 85% are own account enterprises, which are typically run without any permanent employees.
Percentage of MEs that are women-owned		20.4%	NSS data includes the working owners of the unincorporated enterprises, which shows 13 million out of 63 million are female working owners.
MEs per PUE sector	Cooling	Total: 6.6 million Female-owned: 1.3 million	Data on women-owned microenterprises in all sectors except for cottage industries in India is available in Economic Characteristics of Unincorporated Non-Agricultural Enterprises in India by NSSO.
	Retail food/ beverage preparation	Total: 1.5 million Female-owned: 0.3 million	
	Metalwork and carpentry	Total: 0.9 million Female-owned: 2,371	
	Textiles	Total: 2.6 million Female-owned: 1.4 million	
	Egg incubation	Total: 8.4 million Female-owned: 6 million	
	Milking	Total: 1.8 million Female-owned: 990,000	
	Cottage industries	Total: Data unavailable Female owned: Estimated 70%	
Percentage contribution to GDP		8.6%	As per NSS data, gross value addition from unincorporated enterprises is Rs. 11.5 Lakh Crore compared to GDP of Rs. 136 Lakh Crore in 2015-16.
Percentage of MEs that are unregistered		70%	According to NSS data, only 30% of the total estimated 63 million enterprises were registered under various industry specific acts/authorities.
Percentage of labour force		Estimated 16%	As per the Periodic Labour Force Survey report, ⁷² the Labour Force Participation Rate in urban and rural areas of India is 50.4% and 60.8% respectively. This results in a total labour force of 696 million (considering the urban and rural population of 377 million and 833 million respectively). As per NSS data, 111 million workers work in unincorporated enterprises, which is 16% of the country's labour force.

Table 5: Overview of the microenterprise landscape in India

⁶⁹ National Sample Survey Office of India, *Economic Characteristics of Unincorporated Non-Agricultural Enterprises in India, 2016* ([Link](#))

⁷⁰ Note that in the Indian context unincorporated enterprises refer to those that are not registered under the Companies Act, but can still be registered with various other industry-specific acts and authorities.

⁷¹ Enterprises covered by the NSS are microenterprises as per the Indian definition in terms of turnover per year.

⁷² PLFS, Annual Report, 2023 ([Link](#))

In India, women own 20.4% of the country's MSMEs, the majority of which are single person micro and informal businesses (95.6%).⁷³ Historically, women in India have started businesses out of a need to support their family rather than a desire to become an entrepreneur. However, some recent data is encouraging, indicating that there is an increase in younger women, between the ages of 20-30 at the time of starting up, who are 'willing' entrepreneurs.⁷⁴ Female entrepreneurs in India face challenges with restrictive gender norms which limit their access to credit, training, networks and markets. Accessing finance is difficult for women due to their lack of collateral and ingrained biases against lending to women. Low education levels of women are also a contributing factor to female enterprises being predominantly subsistence enterprises in the informal sector. Overall the female literacy rate in India is only 64%, compared to 82% in the case of men. There is a direct correlation between states with higher literacy rates and the number of female entrepreneurs.⁷⁵ Capacity building programmes, especially as it relates to vocational training, tend to favour male entrepreneurs.⁷⁶

According to NSS data, only 30% of the total estimated 63 million enterprises were registered under various industry specific acts or authorities. In India, government support for unincorporated enterprises in the informal sector is notably lacking when compared to the assistance provided to registered MSMEs. This registration is critical because government schemes and subsidies, such as the Emergency Credit Line Guarantee Scheme (ECLGS), Prime Minister's Employment Generation Programme (PMEGP), Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE), Micro and Small Enterprises Cluster Development Programme (MSE-CDP), and the Scheme of Fund for Regeneration of Traditional Industries (SFURTI), are primarily designed for registered enterprises. As a consequence unincorporated enterprises, which are often part of the informal sector, face

significant barriers to accessing government support. According to NSS data, only about 2% of unincorporated non-agricultural enterprises received financial assistance from the government.

3.2 PUE supplier landscape

Productive energy solution suppliers in India are typically conventional enterprises. Donor funded impact-first suppliers are only operational in the cooling, textiles and cottage industry sub sectors. Overall, impact-first suppliers only account for 5% of identified suppliers in India.

Suppliers of PUE technologies in India play a crucial role in manufacturing, assembling, or importing these devices, but other ecosystem players and non-governmental organisations (NGOs) also play a role in enhancing the supply chain by ensuring these technologies reach microenterprises. These organisations, such as Collectives for Integrated Livelihood Initiatives (CINI), SELCO Foundation and Sustain Plus focus on identifying the needs of communities at the bottom of the economic pyramid and facilitate the provision of necessary technologies by collaborating with suppliers. They serve as vital connectors between suppliers and microenterprises through their development programs, often emphasising the adoption of solar-powered PUE technologies.

⁷³ Microsave Consulting, *Decoding Government Support to Women Entrepreneurs in India- The anatomy of entrepreneurship schemes*, 2022 ([Link](#))

⁷⁴ Chakraborty, S. & Mukherjee, R., *Women's Entrepreneurship In India*, 2020 ([Link](#))

⁷⁵ Mathew, A., *Making it in India*, 2019 ([Link](#))

⁷⁶ Mathew, A., *Making it in India*, 2019 ([Link](#))

Box 3: The important role of NGOs in PUE supply chains in India

SELCO Foundation works with both the end users and suppliers of PUE in identifying and developing suitable technologies of PUE. They have a 3-step approach for developing PUE solutions; **innovation, scaling and institutionalisation:**

- The innovation stage includes a needs assessment where SELCO works with end users to identify applications for PUE. Then, they conduct market research for identifying relevant equipment suppliers and assess technological feasibility based on available technologies;
- This is followed by a growth stage which includes the deployment of solutions developed from the innovation stage in small pilot projects and refining the technology through continuous feedback;
- Finally, the most suitable technologies are institutionalised by working with local and national-level stakeholders through integration at the policy level.

With specific programs across agriculture, animal husbandry and microenterprises, SELCO has developed more than 200 PUE solutions. The organisation mainly focuses on solar-integrated PUE applications.

Sustain Plus Energy Foundation does similar work, with SELCO as its one of founding partners along with CInI and Social Alpha. Through Sustain Plus, NGOs with their own strength in different regions collaborate to work across the country.

To support the demand for solar-powered technologies, several companies act as system integrators, combining traditional grid-powered devices with solar energy systems. Notable suppliers in this category include Selco Solar Light Private Limited and Pushan Renewables. These integrators work closely with suppliers to provide sustainable, solar-integrated solutions to microenterprises.

All Indian suppliers identified are locally owned and typically operate on an outright sale business model. They sell either directly to the end user or indirectly via an intermediary. Indirect sales are typically made via NGOs who facilitate the sale to the end customer. This is common among players like Blue Star, Ksheera Enterprises and Pushan Renewables. Others, such as SaiDan Industries, make use of a local distributor network in order to cater to demand across India.

PAYGO and other credit models are considerably less prevalent among Indian suppliers, mainly due

to the high prevalence of conventional suppliers. In contrast to donor funded impact-first suppliers, conventional ones tend to only make use of outright sales models. These suppliers are able to do so because banking has a high penetration even in rural regions in India, thus creating a smaller need for PAYGO as compared to Nigeria and Kenya.

3.2.1 PUE financing trends

Suppliers of PUE technologies in India employ predominantly single proprietorship models and are often unincorporated. This is the case among most identified suppliers like SaiDhan Industries, Nithya Enterprises, Ksheera Enterprises, Blue Star Auto Machinery, AP Poultry and Magnum Innovations. These suppliers are commonly run through the proprietor's funds and partly by bank loans. The dependency on bank loans is limited to short-term needs. For example, Blue Star Auto Machinery seeks bank financing primarily to manage supplier payments during periods of unplanned orders.

The Government of India introduced various support programs to provide financial help for MSMEs, which can also be accessed by the PUE suppliers. The Fund of Funds with a corpus of Rs. 10,000 crore, is aimed at providing equity funding to viable and promising MSMEs with growth potential.

The Reserve Bank of India regards micro and small enterprises as a priority sector for lending. Many banks offer collateral-free loans to MSMEs, including the State Bank of India, HDFC Bank, ICICI Bank and Axis Bank. However, during interviews, suppliers raised some concerns about collateral-free loans. Although beneficial, the application process is often cumbersome, making these loans unsuitable for their more common short-term financing needs. Additionally, non-banking financial companies (NBFCs), small finance banks (SFBs), regional rural banks (RRBs), and microfinance institutions (MFIs) are also sources of financing for MSMEs. These funding offerings are not necessarily tailored to the needs of impact-first suppliers. Instead, they are standard loan offerings applicable to any sector of the economy.

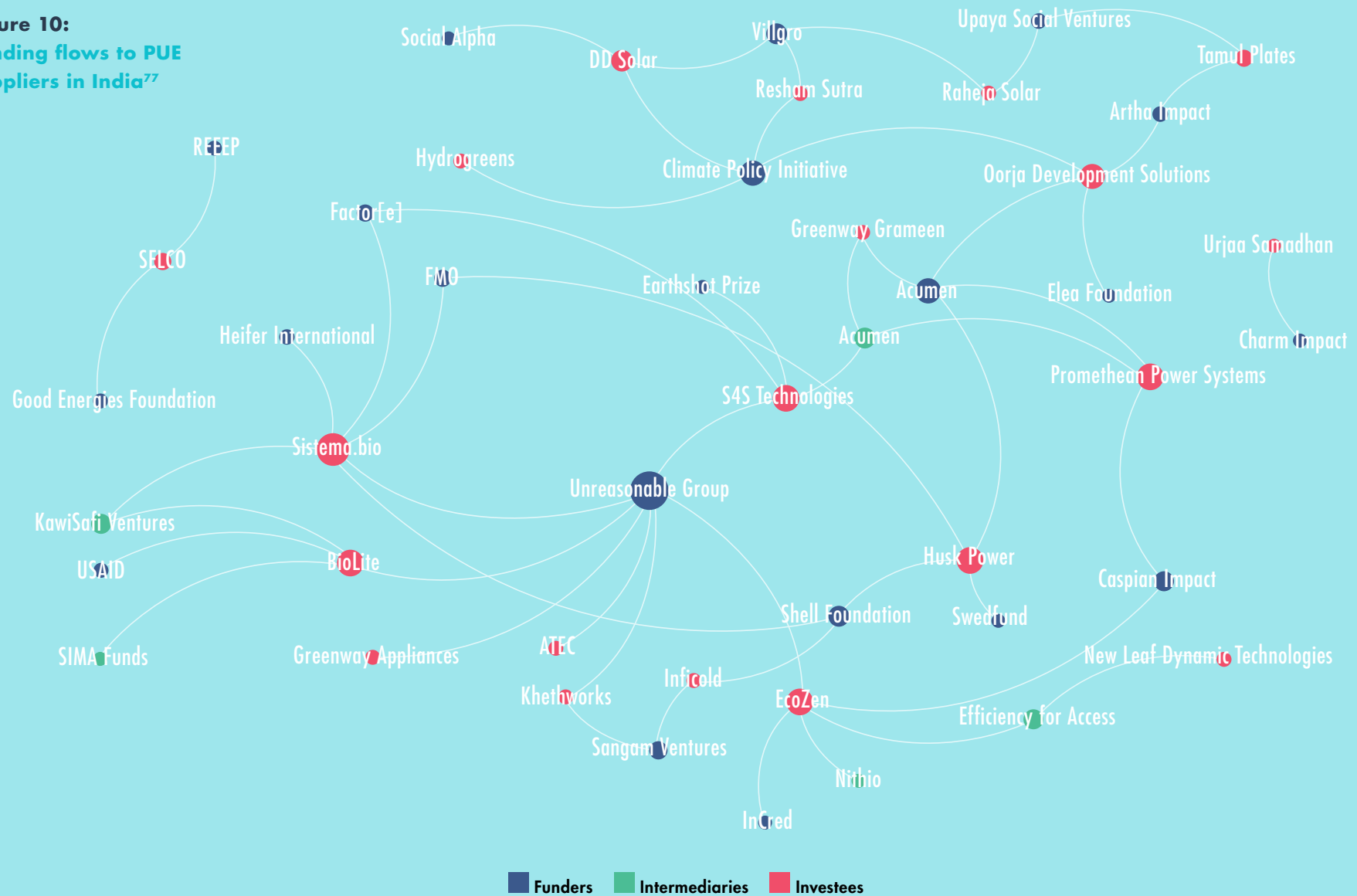
Indian impact-first suppliers typically depend on external finance while conventional suppliers depend on organic growth. Figure 10 presents an overview of investments made in Indian PUE suppliers. The overwhelming majority of deals reflected here were closed between donors and impact-first suppliers. Tracking standard bank loan disbursements is notoriously challenging as details of these are rarely published. This map is therefore not exhaustive nor completely representative of the funding landscape in India. It does, however, offer a useful glance at how development finance flows to PUE in India.

The funding source for impact-first companies include local impact investment firms like Villgro, Upaya Social Ventures, Sangam Ventures, SocialAlpha and Caspian. These institutions typically focus their efforts on seed and early-stage support. Upaya Social Ventures offers seed funding of \$50,000 along with critical advisory support to small and growing businesses, aiming to create significant impact. This seed funding is designed to help businesses scale and achieve their developmental

goals. Similarly, Sangam Ventures focuses on the energy and environmental tech sector, providing investments ranging from \$0.5 to \$2 million to seed and early-stage companies. This supports innovative startups in crucial early growth phases. Social Alpha Fund-1 operates within a similar investment range of \$0.5 to \$2 million, specifically targeting agriculture and farming companies at the seed stage. Caspian, on the other hand, specialises in debt financing for clean energy companies. Its flexible debt solutions enable these companies to manage their working capital efficiently, scale operations rapidly, and attract further investments from private equity and venture capital at more favourable valuations.

The India PURE Finance Facility (IPFF) by the Climate Policy Initiative, and Powering Livelihoods by a consortium of the Council on Energy, Environment and Water (CEEW) and the Villgro Foundation offer technical advisory services for financing, capital support, capacity-building support, and sectoral growth support for companies in PUE sector.

Figure 10:
Funding flows to PUE suppliers in India⁷⁷



⁷⁷ TFE analysis.

Gender dynamics affecting the supplier financing landscape in India

India lags behind other countries covered in this report in terms of gender dynamics and access to finance. Across the economy, only a quarter of the financial needs of women-led MSMEs are being met. Financial inclusion is low and research shows that the majority of women do not make autonomous decisions on how to spend their money.⁷⁸ Not having decision making power over their own money limits women's ability to grow their businesses.

As a result, despite the fact that 20% of India's businesses are led by women,⁷⁹ they only contribute 3% to overall industrial output.⁸⁰ Female-owned businesses tend to be micro businesses, concentrated in the informal sector, contrary to the formal conditions of the PUE supplier sector. In the DRE sector, by extension a largely formal sector,⁸¹ female participation at large has declined from 23% in 2018 to 20% in 2022.⁸² We estimate that the prevalence of companies owned and led by women

is even lower. Among PUE suppliers identified in this study, only three are female-owned. Across sectors, only 2.7% of medium-sized businesses are women-led. Research indicates that women-owned businesses experience a 2.5% higher rejection rate for loans than male owned businesses;⁸³ a major contributing factor to the small share of formal businesses led by women.

Interviews with female owned enterprises confirms this picture. Female owned company **Magnum Innovations** for example reported difficulties accessing loans from banks due to lack of assets in their name and lack of confidence to approach financial institutions. All of this creates a negative feedback loop which in turn means that women do not have credit history which makes it even harder for them to access loans. Given emerging evidence that women-owned, staffed and managed suppliers (especially local ones) reach more female customers,^{84,85} the lack of finance accessed by these suppliers means that fewer women microenterprises benefit from PUE solutions.

Box 4: Local support platforms for women-led businesses in India

The [Women Entrepreneurship Platform](#) aims to strengthen industry linkages and increase awareness of existing programs among female enterprises. It provides access to programs for incubation and acceleration, entrepreneurship skills and mentorship, marketing assistance, funding assistance, compliance and tax assistance, and community and networking. Similarly, the Small Industries Development Bank of India operates the [Stand-Up India scheme](#), which provides loans up to Rs. 1 crore to women entrepreneurs for setting up new ventures in the manufacturing, services, or trading sectors.

⁷⁸ Kumar, S., *Financial Inclusion of Women: Current Evidence from India*, 2023 ([Link](#))

⁷⁹ Indian Ministry of Micro, Small and Medium Enterprises, *Annual Report, 2022* ([Link](#))

⁸⁰ *The Economic Times*, *Women-led MSMEs in India rise 75% to 8.59 lakh units in FY22: Govt data, 2022* ([link](#))

⁸¹ Only about 23% of companies in the Indian DRE sector are considered to be informal.

⁸² *Power for All, Powering Jobs Census 2022: The Energy Access Workforce, 2022* ([link](#))

⁸³ *Goldman Sachs, Breaking Barriers: Unlocking the Potential of Women Entrepreneurs, 2022* ([Link](#))

⁸⁴ *ESMAP, Gender equality in the off-grid solar sector, 2022* ([link](#))

⁸⁵ *ESMAP, GOGLA & Dalberg, Off-Grid Solar Market Trends Report, 2024* ([link](#))

4

KENYA PUE LANDSCAPE



Photo by Illustrate Digital Ug on Pexels

4.1 The landscape of microenterprises in Kenya

Microenterprises in Kenya employ an estimated 83% to 93% of the country's workforce, rendering it highly important for the economic growth of the country. Table 6 presents data on key indicators

regarding the microenterprise landscape in Kenya. The largest concentration of microenterprises is found in the wholesale and retail trade sector. These microenterprises represent the target market for cooling PUE suppliers. 3.7 million microenterprises operate in this sector.

		Data	Notes and data sources ⁸⁶
Total number of MEs		7.29 million (1-9 employees)	Represents the sum of unlicensed microenterprises (5.85 million as per 2016 KNBS report) and licensed microenterprises (1.44 million, which represents 92.2% of all licensed MSMEs as per the report).
Percentage of MEs that are women-owned		55% (1-9 employees)	32.3% of licensed MSMEs are female owned and 60.7% of unlicensed MSMEs are female owned. As there is no data for female ownership of MEs specifically, we assume that these MSME percentages apply to MEs too. As such we calculate that there are 465,000 licensed female-owned MEs (0.323 x 1.44 million) and 3.5 million unlicensed MEs (0.607 x 5.85 million). Together, this equates to 3.97 million female-owned MEs, which represents 55% of all (7.28 million) MEs. ⁸⁷
MEs per PUE sector	Cooling	Total: 3.7 million Female-owned: 2 million	Data on women-owned microenterprises in each sector in Kenya is unavailable. To provide an estimation, we have assumed a blanket approach by applying the statistic of 55% of all MEs being women-owned to the total number of MEs per sector in Kenya.
	Retail food/ beverage preparation	Total: 532,800 Female-owned: 290,000	
	Metalwork, carpentry and textiles	Total: 700,000 Female-owned: 385,000	
	ICT	Total: 12,400 Female-owned: 7,000	
	Egg incubation	Total: 3.7 million ⁸⁸ Female-owned: 2 million	
	Milking	Total: 1.8 million ⁸⁹ Female-owned: 990,000	
	Hairdressing	Data unavailable	
Percentage contribution to GDP		12% (1-9 employees)	Data directly sourced from 2020 Sessional Paper on SMEs (see footnote 86)

⁸⁶ Kenya data collected from: Kenya National Bureau of Statistics, MSME Basic Report, 2016 ([link](#)). Percentage contribution to GDP and percentage of labour force data were unavailable in this report. Data for these points were collected from: Kenyan Ministry of Industrialisation, Trade and Enterprise Development, Sessional Paper no. 05 of 2020 on Kenya Micro and Small Enterprises Policy, 2020 ([link](#))

⁸⁷ This correlates closely to data reported by the Federation of Kenya Employers, which states that 58.5% of microenterprises in Kenya are female-owned. For reference: Federation of Kenya Employers, The Informal Economy in Kenya, 2021 ([link](#))

⁸⁸ Refers to poultry smallholder farmers (owning 5-30 birds). Data collected from: FAO, Livestock and livelihoods spotlight in Kenya - Cattle and poultry sectors, 2018 ([link](#))

⁸⁹ Constitutes a subset of agriculture. Data collected from: Kenyan Ministry of Livestock Development, Kenya National Dairy Master Plan, 2010 ([link](#))

Percentage of MEs that are unregistered		80%	Total number of unregistered MEs (1-9 employees) equates to 5.85 million, which represents 80% of all MEs (7.29 million).
Percentage of labour force		Estimated 93%	Our 93% estimation is derived from Kenya's 2020 Sessional Paper on SMEs, which reports that micro- and small enterprises collectively employ 93% of Kenya's labour force. Data for microenterprises specifically is unavailable. It is probable that the approximate percentage of the labour force employed by microenterprises specifically is around 83%. This is based on the fact that the vast majority of SMEs are MEs as well as data reported by the Federation of Kenya Employers. ⁹⁰

Table 6: Overview of the microenterprise landscape in Kenya

The approximate 4 million female-owned microenterprises in Kenya are mostly found in the informal sector. Female-owned microenterprises represent 61% of unlicensed microenterprises, but only 33% of licensed microenterprises. There are a number of reasons for this phenomenon, but discrepancies between levels of education between women and men is a key factor. Capacity building programmes typically do not discriminate on the basis of sex, but it is clear that women-owned microenterprises struggle to access these opportunities due to systemic barriers already mentioned. Limited awareness of training and capacity building programmes contributes. Aside from lack of education, female Kenyan entrepreneurs also experience comparatively lower levels of access to capital. In many areas, men control the finances in the household, meaning women do not have control over the income they make from their business. Women's low education and limited access to technology such as mobile phones or computers also mean they are less able to access networks and forums to support innovation and marketing or collecting of data. Research conducted by Solar Sister⁹¹ found that many of the Solar Sister entrepreneurs did not have access to a smartphone, very few had access to a computer and data literacy was very limited.⁹² Violence against women is also commonplace and

tolerated in many settings which means women face insecurity in their roles as entrepreneurs, particularly in male dominated technical sectors. Whilst Kenya does have some solid legal frameworks in place for women's economic rights, implementation is weak and there is limited investment in enforcement of these rights.

80% of all microenterprises in Kenya are unregistered and do not qualify for critical government support programmes such as the Microenterprise Loan Product offered by Kenya's Financial Inclusion Fund, the Credit Guarantee Scheme offered by the National Treasury through on-lending arrangements via local banks and the Inuka Enterprise Programme funded by the Kenya Bankers Association. Microenterprises typically require formal registration in order to qualify for standard forms of formal credit. A mere 1% of unregistered enterprises in Kenya access capital from commercial banks.^{93,94} Reports indicate that Kenyan microentrepreneurs typically circumvent this issue by borrowing in their individual capacities and channelling the funds to their businesses.⁹⁵ Reasons cited for the low willingness among microenterprises to register include high cost of compliance with tax, social security and labour laws, as well as bureaucratic procedures and delays.

⁹⁰ Federation of Kenya Employers, *The Informal Economy in Kenya, 2021* ([link](#))

⁹¹ *On enabling female clean energy entrepreneurs in last mile communities in Sub Saharan to use data to improve sales.*

⁹² Farley et al., *Connecting Last Mile Women Entrepreneurs With Data: A Study About Solar Sisters Gender Data Journey, 2023* ([link](#))

⁹³ Federation of Kenya Employers, *The Informal Economy in Kenya, 2021* ([link](#))

⁹⁴ *A handful of support programmes target unincorporated MEs, such as the Personal Loan Product offered by Kenya's Financial Inclusion Fund.*

⁹⁵ Federation of Kenya Employers, *The Informal Economy in Kenya, 2021* ([link](#))

Box 5: The significance of the informal sector in Kenya

Jua Kali – ‘under the fierce sun’ in Swahili – is a term used to describe the informal manufacturing sector in Kenya. The roots of *Jua Kali* arise in the Western Kenyan capital of Kisumu, where it is said that African car mechanics, originally trained by local Indian mechanics, set up their own informal businesses outside, to fix the increasing numbers of lorries and *matatus* (minibus taxis) plying the roads. The sector has grown significantly over the years, spreading nationally and encompassing diverse sectors as metalwork, carpentry, garment manufacturing, automobile repair, primary manufacture and all manner of smaller, supporting suppliers and businesses.

It is estimated that in Kenya, this informal economy accounts for over 95% of businesses and entrepreneurs.⁹⁶ According to the Informal Sector Federation of Kenya, *Jua Kali* employs almost 15 million people accounting for over 80% of the workforce and, according to Kenya’s Economic Survey Report, contributes 25% to national GDP. Kenya is not unique. Worldwide it is estimated that the informal sector encompasses half of the global employment and more than 90 percent of SMEs. As is evident, the significance of these informal sectors cannot be overstated.

The Organisation for Economic Co-operation and Development (OECD)/International Labour Organisation have defined the informal economy as “all the economic activities, excluding illegal activities, by workers and economic units that are in law or practice either not covered or insufficiently covered by formal arrangements.” **They are characterised by similar challenges:**

- **Limited access to capital:** This means entrepreneurs cannot invest in better equipment and are limited to producing lower quality outputs that are sold cheaply, locking them in a cycle of poverty.
- **Lack of quality and standardisation:** Low quality feedstock and a lack of product standardisation reinforces this downward pressure on quality and sale price. Distributors and equipment suppliers that service *Jua Kali* workshops often complain about Africa being a ‘dumping ground’ for low quality goods (such as tools, screws and nails) from Asia.
- **Inadequate training and skills:** According research undertaken in 2024,⁹⁷ most *Jua Kali* artisans gained their skills via apprenticeship (86.3%) while a small percentage (12.7%) trained in Technical Vocational Education Training (TVET) institutions and a further one percent gained their skills in their former employment.
- **Limited market access and marketing skills:** Low levels of education, training and poor ICT access translate to limited ability to access broader markets or gather feedback on products. Businesses are largely word-of-mouth based, further limiting scalability.
- **Fragility:** A lack of access to capital, small market and low margins translate to a lack of resilience to any business shock. Very few *Jua Kali* businesses survive longer than five years.

It should be noted that because of near ubiquitous gender inequality dynamics across Africa, nearly all of these challenges are compounded for females operating in the sector.

The lack of formalisation and data makes the study of the informal sector challenging. This includes studies of the workshops and artisans themselves as well as the value chains of suppliers and distributors supporting them. The lack of data should not, however, be translated into an underestimation of the size or significance of these industries relevant to PUE. For this reason, this research tries to triangulate multiple sources, anecdotal and academic alongside our own experience.

⁹⁶ Safavian, M. S., Wimpey, J. S., & Amin, M., *Informal enterprises in Kenya (English)*, 2016 ([link](#))

⁹⁷ Momanyi, C., *Decent Work in the Informal Sector and Economic Growth: Jua Kali Artisan Businesses’ Sustainability Challenges in Eastlands of Nairobi*, 2024 ([link](#))

4.2 PUE supplier landscape

63% of Kenyan suppliers that we were able to collect ownership data on are locally owned, and the remaining 37% are foreign owned. Female ownership of these companies seems to be low. 39% of interviewed Kenyan companies have some degree of female ownership. We note that female-owned suppliers are largely successful in PUE categories with a large proportion of female customers. One interesting insight from our interviews comes from Mukuru Clean Stoves who noted a positive advantage with being a female owned company in regard to their ability to understand the needs of their cookstove customers, who are 90% female. This in itself is an important finding, and is confirmed by other research.⁹⁸

We note that interviewed suppliers involved with local manufacturing tend to be operational in the cooling and cooking PUE sectors. These suppliers are nevertheless also involved in importation processes as most of them import input materials used in their manufacturing processes. Conversely, suppliers in the ICT and animal husbandry (egg incubation and dairy milking) sectors do not perform any local manufacturing at all, instead opting to import stock from China or procure stock locally in some cases.

As is the case in other countries, donor funded impact-first suppliers tend to be concentrated in the cooling and cooking PUE category and to a lesser extent in the hairdressing category. Animal husbandry, ICT, textiles, metalwork and carpentry categories are dominated by conventional suppliers. We further note that impact-first suppliers are more likely to engage in manufacturing, while conventional ones tend to engage more in importation or local purchasing of finished goods. Given that conventional suppliers operate with the goal of selling standard products to any willing buyer, there is less of a need to manufacture products tailored to the specific needs of bottom of

pyramid customers. Impact-first suppliers conversely design and manufacture products tailored to the specific and sensitive needs of bottom of pyramid customers.

The use of PAYGO and other customer credit schemes are more pronounced among impact-first suppliers. This is often a necessity as bottom of pyramid customers served by these suppliers typically do not have the means to spend large lump sums on upfront purchases. Conversely, conventional suppliers, who do not exclusively focus on bottom of pyramid customers, are not forced by the limited ability to pay of their customers to implement PAYGO schemes. Having a target market that includes customers with a relatively higher ability to pay means that they can limit their sales model to outright sales because their customers have the means to pay the full price upfront. To offer customer credit schemes, most suppliers need financing, and conventional self-funded suppliers typically do not operate on external financing. Kenya also has favourable infrastructure in place, supported by relatively favourable macroeconomic conditions, to facilitate the use of PAYGO.⁹⁹

We further note differences between Kenyan suppliers that **transact directly** with end customers and those that **transact indirectly** through intermediaries. Two types of **indirect model** emerged among interviewed suppliers:

1. **Sales via agents:** Companies such as Mukuru Stoves and Solar Sister sell their products to end users via agents. In the case of Mukuru, the agent receives commission on each sale. Ownership of the product transfers directly from the company to the end user, instead of the agent buying and reselling. Agents are specifically selected because they are members of the communities that the companies seek to sell their products to. It is believed that the agents know best how to reach the intended market.

⁹⁸ 60Decibels, *Why Off-Grid Energy Matters*, 2024 ([Link](#))

⁹⁹ For more details see Section 6.3

Box 6: PAYGO and credit schemes offered by Kenyan PUE suppliers

Zuhura Solutions' food heating cart has a PAYGO system that allows vendors to input a purchased token. The token cost represents instalments that add up to eventually owning the trolley and is set at KES 190 per day. Ownership is typically transferred after 24-30 months. The daily instalment is equal to the amount food vendors spend on charcoal or other fuels on a daily basis, according to market research conducted by Zuhura. Payments are made with mobile money via M-PESA.

Savanna Circuit Tech's mobile dairy chillers are offered to smallholder dairy farmers, used to transport milk to markets. The company's cooling-as-a-service offering requires farmers to pay KES 8 (\$0.06) per litre per kilometre after making about KES 44 per litre. According to Savanna Circuit Tech, farmers typically generate KES 44 (\$0.33) in revenue per litre.

Dairy Systems and Services offer its dairy chillers on a standard customer loan to select customers. The credit facility targets big projects with terms extending up to 90 days. This can extend to 6 months on a per-case basis. Financial resources to support the credit facility are sourced through loans from banks.

Hi-Specs Innovative Solutions prefers to sell its laptops and printers on an outright sales basis, but does offer 30-day terms to select microenterprise customers.

2. Sales via local distributors: This model is especially relevant among suppliers that have manufacturing facilities abroad or companies with a large distribution network. For example, Omnivoltaic sell their products to local distributors in Kenya, without engaging with the end customer.

Elsewhere suppliers also sell indirectly via **energy providers**, but we did not identify any noticeable use of this sales avenue among interviewed Kenyan suppliers. Under this model, suppliers use energy providers such as mini grid operators as intermediaries, who on-sell PUE solutions to their customers.

4.2.1 PUE financing trends

Consistent with the funding landscape in India and Nigeria, Kenyan impact-first suppliers typically depend on external finance while conventional self-funded suppliers mainly depend on organic growth. It must be noted, however, that conventional suppliers opt to self-fund usually not by choice. The likes of SmartBuy and Kuku Farmers

reported their dependence on organic revenues to date but also expressed the need for external finance to continue growing their businesses. Figure 11 presents the funding flows to Kenyan PUE suppliers that have managed to raise funding from external sources. While this map is not exhaustive of all investments made in Kenya to date, it does offer a useful and representative overview of the nature of funding for PUE in Kenya. **Analysing this visualisation of our PUE funding database provides evidence for a number of salient points pertaining to the nature of external finance in this sector:**

- **Development finance institutions remain the main source of funding for PUE:** A glance over the source of funding (blue and orange nodes) immediately shows that donors dominate the funding landscape, especially among impact-first suppliers. Furthermore, the high number of investments made by the likes of EEP Africa, Shell Foundation and SIMA Funds (represented by the high number of links to companies) shows the interest of these organisations in PUE.

- **Funders either invest directly into companies or indirectly through funds and facilities:** For example, Efficiency for Access managed the Global LEAP Off-Grid Cold Chain Challenge, with funds raised from the IKEA Foundation, FCDO, Good Energies Foundation and the DOEN Foundation.
- **Government sources of funding also feature:** PUE-related disbursements from the World Bank-funded and Ministry of Energy-implemented Kenya Off-Grid Solar Access Project (K-OSAP) have been made by SNV into companies such as African Clean Energy and Solar Integrated Technologies Limited.
- **Only a relatively small number of companies tend to be successful at signing deals with investors:** Funding dynamics expressed in Figure 11 indicate that the largest share of all deals identified during this research have been signed with a small number of companies, such as Bboxx, InspiraFarms, Burn, Sistema.bio, Drop Access and Solar Panda. This does not necessarily imply that these companies attract the largest share of total funding in the sector, although a correlation may exist. **There are some common characteristics among companies that have been successful in attracting funding:**
 - **They are impact-first companies.** This is a result of an investor pool dominated by donors. The investment mandates of these organisations (e.g. Shell Foundation, US Africa Development Foundation and EEP Africa) are to catalyse development through PUE, among other interventions.
 - **Impact-first Kenyan companies that have attracted the majority of available funds are concentrated in the cooling and cooking value chains:** This illustrates that suppliers in these value chains have been able to successfully penetrate their target markets.
 - **Most are multinational companies:** This is likely the result of a snowball effect: Increased levels of external finance enable suppliers to expand their operations. Expanded operations in turn aid suppliers in securing follow-up funding and also attract larger deal sizes.
 - **Few are 100% locally owned.** Among Kenyan suppliers that have been able to raise external funds, only Drop Access is fully locally owned.

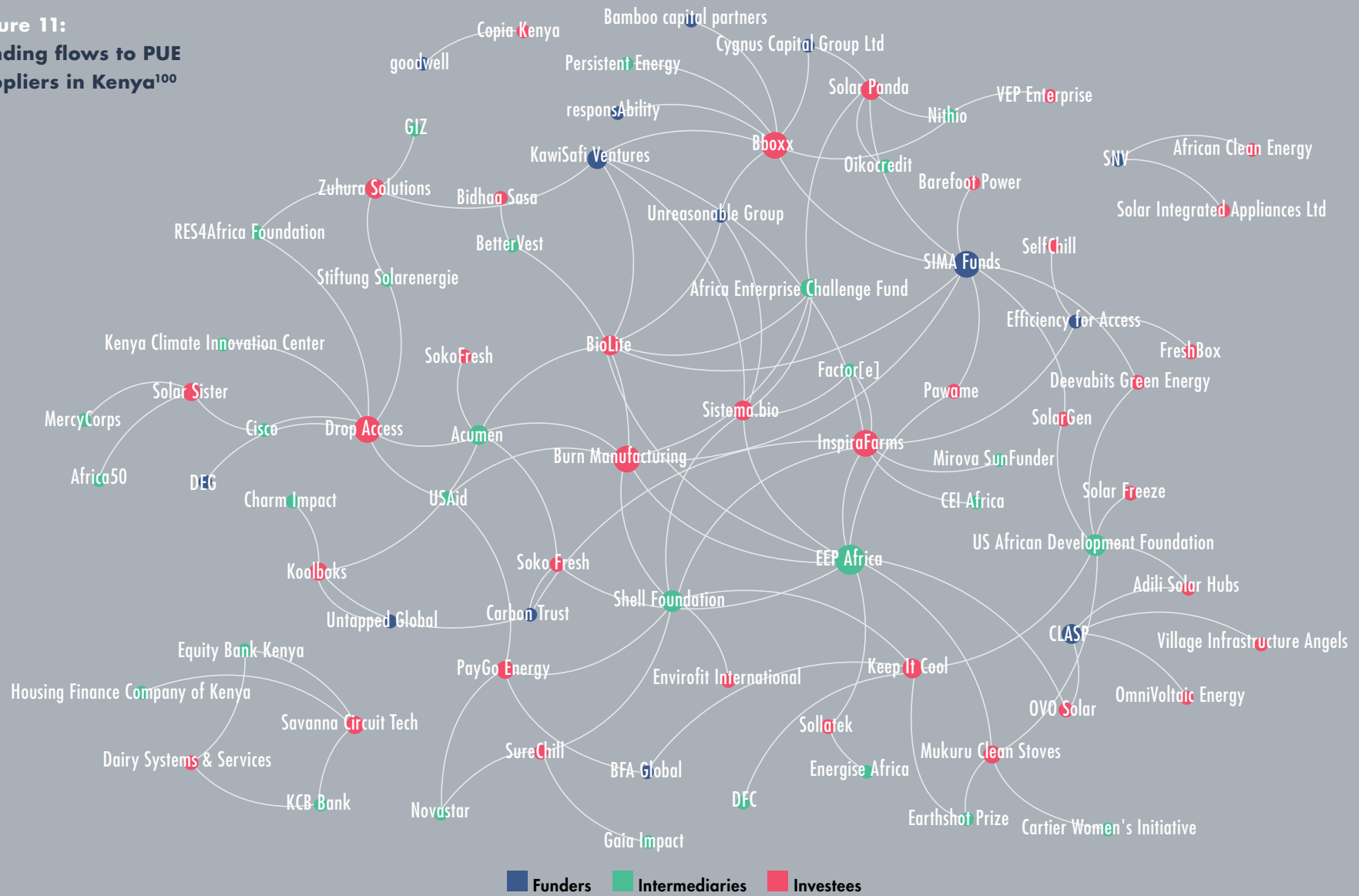
Crowdfunding platforms like Bettervest and Kiva are particularly useful in filling the ticket size gap. Kiva offers ticket sizes not exceeding \$500,000 and tenors of up to 36 months. Bettervest provides larger loans that range from EUR 100,000 to EUR 5 million, the lower end of which is still applicable to the typical scenario of suppliers not being able to absorb large amounts of capital.

While it might seem that commercial finance is absent, it must be noted that commercial banks play an important role in Kenya. Conventional suppliers (for example Dairy Systems and Services) are funded more regularly by local commercial lenders. KCB Bank, The Housing Finance Company of Kenya, Equity Bank Kenya and Co-operative Bank of Kenya are debt providers who have standard offerings for MSMEs. Loan tenors reach up to 5 years (typically for secured borrowing), offered by Equity Bank and KCB Bank. Loan amounts start at Kes 1,000 and can increase to Kes 250 million (as evidenced by KCB Bank's secured SME loan offering). Interest rates vary between 13% on the low end (as a base lending rate) and 20% on the high end.

SACCOs and MFIs is yet another non-development finance source of funding for suppliers. Both Hi-Specs Innovative Solutions and Neo Chicks, a supplier of egg incubators, note for example that in addition to ploughing their profits back into their businesses, they have borrowed from SACCOs and MFIs. The decision to opt for SACCO and MFI financing is usually in response to high interest rates that commercial banks have in place.

Other local funders include the likes of the Kenya Climate Innovation Centre (KCIC), which offer funding to seed and early-stage businesses in local currency. This fills the gap that often exists due to the high number of financiers/funding programmes that offer ticket sizes in foreign currency, mainly Euros and USD. KCIC offers debt, equity and grant funding to SMEs in Kenya that work towards developing innovative ways of addressing climate change.

Figure 11:
Funding flows to PUE
suppliers in Kenya¹⁰⁰



¹⁰⁰ TFE analysis.

Gender dynamics affecting the supplier financing landscape in Kenya

Kenya's gender gap in financial inclusion has narrowed significantly in the last few years, to 4.2% in 2021.¹⁰¹ Female participation in the DRE sector (which employs approximately 50,000 people) has grown significantly from 23% in 2018 to 40% in 2022, spread relatively evenly across skilled, semi-skilled and unskilled work.¹⁰² The prevalence of women-owned and led businesses in DRE and specifically the PUE sector is estimated to be low. 50% female ownership is relatively common, seen among suppliers including Savanna Circuit Tech and Kuku Farmers. Improving the familiar structural barriers impeding women from starting their own businesses and then supporting them to become investment-ready is essential for changing the narrative of extremely little funding attracted by women-owned businesses in the DRE and PUE space.

Our interviews with Kenyan female owned PUE suppliers indicate the same challenges around accessing funding. **Drop Access**, a predominantly female owned company (60% female and 40% male) manufacturing and supplying solar refrigerators in Kenya, notes that despite various campaigns to ensure support to female entrepreneurs, access to funding is still a key challenge. To promote investment into women-owned businesses such as Drop Access, British International Investment has published a diagnostic guide for investors to assist in applying a gender lens in evaluating investments.¹⁰³ Muku Stoves noted their success in reaching female customers is largely attributable to being female owned and having the lived experience of the negative consequences of open charcoal fires. Therefore it stands to reason that increased investment in female-owned and led suppliers, enabled through gender lens investing, can greatly increase the number of women microenterprises benefiting from PUE solutions.

Box 7: Local support platforms for women-led businesses in Kenya

Kenya's Vision 2030¹⁰⁴ has a strong emphasis on expanding women's access to financial services and promoting female led enterprises through initiatives such as the [Uwezo Fund](#) and the [Women Enterprise Fund](#). Similarly, the Safaricom Women in Business programme, launched in 2017, builds the capacity of female-owned companies through a network and mentorship programme as well as partnerships with financial institutions that provide financing.¹⁰⁵ Notably, Stanbic Bank's Dare to Aspire, Dare to Achieve (DADA) platform offers financial and non-financial services for women to help them launch and grow businesses.¹⁰⁶ In the DRE and PUE sector the Women in Energy Enterprises in Kenya programme has reached significant success, having assisted 360 female entrepreneurs to grow their businesses with 70% reporting increased sales.¹⁰⁷

¹⁰¹ FinAccess, *FinAccess Household Survey, 2021* ([Link](#))

¹⁰² Power for All, *Powering Jobs Census 2022: The Energy Access Workforce, 2022* ([link](#))

¹⁰³ British International Investment, *Gender sector brief: Off-grid solar, 2022* ([link](#))

¹⁰⁴ Government of Kenya, *Social Pillar #69, 2007* ([Link](#))

¹⁰⁵ Safaricom, *Sustainable Business Report, 2020* ([Link](#))

¹⁰⁶ Stanbic Bank, *Stanbic Bank Kenya Foundation Blog, 2020* ([Link](#))

¹⁰⁷ Practical Action, *Women in Energy Enterprises in Kenya – WEEK2, 2022* ([link](#))

5

NIGERIA PUE LANDSCAPE



5.1 Introduction to the landscape of microenterprises in Nigeria

Table 7 presents key indicators on the microenterprise landscape in Nigeria. The largest concentration of microenterprises is found in the retail sector. 12.1 million microenterprises operate in this sector.

		Data	Notes and data sources ¹⁰⁸
Number of MEs		33 million (1-2 employees)	Refers to nanoenterprises specifically. Calculated based on data from Nigeria’s 2021 MSME survey report. As per the report, Nigeria has 172,232 registered nanoenterprises, and 32,862,245 unregistered ones, which together totals 33 million. <i>Additional note:</i> Nano enterprises represent 85.6% of all microenterprises in Nigeria.
Percentage of MEs that are women-owned		33% (1-9 employees)	Gender disaggregated data in Nigeria is only available for nano- and microenterprises collectively (as it is defined by the bureau of statistics). Due to nano enterprises ¹⁰⁹ constituting the majority share of enterprises (85%), it is our opinion that this gender disaggregated data is still a reliable estimation of female ownership in the nano enterprise sector.
MEs per PUE sector	Cooling	Total: 12.1 million Female-owned: 6.5 million	
	Retail food/ beverage preparation	Total: 1.2 million Female-owned: 1 million	
	Metalwork, carpentry and textiles	Total: 1.4 million Female-owned: 820,684	
	ICT	Total: 197,124 Female-owned: 26,885	
	Egg incubation	Data unavailable	
	Milking	Data unavailable	Pastoralists and smallholders own 95% of the country’s cattle, therefore estimated millions.
	Hairdressing	Data unavailable	
Percentage contribution to GDP		46.3%	Data sourced directly from Nigeria’s 2021 MSME survey report, and covers MSMEs collectively. Note however that microenterprises comprise 96.9% of MSMEs and nanoenterprises comprise 86.6% of microenterprises. It can thus be logically assumed that the vast majority of the 46.3% contribution to GDP is made by nanoenterprises.
Percentage of MEs that are unregistered		99.5% (1-2 employees)	Refers to nanoenterprises specifically. Calculated based on data from Nigeria’s 2021 MSME survey report. As per the report, Nigeria has 172,232 registered nanoenterprises, and 32,862,245 unregistered ones. The latter represents 99.5% of the total.
Percentage of labour force		87.9% (1-9 employees)	Data sourced directly from Nigeria’s 2021 MSME survey report. Data only available for nano- and microenterprises collectively.

Table 7: Overview of the microenterprise landscape in Nigeria

¹⁰⁸ National Bureau of Statistics of Nigeria, MSME Survey Report, 2021 ([link](#))

¹⁰⁹ Nano enterprises in Nigeria are defined in the same way as microenterprises are defined by the Shell Foundation. See the glossary for more details.

The approximate 11 million female-owned microenterprises in the country are mostly found in the wholesale/retail, manufacturing and accommodation and food services.^{110,111} Like in Kenya, women who run their own business face cultural and structural barriers which restrict their access to finance and capacity building programmes and limit their control over household assets. For example, financial institutions often require husbands to serve as guarantors for women's financing.¹¹² Access to financing is also dependent on whether women are in urban or rural areas and in which region of the country they are in. Interviews with Nigerian female entrepreneurs¹¹³ show that women in the more commercially developed Southern parts have easier access to finance. In the last five years, only 2.8% of investment in women-owned businesses was disbursed to Northern Nigeria. Similar reports emerge from our interviews with Nigerian suppliers. Engie Energy Access reports that due to cultural and religious beliefs in northern Nigeria, uptake of PUE machines offered by Engie Energy Access among women is low. The company notes that only 30% of customers purchasing PUE machines in the north are female.

While capacity building programmes specifically targeting female-owned microenterprises would offer a solution to the limited access that women experience in this regard, reports suggest that the presence of such programmes can be vastly increased. Those that are available tend to target urban areas and women with a certain education and skill level.¹¹⁴

Virtually all of the 33 million microenterprises in Nigeria are unregistered. The downside of non-registration is similar to the realities in India and Kenya. Unregistered microenterprises are typically

excluded from most government support programmes and despite efforts to accommodate the realities of informal microenterprises and their workers in social security programmes, implementation has largely faltered.¹¹⁵ Microentrepreneurs typically avoid registration for similar reasons as Kenyan microentrepreneurs: Costly registration processes, inefficiencies inherent in compliance processes, corruption and taxation.¹¹⁶

As far as access to capital is concerned, evidence gathered to date however seems to suggest that registered microenterprises are not considerably better off than unregistered ones. Of unregistered microenterprises that have been able to access funding,¹¹⁷ only 0.4% were able to access grants and 9.5% in the case of loans. 56.8% of unregistered microenterprises have to depend on personal savings and 21.9% on family sources. Yet the reality for registered microenterprises is only marginally better. Only 1.2% have been able to access grants and 15.4% loans, while 59% depend on personal savings and 16.7% on family sources of funding.¹¹⁸

5.2 PUE supplier landscape

Nigerian suppliers are almost evenly spread in terms of local versus foreign ownership. 53% of companies that we were able to collect ownership data on are locally owned, and the remaining 47% are foreign owned. Half of the interviewed Nigerian companies have some degree of female ownership, although only three are fully female owned.

As with Kenya, we note that suppliers in the cooling and cooking PUE sectors are more likely to perform local manufacturing, while procuring their input materials from abroad. Conversely, Nigerian suppliers in the ICT sector do not perform any

¹¹⁰ Nigeria Bureau of Statistics, MSME Survey Report, 2021 ([link](#))

¹¹¹ See Table 7 for a full breakdown of female-owned microenterprises per PUE sector.

¹¹² ENERGIA, Energy Access and Gender in Nigeria, Policy Brief, ([link](#)).

¹¹³ Shokunbi, S., Women-led businesses in north Nigeria struggle for funds, 2022 ([link](#))

¹¹⁴ ILO, National Assessment of Women's Entrepreneurship Development in Nigeria, 2022 ([link](#))

¹¹⁵ Sesan, T., Enabling Social Protection within the Informal Economy, 2021 ([link](#))

¹¹⁶ Etim, E. & Daramola, O. The Informal Sector and Economic Growth of South Africa and Nigeria: A Comparative Systematic Review, 2020 ([link](#))

¹¹⁷ Note that, in the Nigerian context, this includes a combination of microenterprises (1-9 employees) and nanoenterprises (1-2 employees). Nano enterprises make up 85.6% of this group, which implies that this data is largely applicable to enterprises with up to 2 employees.

¹¹⁸ National Bureau of Statistics of Nigeria, MSME Survey Report, 2021 ([link](#))

local manufacturing, instead opting to import stock from China or procure stock locally in a few cases. Impact-first suppliers tend to be concentrated in the cooling and cooking PUE categories. Animal husbandry, ICT, textiles, metalwork and carpentry categories are dominated by conventional suppliers.

Nigerian suppliers have a preference for outright sales of products. As [Section 6](#) explains in further detail, domestic macroeconomic conditions create significant barriers that inhibit Nigerian suppliers from extending PAYGO and other credit schemes to their customers. Other reasons for the low prevalence of PAYGO and other customer credit schemes also exist. The owner of Zinsutech, a small but experienced sewing machine supplier in Lagos, notes that demand for their products have increased to such an extent that customers are willing to pay the full price upfront. This has eliminated the need to extend credit to their customers. In Zinsutech's experience this increased demand emanates from a growing domestic textiles and garments industry in Nigeria. We further note that in general conventional, non-donor funded suppliers in all PUE categories are less likely to implement customer

credit schemes as they target market segments that have the ability to pay the full product price upfront.

Box 8 details some isolated success stories of Nigerian suppliers that have been able to continue extending credit to their customers. In addition to these reports, other suppliers extend credit to customers, but this is only for a select few trustworthy customers. Terms are typically shortened to a maximum of 3 months and suppliers usually ask for deposits of at least 50%.

We further note differences between Nigerian suppliers that **transact directly** with end customers and those that **transact indirectly** through intermediaries. Three types of **indirect model** emerged among interviewed suppliers:

1. **Sales via agents:** Companies such as Solar Sister sell their products to end users via agents. Solar Sister's agents first buy the products from the organisation on an outright sale basis before distributing to end-users. Agents are specifically selected because they are members of the communities that the companies seek to sell their products to.

Box 8: PAYGO and credit schemes offered by Nigerian PUE suppliers

Sosai Renewable Energies offers a PAYGO payment model enabled by PaygOps and Angaza. Customers pay a 20% deposit and the remainder over the course of 3 to 24 months for solar home systems. Contract periods extend up to 4 years for bigger products such as freezers.

Eja Ice offers a cooling-as-a-service model where customers can lease a cold room, a cold van or purchase a standalone freezer box on an instalment basis. Customer credit for standalone freezers boxes is financed by third parties. Eja Ice takes responsibility for introductions, while the ongoing PAYGO contract is handled by local financing institutions that include Baobab, FCMB Bank, Sterling Bank and Sunfi. The PAYGO period is mostly 1 to 36 months.

Engie Energy Access purchases welding, carpentry and sewing machines as well as refrigerators and freezers from local suppliers and sells these to their customers on a deferred payment basis. Their lease-to-own model involves instalment payments spanning 10 to 12 months following a down payment. Machines are also offered on a pay-per-service basis. With this model, Engie Energy Access retains ownership of the machines and customers only pay a fee on a per-case basis.

- 2. Sales via energy providers:** Others, such as Energy Excell, use mini grid operators as intermediaries, who on-sell welding machines, hairdressing equipment and cooling solutions to their customers.¹¹⁹ Mini grid operators Sosai Renewable Energies and Engie Energy Access are examples of energy providers who purchase PUE equipment from suppliers and on-sell to their customers. For example, Sosai offers fridges and freezers purchased from Koolboks and Eja Ice to their customers.
- 3. Sales via local distributors:** This model is especially relevant among suppliers that have manufacturing facilities abroad or companies with a large distribution network. For example, Burn manufactures their cookstoves in Kenya and sells their products in Nigeria via local distributors. An interesting model is employed by Abuja-based HTS Farms, whereby the company operates an e-commerce platform for vendors to sell agricultural equipment and inputs including egg incubators to approximately 10,000 monthly website visitors from across Nigeria.

5.2.1 PUE financing trends

Consistent with the funding landscape in India and Kenya, even the smallest Nigerian impact-first suppliers that we interviewed have been able to raise some external grants. Interviews with Nigerian suppliers in the conventional self-funded group show that these suppliers tend to depend on their own organic revenues to grow their businesses. Zinsutech for example only obtained one loan during the course of its long existence, from the Lagos City Government 5 years ago for ₦5 million (\$14,000 at the time). The company also makes use of microfinance loans but interest rates can be as high as 40%. In the animal husbandry sector, HTS Farms has not raised external funds before but has expressed the need to raise capital to grow their business. The same applies to Energy Excell, a supplier of metalwork, cooling and hairdressing

equipment and S.Y Opayemi Enterprises, a supplier of sewing machines.¹²⁰

In cases where suppliers do raise external funding, they do so from a combination of commercial lenders, impact investors, non-profit organisations, philanthropic organisations, crowdfunders and DFI funded programmes and funds. Figure 12 presents funding flows to PUE suppliers in Nigeria. This mainly includes donor funded impact-first suppliers. While this map is not exhaustive of all investments made in the identified PUE sectors in Nigeria to date, it does offer a useful and representative overview of the nature of funding for PUE in Nigeria. **Analysing this visualisation of our PUE funding database suggests the following regarding external finance in this sector:**

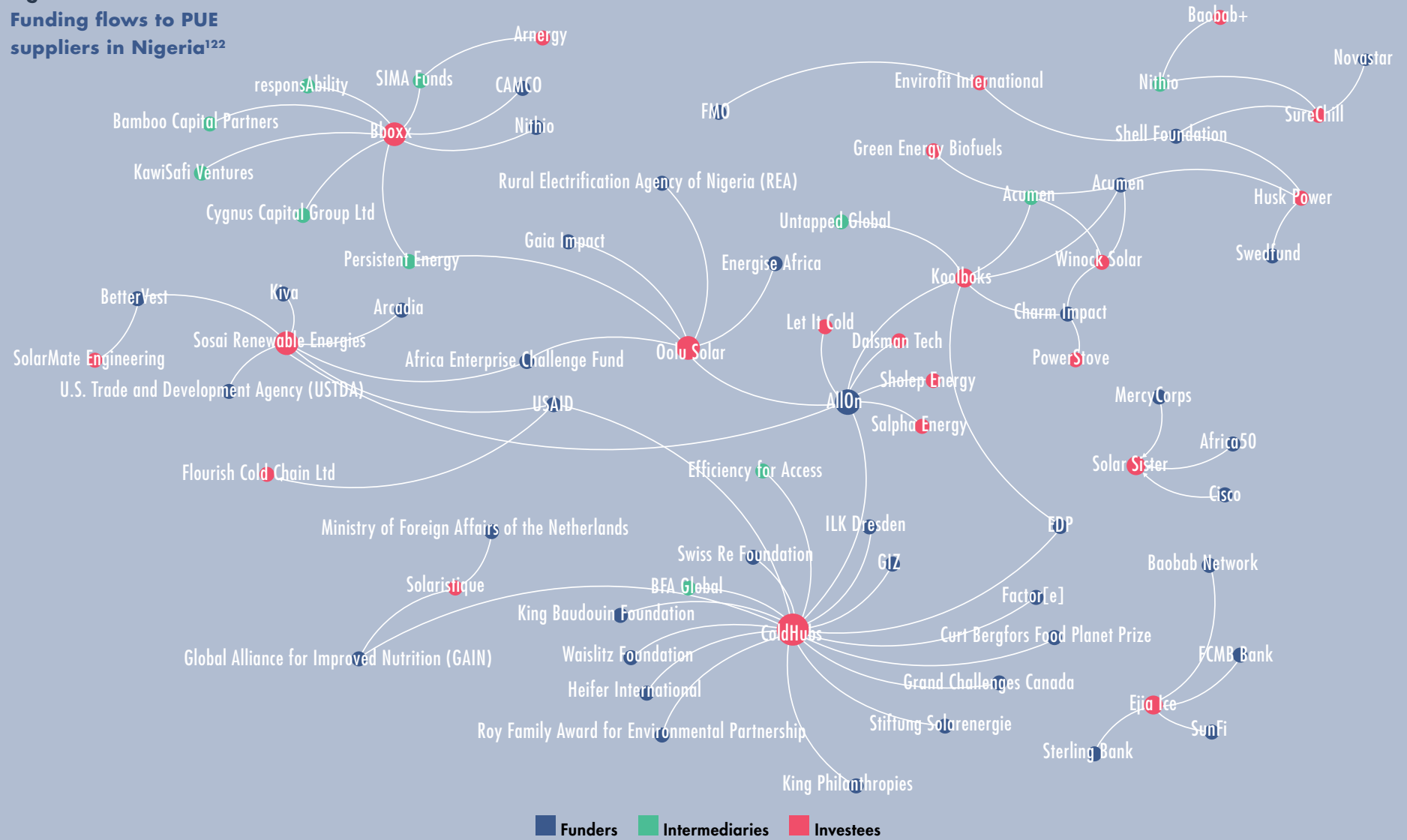
- **Donors remain the main source of funding for PUE:** As with the Kenyan landscape, donors dominate the funding landscape, especially among impact-first suppliers.
- **Funders either invest directly into companies or indirectly through funds and facilities:** For example, Acumen manages the Pioneer Energy Investment Initiative until 2026, with funds raised from the IKEA Foundation, Autodesk Foundation, UKAid's TEA Programme and Schusterman Family Philanthropies.
- **Government sources of funding also feature:** The Results Based Financing for Productive Technologies & Equipment programme was launched as part of the Nigeria Electrification Project, with the aim to boost productive use of energy in remote communities. The project was initiated by the Rural Electrification Agency with AfDB providing the funding. Phase 1 launched in 2021 and by June 2023 grant agreements were signed with 14 energy access companies.¹²¹

¹¹⁹ Energy Excell also sells directly to microenterprises.

¹²⁰ See Box 9 for the intended applications of external funds as reported by various suppliers.

¹²¹ Technologies marked under this project include freezers/fridges, solar cold storage, fryers, grinders and welding machines.

Figure 12:
Funding flows to PUE
suppliers in Nigeria¹²²



¹²² TFE analysis.

- **A small number of companies attract the majority of funding:** As with Kenya, funding dynamics expressed in Figure 12 are consistent with findings from our interviews with suppliers: Disbursement of external finance is highly concentrated among a small number of companies, such as ColdHubs, Sosai Renewable Energies, Oolu Solar¹²³ and Bboxx. **There are some common characteristics among these companies that have been successful in attracting funding:**
 - **They are impact-first companies.** This is a result of a donor-dominated investor pool. The investment mandates of these organisations (e.g. AllOn, Shell Foundation and Acumen) are to catalyse development through PUE, among other interventions.
 - Impact-first Nigerian companies that have attracted the majority of available funds are concentrated in the cooling value chain. This is evidenced by the successful fundraising efforts of ColdHubs, Eja Ice, Koolboks and Sosai Renewable Energies' multi-faceted PUE focus that includes cooling.
 - **Contrary to Kenya, and consistent with India, most only focus on the domestic market:** This suggests that like Indian suppliers, Nigerian suppliers have been more successful than Kenyan ones in unlocking their local market. This can be indicative of a larger addressable market characterised by higher per capita income and in turn more attractive willingness to pay indicators among Nigerian microenterprise customers.
 - **Contrary to Kenya, and consistent with India, most are 100% locally owned.**

Some commercial funding has also been disbursed in the Nigerian PUE sector. Suppliers such as Eja Ice have benefited from commercial loans from FCMB Bank and Sterling Bank. Additional relevant

local commercial lenders included in our funding database are First Bank of Nigeria and Stanbic Bank Nigeria.¹²⁴ Commercial lending offered to suppliers in Nigeria is expensive with interest rates typically exceeding 20%.¹²⁵ Banks aiming to be attractive to specific borrower profiles additionally offer funding opportunities that are unique to such profiles. One such example is the FirstGems Funds loan from First Bank of Nigeria which is aimed at enabling female MSMEs to meet working capital needs and asset finance needs. The loan is priced at a discounted 9%. Sterling Bank has offerings tailored specifically to the health, education, agriculture, renewable energy and transportation sectors, and has funded over 1,000 projects within these focus areas. The loans start at NGN 10 million and go up to NGN 50 million with tenors going from 12 months to 36 months.¹²⁶

Nigerian PUE suppliers (e.g. Sosai Renewable Energies, ColdHubs and Oolu Solar) have also been able to raise debt from players other than banks. This includes Mirova SunFunder, who offer ticket sizes between \$500,000 and \$10 million. Equity is also provided by impact investors such as Factor[e] and Persistent Energy with tickets ranging from \$100,000 - \$1 million.

We also note funding calls to address specific negative conditions faced by suppliers. These programmes only run for a set period, typically as a single funding round. For example, the USAID/Nigeria Covid-19 Food Security Challenge launched in 2021 and ran as a 15-month challenge. This \$4 million fund provided technical assistance and funding to youth led companies and mid-stage companies working in food production, processing, and distribution in Nigeria. Funding was granted to 32 MSMEs to adapt and expand their business models, enhancing the accessibility and affordability of food.

¹²³ Oolu has recently been acquired by Ignite Solar.

¹²⁴ Kemp, Y., *Nigeria: Renewable energy sector players to get investment know-how*, 2023 ([link](#))

¹²⁵ Troost, A.P., Sephelane, N., Küstner, M., Chizema, T.R. & Duby, S., *Business models for electrification of smallholder agriculture in sub-Saharan Africa*, 2023 ([link](#))

¹²⁶ Sterling Bank Nigeria, *H.E.A.R.T.*, 2024 ([link](#))

Gender dynamics affecting the supplier financing landscape in Nigeria

A World Bank Enterprise Survey from 2021 found that only 11% of surveyed banks' MSME loan portfolio have been disbursed to women-led businesses.¹²⁷ Two major contributing factors to women's difficulty in accessing credit in Nigeria are restrictive societal norms around gender and women's lack of access to resources and assets for collateral. Women's struggle to access finance in Nigeria is rooted in structural barriers which limits their control over household assets, meaning women cannot make autonomous decisions over their own resources and lack collateral for loans. This lack of autonomy is also reflected in the lending criteria among financial institutions in Nigeria who often require husbands to serve as guarantors for women's financing.¹²⁸

In the DRE sector, despite significant growth in women participation from 27% in 2018 to 40% in 2022,¹²⁹ companies led by women are still few. **Energy Excell**, a female owned supplier of metalwork, hairdressing and cooling equipment is an exception. Perhaps unsurprisingly, we find that the limited finance access occurring among female owned businesses across Nigerian sectors also manifests in the PUE sector. For example **Sosai Renewable Energies** is a fully female owned company providing, amongst other technologies, solar refrigerators and freezers, milling machines and clean cooking solutions. The company notes that one of their biggest challenges has been being taken seriously by banks and other financial institutions, which has, as a result, slowed down the growth of the company.

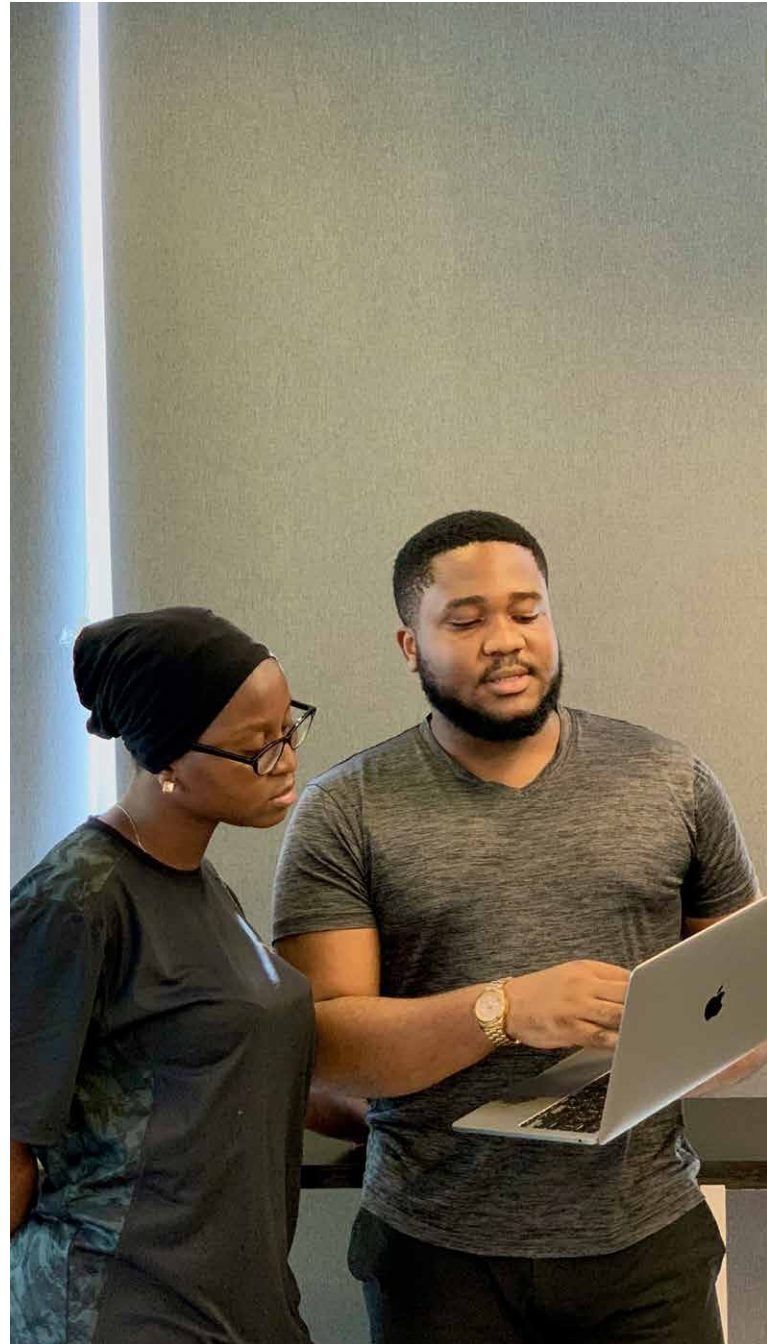


Photo by Francis Odeyemi on Unsplash

¹²⁷ World Bank, *Supporting women entrepreneurs in Nigeria; Access to finance and market diagnostics*, 2021 ([link](#))

¹²⁸ ENERGIA, *Energy Access and Gender in Nigeria, Policy Brief*, 2021 ([link](#))

¹²⁹ Power for All, *Powering Jobs Census 2022: The Energy Access Workforce*, 2022 ([link](#))

6

COMMON CHALLENGES FACED BY PUE SUPPLIERS



We asked suppliers what are the challenges that, if resolved, would lead to an exponential increase in the adoption of their PUE solutions among microenterprises. While suppliers reported a host of challenges, **access to finance, cumbersome regulations and low consumer awareness of PUE solutions** are especially pervasive. As Figure 13 shows, access to finance is the challenge that was mentioned most often by suppliers, followed by cumbersome regulations and limited consumer awareness. For the most part, the prevalence of supplier challenges are evenly spread across India, Kenya and Nigeria. Figure 14 presents an overview

of the prevalence of each reported challenge across the countries, based on responses from suppliers.

It is important to note, however, that challenges presented in Figures 13 and 14 do not occur in isolation. For example, cumbersome regulations and adverse macroeconomic conditions typically contribute to affordability issues when it comes to PUE solutions. All identified challenges and their relationships are discussed in further detail below. Figure 19 provides an overview of the interrelatedness between many of the challenges.

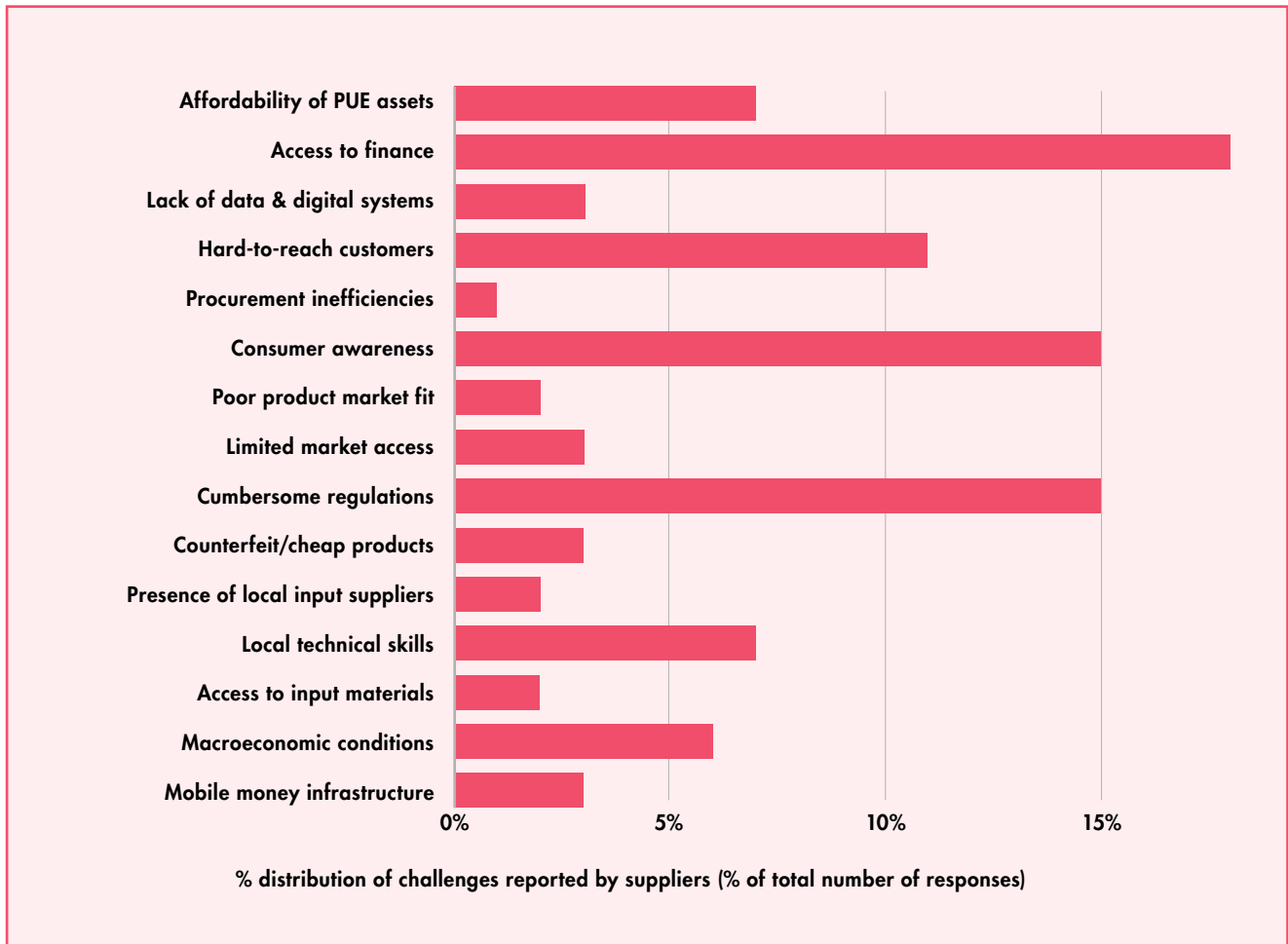


Figure 13: Relative severity of challenges faced by PUE solution suppliers¹³⁰

¹³⁰ TFE analysis based on interview data

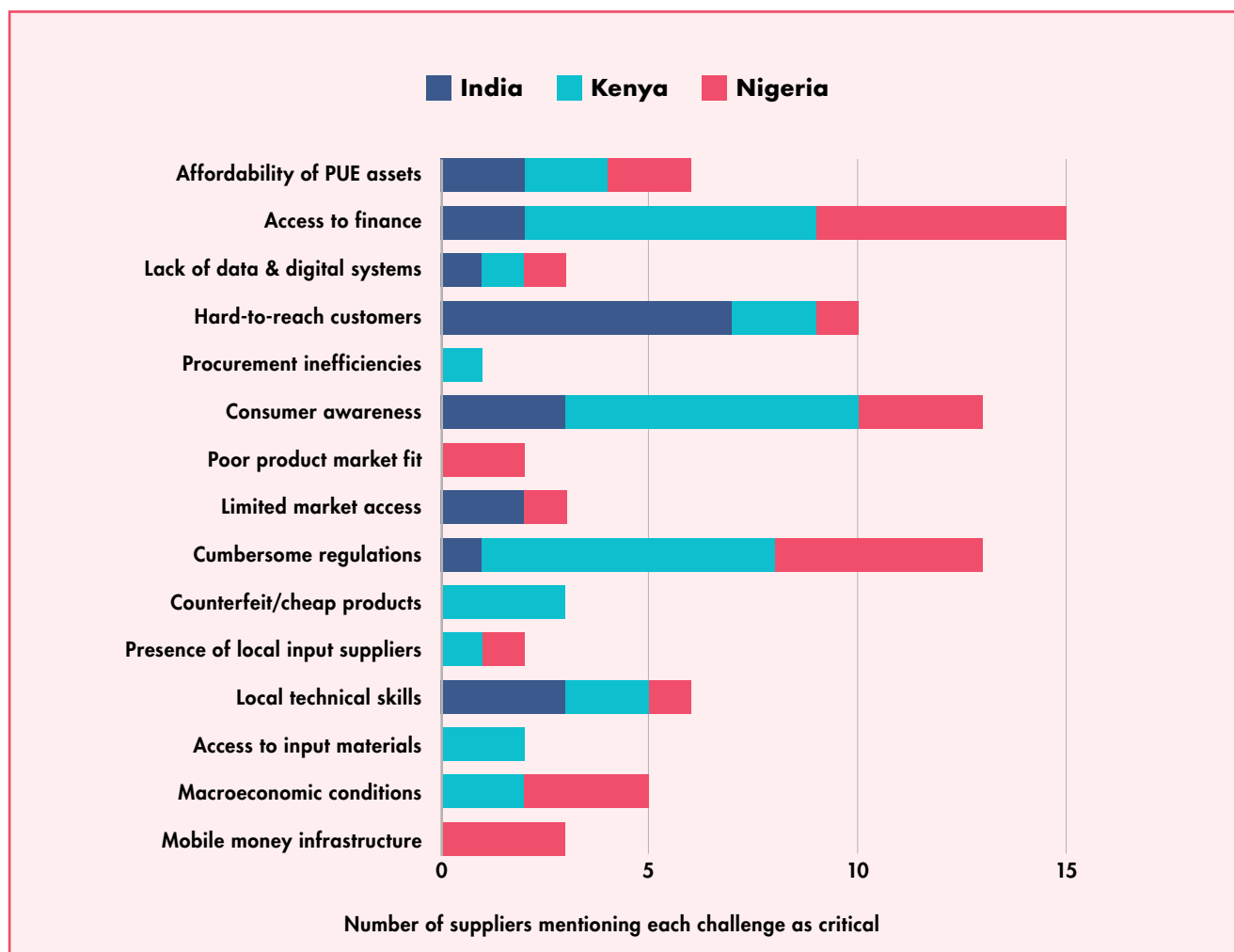


Figure 14: Prevalence of supplier challenges in India, Kenya and Nigeria

6.1 Affordability of PUE solutions

While extensive work is being done across the board by suppliers and advisors to deploy PUE solutions at lower cost (through for example results-based financing and end user subsidies) and in ways that ease payment pressures on consumers (e.g. microfinancing, lease-to-own and PAYGO), the affordability gap that consumers face remains one of the largest challenges inhibiting suppliers from scaling up. This affects suppliers across all levels of maturity. PUE solutions have yet to reach significant proportions of microenterprises earning below a living income. Research conducted by Efficiency for Access and CLASP shows that, at least in the case

of solar-powered technologies, typical existing users live above most poverty lines.¹³¹ The definition of affordability goes beyond the mismatch between capital expenditure (and operational expenditure) and customer income to also include variability of the income, cost and access to capital and opportunity costs.

Through consultations with suppliers, independent experts and our desk-based research, we uncovered the following root causes of affordability constraints:

- **Cost of manufacturing**, especially among suppliers who opt for local manufacturing. A subset of this is the high cost of input materials.

¹³¹ Efficiency for Access, *Appliances for All: Assessing the Inclusivity of the Solar Lighting and Appliances Sector, 2022* ([link](#))

- **Cost price of stock:** In Nigeria, for example, Sosai notes that the price at which they buy freezers and fridges exceeds the ability to pay of most bottom-of-pyramid microenterprises. As many reports have noted in the past, limited economies of scale and resulting small order volumes remain root causes of high prices.¹³²
- **Cost of capital:** When companies take out high interest loans, cash flow shortfalls can easily occur. This can force companies to increase the prices of their products in an attempt to increase revenues in order to honour loan instalments. This is especially the case with local commercial debt which typically comes with high interest rates. The cost of capital can also unexpectedly increase for suppliers that access hard currency debt when a currency devaluation occurs.
- **Costs of transportation:** In India, companies like SaiDhan Industries and Blue Star Auto Machinery note how transportation costs add up especially for serving remote customers with limited orders. This affects the affordability of PUE technologies for microenterprises. Transportation costs can add an additional 10-15% to the end user price.
- **Costs induced by cumbersome regulations,** especially taxes and import duties.

These high input costs are pushed on to the consumer, which further exacerbates affordability issues. Alternatively, if the supplier internalises these input costs, profit margins shrink.

The cost of inputs (materials as well as finished goods) increases further when currency devaluations take place. It follows that a stable exchange rate between local currency and hard currencies such as the US Dollar bodes well for not only reduced costs of inputs but also reduced cost of capital as a result of increased stability. Figure 15 presents monthly fluctuations between the USD and the Indian Rupee, Kenyan Shilling and Nigerian Naira. The Indian Rupee is the most stable currency of the

countries under study, with a standard deviation of 0.04, followed by the Kenyan Shilling, which shows a standard deviation of 0.079. The most volatile currency is the Nigerian Naira, caused by an extensive and severe period of devaluation from June 2023 to date. Compared to the currencies of India and Kenya, the Nigerian Naira is highly volatile, with a standard deviation of 0.364. Figure 16 excludes the behaviour of the Naira, to more accurately reflect the behaviour of the Rupee and the Shilling. Even less severe fluctuations can have negative effects on the procurement efforts of suppliers. SmartBuy, who procures ICT equipment on credit from Dubai in US Dollar, notes for example that loan repayments often increase substantially when the Kenyan Shilling weakens in the timeframe between when equipment was initially purchased and when payment is due. Similarly, Kuku Farmers mentioned that the prices of egg incubators depend highly on the US Dollar exchange rate.

India's relatively stable currency creates favourable conditions for foreign currency investment, which bodes well for investment into productive energy solution suppliers. Conversely, foreign currency investment into Nigeria is hampered by a volatile exchange rate which in turn stifles investment into Nigerian companies.

¹³² Wakoli, M., Abagi, N., Tarus, K., Mulinge, S. & Masters, H., *Leave no one behind – Bridging the energy access gap with innovative off-grid solar solutions*, 2024 ([link](#))

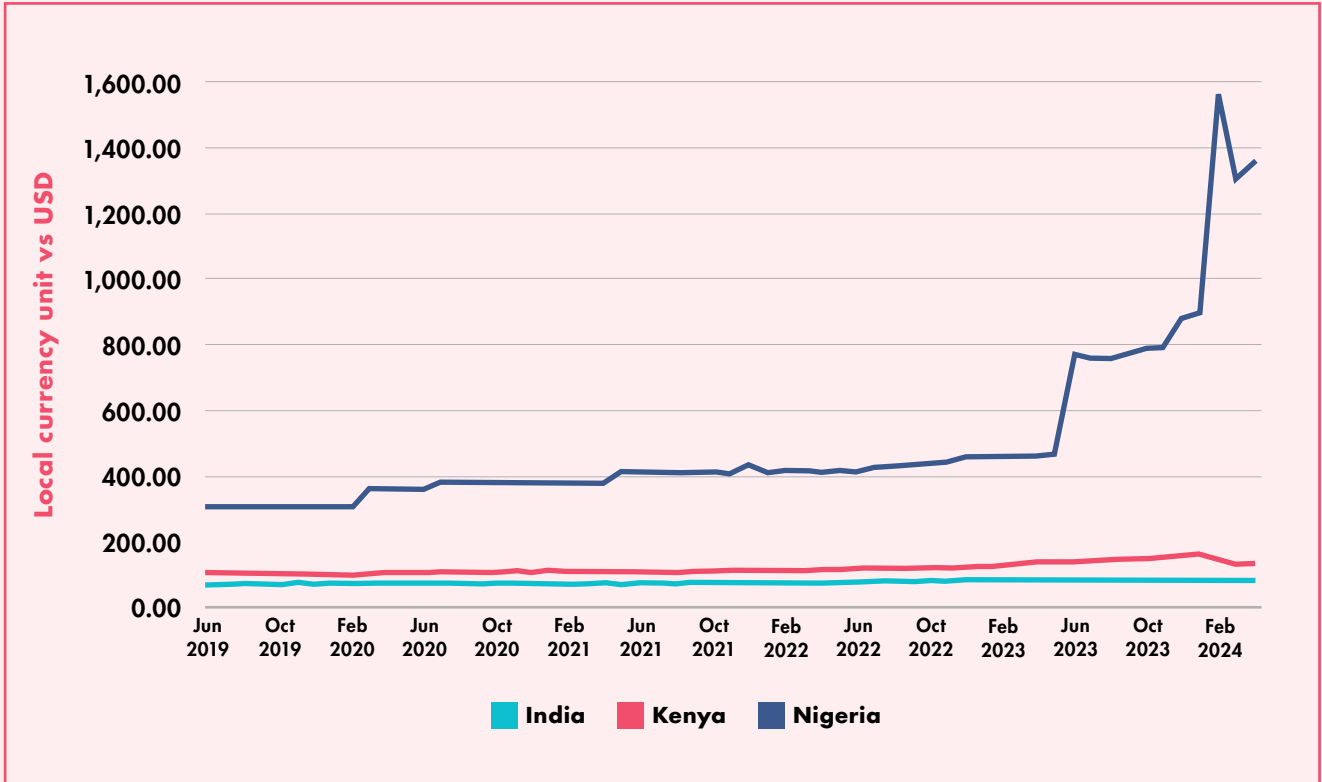


Figure 15: Exchange rate history of the Nigerian Naira, Indian Rupee and Kenyan Shilling vs USD¹³³

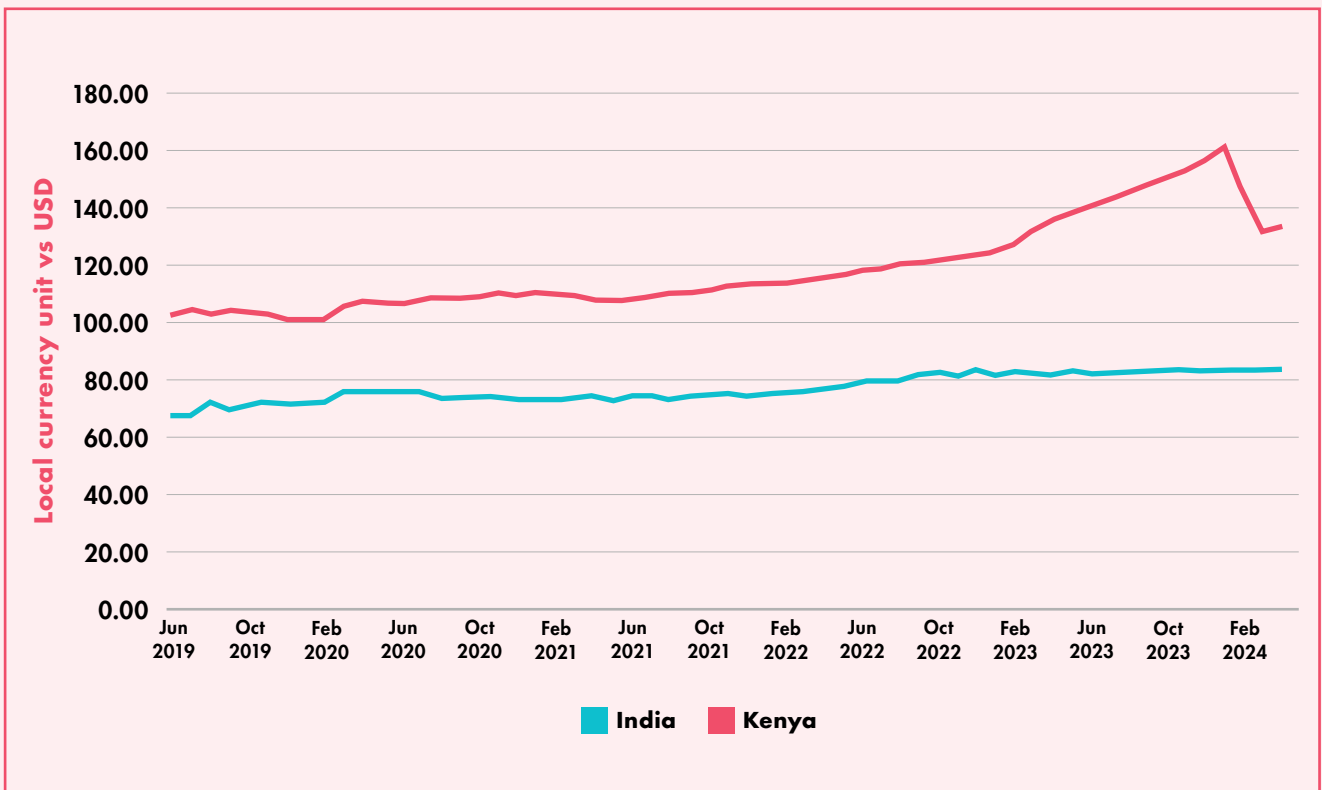


Figure 16: Exchange rate history of the Indian Rupee and Kenyan Shilling vs USD¹³⁴

¹³³ TFE analysis based on data from: IMF, International Financial Statistics, 2024 ([link](#))

¹³⁴ TFE analysis based on data from: IMF, International Financial Statistics, 2024 ([link](#))

6.1.1 Current strategies employed by suppliers to address the affordability challenge

The main approach that suppliers currently use in circumventing the challenge of low affordability is to offer **consumer finance** packages, including pay-per-use/PAYGO, lease-to-own and customer credit. The majority of suppliers offer these packages in partnership with MFIs. In **Nigeria** specifically, consumer financing including microfinance, lease-to-own and PAYGO have their own unique set of challenges: The currency instability and high inflation rate means that the net present value of future cash flows is discounted to the extent that it becomes difficult to finance products over a multi-year basis. Consequently suppliers such as Oolu only offer up to 3 months financing with deposits equating to more than 50% of the total cost, while Solaristique has decided to discontinue PAYGO and lease-to-own models and now only sell products on an outright cash sale basis. The same applies to Zinsutech, who discontinued the credit extended to their sewing machine customers. Solaristique expressed an interest in returning to these business models if they can develop a relationship with a third-party micro financier. There are other options available to Nigerian suppliers. Sosai Renewable Energies works with PaygOps and Angaza to implement PAYGO solutions. Customers pay a 20% deposit with the contract period extending up to four years for bigger products such as freezers. Sosai however notes that these off-the-shelf services are expensive, incentivising them to explore other options.

Other suppliers opt for **cross-subsidisation** of products sold to microenterprises. Mukuru Stoves is aiming to design premium higher cost cookstoves for outdoor enthusiasts in developed markets. The company intends to sell these stoves to outdoor US-based brands such as Patagonia and Marmot and use these revenues to cross-subsidise low cost cookstoves to their target market in the rural areas of Western Kenya.

Demand-side subsidies are also useful in attempting to lower end-user costs. DD Solar in India is helping customers by subsidising the cost of fridges through grants from development partners like Villgro. This can be seen across the suppliers working with NGOs like SELCO Foundation and Sustain Plus in India, where subsidies are provided through their existing programs supported by development funds from the likes of IKEA Foundation. The subsidy model is however not sustainable in the long run. The risk is that these programs often end abruptly. As the case of the World Bank-funded National Electrification Programme illustrates, many companies, including some interviewed as part of this study, suddenly had to change their business models when the subsidy ended, because the price that they had to sell their products for increased dramatically.

Finally, **carbon credits** are used by a large number of suppliers to generate an additional revenue stream. This revenue is often then used to lower the price the customer pays. In the case of Burn, for example, carbon credits enabled the company to lower the price of their improved cookstoves substantially, from \$25-\$40 to \$3-\$15. In Nigeria, solar-powered freezer supplier Solaristique makes use of carbon credits to reduce the price of their refurbished freezers. The company notes, however, that operation of a carbon credit instrument is in itself costly, which means that a minimum level of scale is required to make it worthwhile. Solaristique employs the services of a third-party verifier but noted that with sufficient funding and structuring they would prefer to operate the instrument themselves.

6.2 Access to finance

6.2.1 Supply side finance (supplier finance)

Lack of financing has long been cited as a critical challenge for MSMEs. This is particularly true in sub-Saharan Africa¹³⁵ and South Asia. A 2019 study on Kenya, Nigeria, South Africa and Ethiopia shows that on average, only 21% of

¹³⁵ UNECA (United Nations Economic Commission for Africa), *Economic Report on Africa 2020: Innovative Finance for Private Sector Development in Africa, 2020* ([link](#))

MSMEs are satisfied with the ease with which they access finance.¹³⁶ Yet, while improvements in the deployment of supply-side finance can be made, the uptake of PUE solutions has continued to lag in recent years despite increased levels of financial support for suppliers. This means that it is both the **scale** as well as the **nature** of financing that need to change if we are to see tangible impact in the form of product uptake facilitated by access to finance.

The disconnect between what companies actually need and what (often foreign) financiers provide is a challenge endemic to the industry. This presents an opportunity for local commercial lenders and government backed programmes to provide suitable solutions.

Cash-strapped suppliers are further hampered by co-funding requirements that some funding programmes have in place. Programmes like the AECF Innovation Fund only cover 70% of project costs, requiring a 30% co-financing contribution from investees. Funding will, in such cases, favour companies in the growth- or mature stages who

have a larger footprint and can typically afford to co-finance when required.

Lengthy time periods between funding calls is an additional barrier. The Global LEAP Off-Grid Cold Chain Challenge, for example, was first launched in 2018 and the second round was only launched in 2022. The competition identifies and promotes energy-efficient, sustainable and cost-effective technologies designed for use by smallholder farmers and producers that can meet cold storage requirements for fresh fruits, vegetables, fish, and dairy products. In this instance, productive energy solution suppliers in the cooling sector would not have had any access to the programme's offerings until it was launched again in 2022. During this time multiple companies could have had the opportunity to test products, expand their footprint, gain valuable market insights that could assist in improving their offering and increase overall usage of cooling products.

In India, PUE suppliers, most who are conventional self-funded enterprises, often find it challenging



Photo by Wirestock on Envato

¹³⁶ Worku, Y. & Muchie, M., *The survival of business enterprises and access to finance: The case of 4 African countries*, 2019 [\(link\)](#)

to secure funding from development agencies, which tends to be more readily available to non-commercial entities or those directly involved in developmental work. Consequently, PUE suppliers typically rely on organic financing methods, such as their own revenues or equity from family and friends. In cases where external funding is sourced, these suppliers do so from local banks.

Several key challenges arise with these traditional financing routes. Firstly, bank loans usually require collateral, which can be a significant barrier for companies that may not have sufficient assets to offer as security. Additionally, the traditional loan approval process is often slow and cumbersome.¹³⁷ This can be particularly problematic for companies that frequently require quick access to funds to respond to business opportunities or urgent needs. For example, AP Poultry in India noted that collateral-free loan disbursements can take as long as four months. Furthermore, due to their smaller size and often limited credit history, companies generally face higher interest rates compared to larger businesses. Interest rates for standard commercial loans between 25% and 28% are not uncommon.¹³⁸ The combination of high interest rates and the absence of a robust credit score makes it difficult for many companies to afford loans. This is true in India, Kenya and Nigeria and is a broadly applicable characteristic of emerging economies.

The scale of finance

Despite the increased volumes of funding disbursed in the PUE sector in recent years, there remains a significant need to further increase the finance available. In Kenya and Nigeria, local bank financing is still largely absent from the PUE sector which forces productive energy solution suppliers to rely on their own limited revenues for funding or look to international development finance. A number of suppliers told us that banks do not always understand the productive use of their technologies and so struggle to finance them. Where outside funding is available, it is often in

the form of foreign currency grants, venture capital and impact-focused debt. Companies, especially small ones, are not always aware of these funding opportunities or processes that they need to follow to apply because international (often development-focused financiers) are geographically separated from local markets. Financial products and services, especially those originating from international financiers, are often not designed with enough flexibility to meet the needs of small PUE suppliers. Finally, companies often do not meet the minimum ticket sizes that these funders seek to invest with. A thorough assessment of our database containing data on funders that have invested in PUE solutions shows that the average minimum ticket sizes exceed the maximum amounts that most, especially less mature suppliers can absorb. Table 8 shows these results, covering ticket sizes from all types of funders including donors, impact investors and local commercial banks across the three countries.

Funding type	Average minimum ticket size
Grants	\$130,000
Debt	\$300,000
Equity	\$630,000

Table 8: Average minimum ticket sizes of funding available to PUE suppliers¹³⁹

6.2.2 Demand-side finance (finance for customers)

Demand-side financing for PUE technologies can greatly enhance the affordability of PUE solutions. This can in turn boost the demand for PUE technologies, thereby expanding the operational scale of suppliers. Since most PUE suppliers are profit-driven entities, development institutions could more effectively implement direct demand-side financing strategies. This approach not only aids

¹³⁷ Interviews

¹³⁸ Interviews

¹³⁹ TFE analysis

the end-users but also indirectly benefits suppliers by increasing demand for their products.

In India there is a notable disparity in the availability of demand-side financing across different sectors. Customers in the textiles and carpentry industries often have better access to local MFI loans, driven by national government interest in supporting these sectors.¹⁴⁰ However, other PUE sectors struggle to secure similar financing, highlighting the uneven distribution of financial support.

Historically, in India, financing through subsidies has not, however, yielded sustainable growth within industries, particularly in the agri value chains for PUE technologies. This has been blamed on subsidies causing users to become accustomed to artificially low prices, compelling companies to sell technologies at rates that are not financially viable.

MFI loans however seem to have had more success. A 2019 study showed that despite interest rates of 16% per annum, loans made by Shri Kshethra Dharmasthala Rural Development Project (SKDRDP) to microenterprises to buy solar powered printer copiers and solar powered sewing machines were paid back within 11-15 months and resulted in an average increase in incomes of 39%.¹⁴¹

6.2.3 Gender-related challenges pertaining to access to finance

All female-owned suppliers in our outreach were asked whether they have experienced challenges on the basis of being female owned. Accessing funding was the only challenge that female-owned suppliers responded with. Our research indicates that while the problem of accessing funding is a reality for both male and female owned companies,

this issue is additionally challenging for female owned companies for reasons discussed in sections 3.2.1, 4.2.1 and 5.2.1.

A 60 Decibels study conducted across 30 countries found that in 2022¹⁴² only an estimated 1% of off-grid solar investments were received by women-owned companies. Despite this, evidence suggests that women-led companies delivered greater social impact, had lower customer debt burdens, experienced fewer customer complaints and served a larger proportion of female customers.¹⁴³ Women in the energy sector face a double challenge: Convincing financial institutions to lend to them and accessing networks and partnerships to support their businesses. A World Bank study on female enterprises in the off-grid solar sector notes that financing options are particularly limited for women who want to operate beyond the level of individual enterprises, for example businesses installing rooftop solar or operating mini grids.¹⁴⁴

The fact that access to funding is the only gender-specific challenge does not necessarily indicate that there are few challenges faced by female-owned suppliers. First of all, the low number of female-owned companies is indicative in itself. Research indicates that female entrepreneurs in emerging economies like Nigeria, Kenya and India are concentrated in the informal sector, operating as microentrepreneurs and that due to restrictive gender norms and difficulty accessing funding particularly for female entrepreneurs, struggle to grow past the micro phase. The female entrepreneurs who have made it to this stage are therefore also likely to be highly determined, used to fighting adverse conditions and overcoming challenges, which may affect how they view what is a challenge and what is not.

¹⁴⁰ Pankaj, D., Farhad, A., & Ramyar R.A., *Microfinance Institutions And Their Importance In Growing Economic Development: A Study Of Rural Indian Economy*, 2019 ([link](#))

¹⁴¹ Jha, S., Patnaik, S., & Jain, A., *Financing Solar-powered Livelihoods in India: Evidence from Microenterprises*, 2019 ([link](#))

¹⁴² Findings came from over 79,000 individuals in diverse settings, from remote villages to cities.

¹⁴³ 60 Decibels, *Why off-Grid Energy Matters*, 2024 ([link](#))

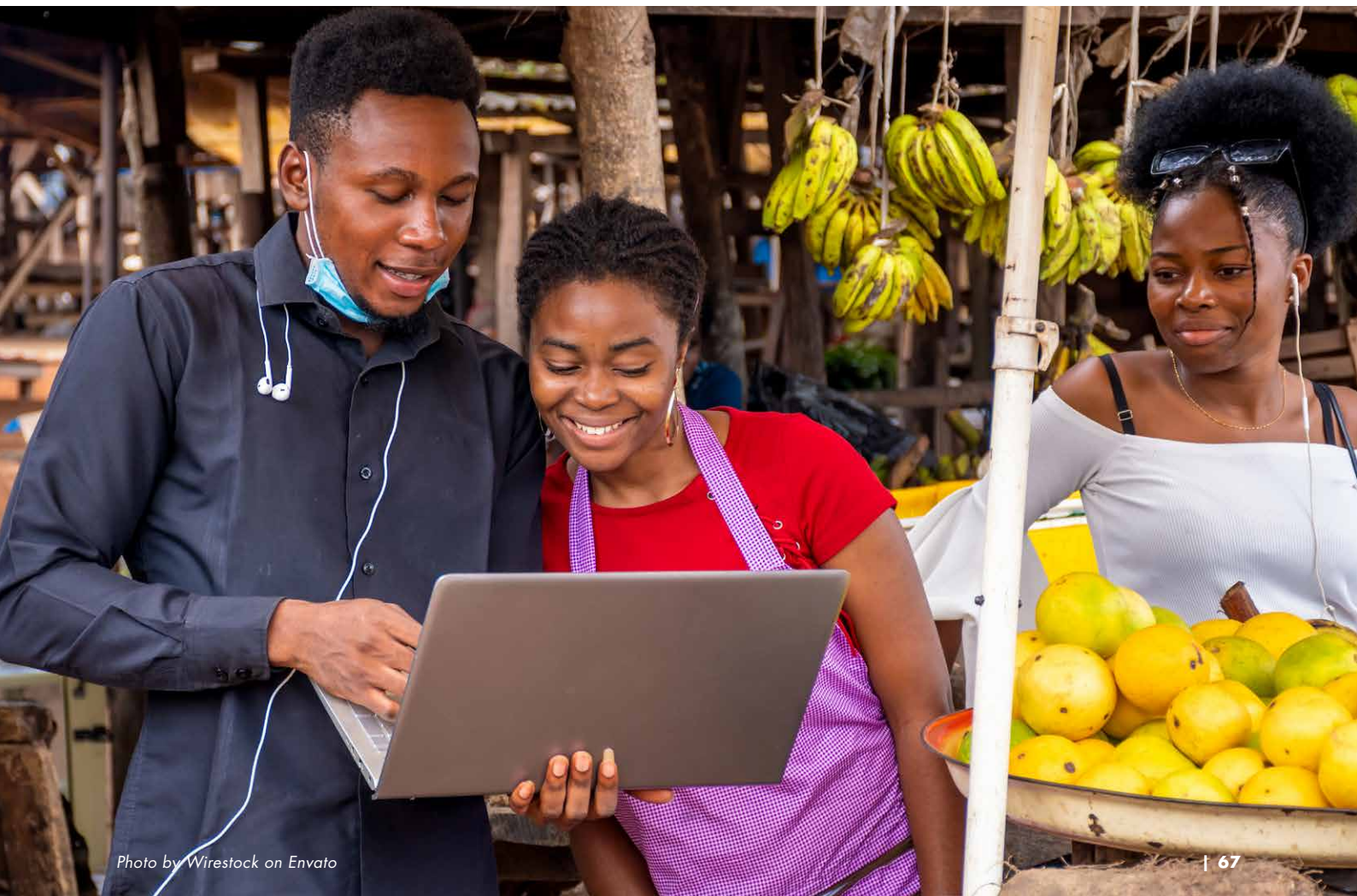
¹⁴⁴ World Bank, *Gender Equality in the Off Grid Solar Sector- Operational Handbook for Gender Equality in the Off Grid Solar Sector*, 2022 ([link](#))

6.3 Lack of data and digital systems

Productive energy solution suppliers, especially early-stage ones, often do not have the digital systems in place to track customer satisfaction and the performance of technologies. This makes it difficult to react to customer complaints and improve company reputation. It also does not give a company visibility on which technologies are more profitable than others.

Those that have adopted e-commerce have been able to expand their reach. SmartBuy, an ICT supplier based in Nairobi interviewed as part of this research, offers an online shop and delivers to all major towns in Kenya. The company was founded 8 years ago and is successfully operated with 12 employees including delivery drivers. Elsewhere it is also becoming increasingly common for suppliers to sell their products on generic e-commerce sites such as Jumia and Jiji.

The lack of digital systems is a phenomenon that also occurs in the way that suppliers transact with their customers. The root cause of this specific problem can be traced to the presence or absence of digital infrastructure available to seamlessly transact with customers. In Nigeria, where mobile money penetration is comparatively low (only 226 accounts per 1,000 adults), suppliers find it difficult to successfully implement PAYGO business models. Instead, direct cash collections are used, reducing the scalability of their offerings to customers. Conversely, in Kenya, PAYGO faces fewer challenges, mainly thanks to a high penetration rate of mobile money at 2,176 per 1,000 adults according to IMF data. This is enabling a much larger usage rate of these business models compared to outright cash sales (see [Section 4.2](#)). Figure 17 presents the penetration rate of mobile money in India, Kenya and Nigeria.



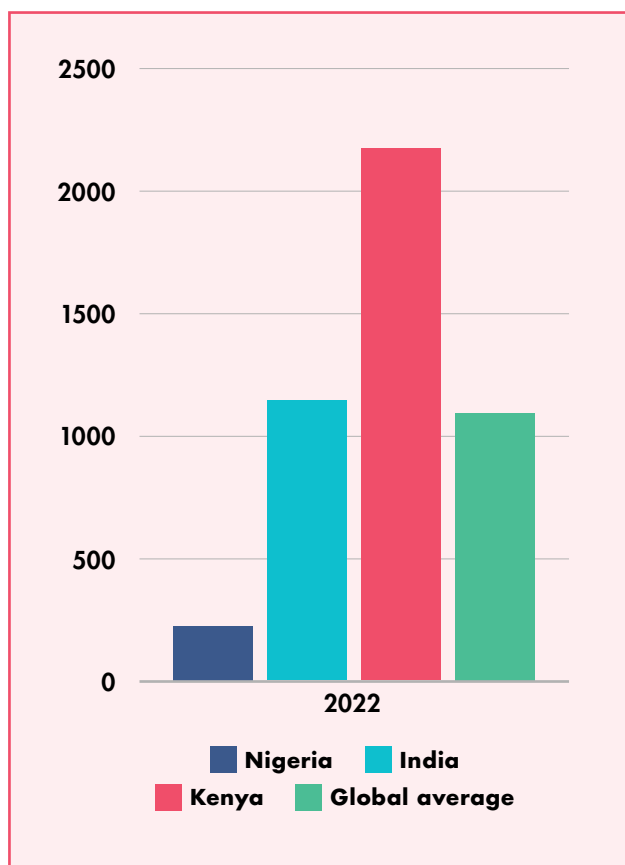


Figure 17: Number of registered mobile money accounts per 1,000 adults¹⁴⁵

Nigerian suppliers note that consumer trust in digital transaction methods is still relatively low. Electronic interbank transfers are, however, relatively easy and suppliers such as ColdHubs and S.Y Opayemi Enterprises indicated that this is currently their preferred method of transacting with customers.

According to India-based DD Solar, the lack of a robust communication network impedes remote monitoring systems essential for ensuring payment compliance and operational functionality. As such they faced challenges in implementing the PAYGO mechanism for consumer financing. Additionally, the absence of reliable data on the credit history of users complicates the assessment of consumer creditworthiness, increasing the financial risk for the company. These factors collectively hinder the scalability and effectiveness of DD Solar's PAYGO financing model in underserved regions.

¹⁴⁵ TFE analysis based on data from: IMF, Number of registered mobile money accounts per 1,000 adults, 2024 ([link](#))

¹⁴⁶ TFE data

6.4 The high cost of serving hard-to-reach customers

Reaching last-mile customers is expensive and time consuming, irrespective of the maturity of the supplier. This is especially the case with PUE technologies, which are typically heavier and of higher value than smaller fast moving consumer goods. The same applies to marketing outreach – finding the right communication channels is often less straightforward in last mile areas than in cities. Investing in a PUE technology is a big decision for many microenterprises, so there should ideally be an opportunity for the microentrepreneur to test the product before buying. This requires roadshows, which is especially difficult to conduct across large geographies or in hard-to-reach areas.

If a supplier can unlock the potential of hard-to-reach markets, there is a substantial market to address. Interviewed suppliers of egg incubators and dairy milking machines acknowledge this, but grapple with the issue of reaching larger portions of the smallholder farmer market, which is typically located in deep rural areas. In the cooking sector, Mukuru Stoves opted to target rural communities in the Siaya, Kisumu, Migori and Homa Bay counties of Kenya due to the crowded nature of the cookstove market in Nairobi. It required a price reduction of the Mukuru cookstove from \$10 to \$5. The company believes that this fits the ability-to-pay of their target population, which typically has income of \$40 to \$100 per month. Price reduction is especially important in the cooking PUE sector given that the target market must make a fundamental paradigm shift in order to purchase an improved or modern cookstove. These customers, households and microenterprises alike, are accustomed to paying very little for traditional stoves (approximately \$1 - \$15 in Kenya¹⁴⁶), while fuel, in the form of wood, is considered to be free. For this reason, suppliers in the cooking PUE cooking sector noted that their largest competitors are not competing suppliers, but rather the traditional open fire.

The majority of Indian suppliers interviewed (78%) identify the high cost of reaching remote customers as a major challenge for scaling their business. Suppliers in the cottage industry, such as SaiDhan and Blue Star Auto Machines, have reported that transport costs to remote areas increase equipment prices by 10-15%. To address this, they are building a network of champions from their customer base to assist with marketing and securing large orders, thereby optimising transport costs to these areas.

Local distributors and retailers often rely on manufacturer expertise to extend after-sales support to customers, especially when it comes to repairs. Manufacturers, however, tend to only hire in-country capacity if there is a critical mass market to service. This is often not the case with more nascent products for which demand is low. In India, suppliers like Pushan, DD Solar, and SELCO face challenges in providing after-sales services to remote customers, which impacts their business. Due to these difficulties, SELCO has discontinued offering printers in their service lineup.

Rural customers are not only hard to reach in the physical sense, but also in the digital sense. Solar Sister for example notes that their business model is limited by the limited smartphone penetration among the female entrepreneurs distributing their products. The organisation is consequently developing an unstructured supplementary service data (USSD) programme, which is suitable for more basic feature phones. This will enable Solar Sister to more effectively engage with their agents and customers.

6.5 Procurement inefficiencies

Procurement inefficiencies manifest in a number of ways. Firstly, suppliers often struggle to secure the inputs that they need in order to run their businesses. Mukuru Stoves for example note the difficulty of securing scrap metal for their ongoing cookstove manufacturing operations, due to the high demand for these metals in Kenya.

Secondly, it is well known that local wholesalers, distributors and retailers can benefit from attractive cost savings when buying in bulk from overseas manufacturers. Often, however, manufacturers have relatively large minimum order sizes in place and these requirements tend to be too large for the warehousing capacity of local suppliers. This is exacerbated by limited finances to procure large order volumes. In Kenya, ICT supplier SmartBuy noted how it would like to raise external finance in order to import larger quantities. The company states that the ability to free up their capital tied down in inventory would enable them to place larger orders with overseas manufacturers and suppliers. There are also examples of local asset supply companies opting to form conglomerates or work within cooperative societies to aggregate orders and share the benefits of lower prices. One example is the case of local Nigerian sewing machine suppliers who often join forces to increase their order volume.¹⁴⁷ This challenge is especially pronounced among smaller suppliers, who often do not have the capacity to hold large quantities of stock.

6.6 Consumer awareness

The vast majority of interviewed suppliers, from early-stage to mature, note the lack of consumer awareness as a critical barrier to the scaling of PUE solutions. Consumer awareness is particularly an issue for would-be customers who would need to undergo fundamental transitions in how they perform key activities in their businesses to incorporate the use of a PUE product. For microenterprises involved in the cooking sector, such as street food vendors, the transition from biomass cookstoves to electric cookstoves involves extensive sensitisation due to ingrained habits of using biomass for cooking. Solar Sister, Sosai Renewable Energies, Burn and others all mentioned cultural hesitations around the use of electric cooking equipment over traditional biomass methods. In the dairy value chain, Savanna Circuit Tech for example indicated that they spend considerable amounts of time to educate customers

¹⁴⁷ Interview data with Zinsutech

on the value offering of their mobile milk chillers. The same applies to Dairy Systems and Services, who note that smallholder farmers do not easily understand the value of the milking machines that they offer. Egg incubator suppliers recount similar experiences. They point out that incubation technology develops so fast that customers need to be retrained on a regular basis as new products become available.

Suppliers currently address this challenge by offering training to customers on how to use their products. This occurs across countries and across PUE value chains. In Kenya, Kuku Farmers offer training to smallholder poultry farmers on the utility of incubators in addition to general business development support. In India, Pushan Renewables believes that smallholder farmers can make a profit from using their solar egg incubator without the need of a demand-side subsidy. The company has however observed that low awareness among consumers on how to use incubators profitably leads to expectations of subsidies. Consequently, a significant portion of Pushan's efforts is spent collaborating with banks, MFIs, and development agencies to identify appropriate subsidisation models, which impacts their business growth. To address this, they are piloting a demonstration project in Central India.

6.7 Poor product market fit

The assumption can easily be made that all un- or under-electrified microenterprises would be attracted to the opportunity of owning a modern energy solution to run and improve their business operations. However the value proposition of any PUE product is highly dependent on whether it is the appropriate size, how often and for how long it is used and the business model that is used to sell the product to the customer (e.g. pay-per-service and lease-to-own vs outright sale or single ownership vs collective ownership). Microenterprises that are able to reduce the idle time of their PUE technologies will derive increased value from the

technology. Collective ownership, such as the case of cooperatives of microenterprises, is a useful model to decrease the idle time of a technology. Suppliers such as Dairy Systems and Services in Kenya recognise this need and are looking to support their customers to form cooperatives. As such, the value proposition of any PUE technology is reduced if its design and utility is ill suited to the needs of the would-be customer. This use case sensitivity challenge means that suppliers such as Oolu Solar and Omnivoltaic have started to transition away from activity-specific products to inverter-based products; selling the energy supply equipment only. The onus is then on the microenterprise to purchase their own appliance that is powered by the inverter product.¹⁴⁸ Other suppliers, such as Solaristique, have become aware of the need to adjust their product designs. Solaristique, who offers refurbished freezers, notes a preference among their customers for brand new freezers.

6.8 Limited market access among microenterprises

The relationship between PUE solution ownership and microenterprise success is complex. While evidence seems to suggest that PUE technologies have a transformative positive impact on businesses, external factors such as market access also play a role. Using a PUE technology is thus not the only predictor of microenterprise success.

Market linkage presents a significant challenge for users of PUE technologies, impacting productive energy solution suppliers and their business expansion strategies. For microenterprises, the primary challenge lies in accessing markets where they can sell the products produced or processed using these technologies. This market must also be willing to pay a higher price for the improved quality of these products. Without robust market linkages, microenterprises struggle to find buyers for their products, limiting their potential income and reducing the return on investment for PUE

¹⁴⁸ The smallest product offered by Oolu in this regard is a Bluetti 1,000W inverter with a 700Wh battery for \$650. Targeting microenterprises living below a living income would thus require a very high subsidy to match ability to pay. The smallest inverter product on offer by Omnivoltaic is a 3,000W inverter.

technologies. Lack of market access can deter potential users from adopting PUE technologies, as the economic benefits remain unclear or unattainable. In the case of plate making machines in India, although there is an export market for disposable plates made from natural material like tamul and bamboo, smaller plate makers find it difficult to tap the export market resulting in low adoption of plate making machines among the microenterprises. **For suppliers of PUE technologies, the situation creates a two-fold challenge:**

- Firstly, the limited success among microenterprises in leveraging these technologies for economic gain reduces overall demand for such technologies. Suppliers find it difficult to sell their products if the users are not confident in achieving a viable off-take market for their goods and services.
- Secondly, the scalability and economic viability of suppliers' business models are tightly coupled with the successful adoption and effective utilisation of their products. If users cannot access or develop markets, the perceived value and utility of the technologies drop, leading to decreased sales and difficulties in achieving economies of scale.

6.9 Regulations impeding the sector

Regulations affect all sizes of suppliers in the different sectors. Suppliers in Nigeria (e.g. Oolu and ColdHubs) especially note the high cost of clearing through customs both imported finished products and components needed for manufacturing of products. Some companies are currently circumventing this challenge by applying for Import Duty Exemption Certificates (IDECs). Receiving an IDEC is however a time-consuming process and an IDEC is only valid for one year. Officially the processing time of an IDEC is 10-15 working days if the application is not queried.¹⁴⁹ Complex or incomplete applications can however take several

weeks or months to be processed.^{150,151} This impacts affordability. In Kenya, ICT suppliers find it difficult to extend cost savings to customers due to high tax rates applied to imported ICT products.

Taxes and import duties of products in each PUE value chain in India, Kenya and Nigeria are presented in Table 9. Lithium ion batteries are highly taxed in all countries. Assembled fridges and freezers, despite attracting a 0% VAT rate in Kenya, are also taxed rather heavily across the three countries. Such taxes and duties greatly add to suppliers' input costs, which in turn contributes to the issue of product affordability. Where possible, governments can greatly contribute to PUE sector growth by applying reduced rates and duties as is the case with the likes of egg incubators, welding machines and dairy milking machines in Kenya and Nigeria and some ICT equipment in India.

Occasionally, tax rates can be applied inconsistently. We noted multiple anecdotes of officials applying rates that vary from those stated in regulations. In Nigeria, Sosai Renewable Energies reported instances of being victim to exploitation by officials, where tax rates are applied incorrectly. Similarly, S.Y Opayemi Enterprises, an importer and local retailer of sewing machines in Nigeria, notes that unclear customs guidelines create a challenge for importation from China and India.

¹⁴⁹ Government of Nigeria, IDEC user guide, 2024 ([link](#))

¹⁵⁰ Nethersole, M., Business charter increased globally during the pandemic and Nigeria is one country enjoying its growth, 2023 ([link](#))

¹⁵¹ Goosen, S., Stakeholder collaboration and process improvements speed up deliveries to Nigeria, 2023 ([link](#))

COMMON CHALLENGES FACED BY PUE SUPPLIERS

	India				Kenya		Nigeria	
	Import duty	CGST	SGST	IGST	Import duty	VAT	Import duty	VAT
Li-ion batteries	20%	9%	9%	18%	25%	16%	20%	7.5%
Egg incubators	7.5%	6%	6%	12%	0%	0%	5%	0%
Welding machines	10%	9%	9%	18%	0%	0%, 16% for parts	5%	0%
Assembled fridges & freezers	20% (household type), 15% (commercial type)	9%	9%	18%	25%	0%	20%	7.5%
All cookstove parts	N/A	N/A	N/A	N/A	10%	16%	10%	7.5%
All assembled cookstoves	15%	6% (kerosene & wood), 9% (others)	6% (kerosene & wood), 9% (others)	12% (kerosene & wood), 18% (others)	35% (solid fuels), 10% (gas and liquid fuels)	16%	20%	7.5%
Carpentry tools	10%	9%	9%	18%	10%	16%	10%	0-7.5% depending on tool type
Printers	0-10% depending on printer type	9%	9%	18%	10%	16%	20%	N/A, but a separate 5% levy applies
Laptops and desktop computers	0%	9%	9%	18%	0%	16%	5%	0%
Assembled hair clippers and shavers	Not covered in this study	Not covered in this study	Not covered in this study	Not covered in this study	25%	16%	20%	7.5%
Hair clipper and shaver parts	Not covered in this study	Not covered in this study	Not covered in this study	Not covered in this study	25%	16%	10%	7.5%
Hair dryers	Not covered in this study	Not covered in this study	Not covered in this study	Not covered in this study	10%	16%	20%	7.5%
Dairy milking machines	7.5%	9%	9%	18%	0%	0%, 16% for parts	5%	0%
Sewing machines	10%	6%	6%	12%	0%	0%	5%	7.5%

Table 9: Prevailing VAT and import duty rates of PUE technologies^{152,153,154,155}

¹⁵² World Trade Organisation, *Tariff line duties, 2024* ([link](#))

¹⁵³ Federal Government of Nigeria, *Tariff search, 2024* ([link](#))

¹⁵⁴ Government of Kenya, *VAT Act, 2013* ([link](#))

¹⁵⁵ Ministry of Finance of India, *GST Rates, 2023* ([link](#))

Beyond regulations that directly affect the supply of PUE solutions, there are also a number of regulations that indirectly affect the sector. These include regulations focused on the respective sectors under study. For example, in Kenya, according to Zuhura Solutions, who supply solar-powered food heating trolleys for food vendors, there are a host of unfavourable policies affecting street food vendors generally. Most street food vendors are unlicensed and as such the products that they use (including food trolleys) carry the risk of being confiscated by authorities.

In India, suppliers such as DD Solar and Pushan Renewables have raised concerns about their inability to participate in national and subnational tenders due to high revenue thresholds and participation costs. These suppliers feel that their small scale of operations, which should ideally be supported by government subsidy programs, is instead hindering their chances of participating in these schemes.



7

RESOLUTIONS FOR ROOT CAUSES OF CHALLENGES



Photo by Tunde Buremo on Unsplash

Challenges as diverse as those discussed in this report require a multi-faceted response that draws on a set of diverse skills and responsibilities. Stakeholders from across the value chain therefore all have roles to play in contributing to the resolution of these issues. **For the purposes of this discussion, we group stakeholders into the following groups:**

- **Financial institutions:** All types of funders and investors;
- **Go-to-market partners:** All stakeholders involved with getting products to market, including suppliers and distributors;
- **Market enablers:** Stakeholders involved with catalysing markets for PUE, including government and donor support initiatives (e.g. technical assistance programmes).

Figure 18 presents an overview of resolutions we propose in response to the critical challenges identified during this research.

All resolutions discussed here are relevant to all country markets. However, in each country there are a select few proposed resolutions that will be more impactful than others, if implemented. This is based on the nature of the most critical challenges plaguing each respective country market.

In India, supplier challenges are concentrated in the sales and usage segments of the value chain: Servicing hard-to-reach customers is particularly challenging here, and low consumer awareness and the low market reach of their customers also pose significant barriers. It follows that the most critical interventions are required in the sales and usage of equipment segment of the value chain. In Nigeria, where suppliers report that access to finance and cumbersome regulations (especially import regulations) are especially pervasive, the most important resolutions for this market are accordingly concentrated in the sourcing and manufacturing/assembling segments of the value chain. In Kenya, limited access to finance has a sweeping effect across the market, suppliers struggle to make consumers aware of the value proposition

of their products and cumbersome regulations often create difficult operating conditions. Therefore, our proposed resolutions for the Kenyan market target the sourcing, manufacturing/assembling and sales segments of the value chain.

Below we present an outline of resolutions best placed for implementation by the respective stakeholders in the value chain.

7.1 Bulk purchasing and warehousing facilities to tackle market fragmentation

The root causes of many of the challenges articulated by the PUE suppliers we interviewed and presented above stem from a few simple facts; the low-income markets (microenterprise customers) are fragmented and the entities servicing them (suppliers) are diverse and small. These, in turn, lead to a cascade of implications, most of which manifest as challenges to the sector. It follows that efforts to reduce the burden of fragmentation are key. An overview is provided in Figure 19.

The best way to tackle the challenges of fragmentation is to look at opportunities for aggregation. Aggregation in this context can take numerous forms. Figure 19 shows how fragmented demand is one of the several challenges that make it difficult for suppliers to scale up operations, engage economies of scale and pass the cost savings on to consumers.

7.1.1 For financial institutions

It follows that an obvious institutional intervention would be for funders and investors to provide numerous small suppliers with economies of scale through for example **bulk purchasing and the provision of warehousing facilities**. Facilities such as the Productive Use Appliance Financing Facility by CLASP and Nithio provides a subsidy that allows suppliers to access bulk discounts on solar product procurement and offer products on credit to lower the costs of technologies for end-users. This in turn could expand the reach of productive energy solution suppliers and enable

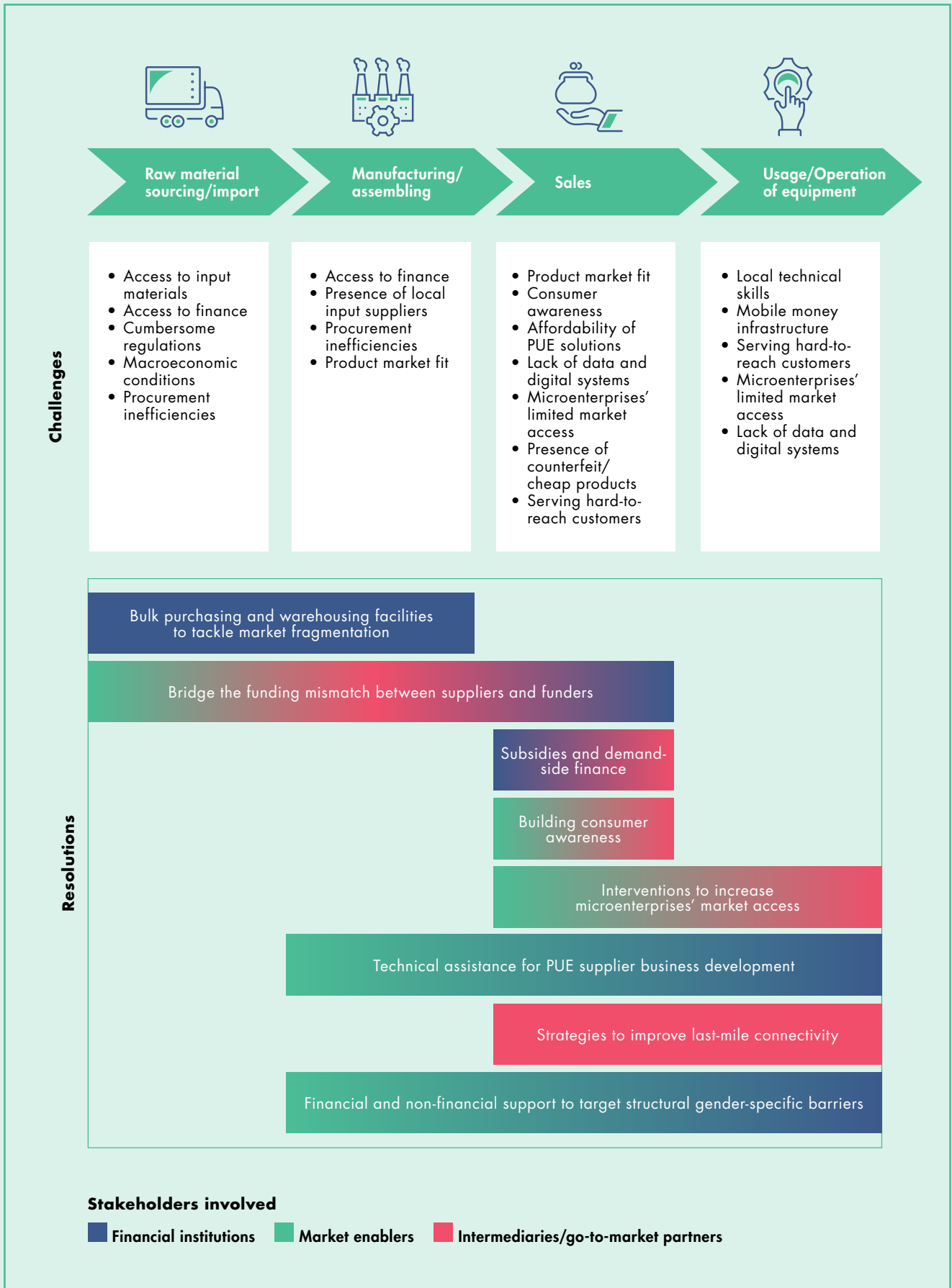


Figure 18: Overview of resolutions for challenges inhibiting adoption of PUE solutions

them to cater to a broader market. The ticket sizes start from \$500,000 with an offering that includes procurement subsidies, capacity-building grants, consumer financing loans, and advisory support. This facility is available in both Nigeria and Kenya (additionally, Uganda, DRC, Ethiopia and Sierra Leone). The product scope includes electric pressure cookers, fans, milling, solar water pumps, refrigerators/freezers, and walk-in cold storage.¹⁵⁶ PUE suppliers that have been supported include Bidhaa Sasa, SureChill and EcoZen.

Another advantage of a warehousing facility is the opportunity to centralise supply side financing; rather than approaching or interacting with a multitude of small suppliers to arrange supply side subsidies, with the high transaction costs that this implies, smaller suppliers will be attracted to a centralised facility. In the same way, tax exemptions and the frictions of importation can be negotiated (and paid for) centrally, by a well-connected, concessionary (or government) player.

A bulk purchasing and warehousing intervention will only be successful if suppliers are willing to buy the equipment purchased. This, in turn, will only be driven by an evident demand from end users. **As such, care must be taken to ensure that there is sufficient evidence to prove that (among other things):**

1. The addressable market is large enough;
2. There is adequate product market fit (in terms of product form and function);
3. The eventual end-user price is favourable.

Much of the associated risk of an intervention of this nature will be reduced through the use of standardised, certified and thoroughly tested products. The thread of standardisation is one woven through solutions to many of the challenges described. We have seen above how product standardisation can be beneficial along various value chains for example. Standardisation can also be a fundamental enabler to address some of the other sectoral challenges including the lack of available finance.



Photo by Anjali Paarol on Pexels

¹⁵⁶ Hacker, S., *Productive Use Financing Facility opens first public auction window, 2023* ([link](#))

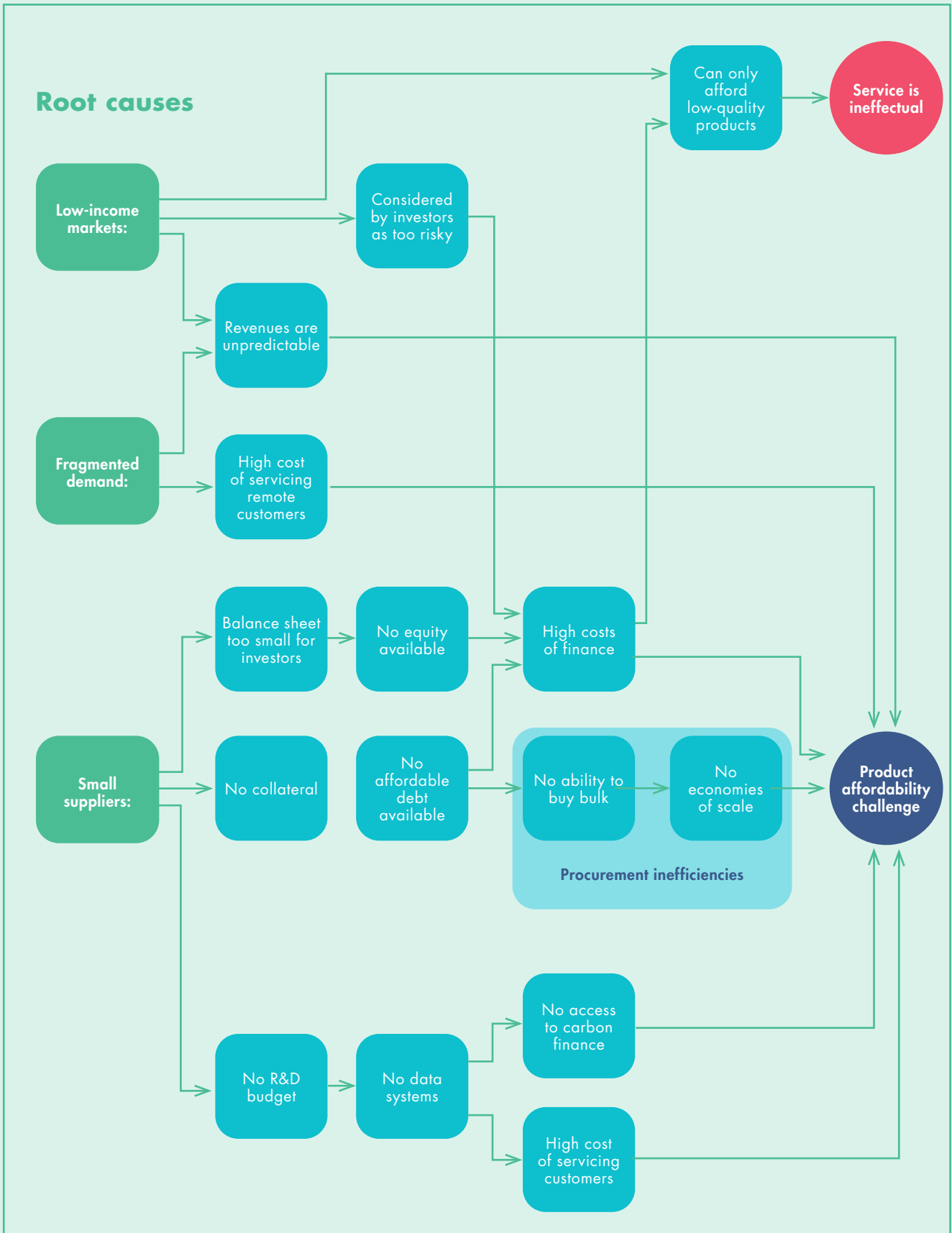


Figure 19: Overview of root causes of challenges¹⁵⁷

¹⁵⁷ TFE analysis

7.2 Bridge the funding mismatch between suppliers and funders

7.2.1 For financial institutions

The limited access to finance that suppliers experience is not always the result of a limited supply of available funding opportunities. It is often also the result of the lack of funding opportunities designed and tailored to meet supplier realities, especially in terms of ticket sizes. [Section 6.2](#) introduced the concept of this pervasive funding mismatch between suppliers and funders. Investors in this sector often struggle to find investment-ready companies, while companies struggle to find funding that meets their needs. The end result of this mismatch is a scenario where the small, select group of companies that do meet investor requirements access the lion’s share of funding. These are typically foreign-owned, multinational companies that have already graduated to a critical mass of scale.

What is important to recognise, however, is that among suppliers that currently do not meet investor requirements, there is a myriad of quality companies that can offer bankable investments provided that adjustments are made to investors and funders’ qualification requirements. This relates especially to minimum ticket sizes offered, funding type and due diligence requirements. Many quality suppliers do not have the scale of operations to meet investors’ minimum ticket sizes nor the resources to meet extensive due diligence requirements.

Figures 20, 21 and 22 present grant, debt and equity funders active in the PUE space, the ticket sizes that these funders tend to invest and the scale and maturity of companies they target. Consistent with Table 10, grant ticket sizes are the smallest of the three funding instruments, followed by debt and then equity. What this suggests is that it is only grants that are suitable to the small capital needs of many PUE suppliers.

Funding type	Average minimum ticket size offered by investors	Average funding quantum required by suppliers
Grants	\$130,000	<ul style="list-style-type: none"> • Low end: \$33,000 • Mid range: \$330,000 • High end: \$2.25 million
Debt	\$300,000	<ul style="list-style-type: none"> • Low end: \$68,000 • Mid range: \$150,000 • High end: \$2.75 million
Equity	\$630,000	<ul style="list-style-type: none"> • Low end: \$200,000 • High end: \$950,000

Table 10: Minimum ticket sizes offered by investors vs funding quantum required by suppliers¹⁵⁸

Table 10 shows that it is only the more mature suppliers (those requiring large amounts) that are likely to successfully raise grants, debt, as well as equity. In terms of debt specifically, suppliers in the mid range and low end of funding needs will likely find it difficult to raise capital from most funders, although we do note that some success could be achieved with small loans offered by

local commercial banks.¹⁵⁹ Given that the average minimum ticket size offered by grant funders is lower, we note that suppliers in both the mid range and high end are likely to be successful. Suppliers on the low end, however, might find it difficult to qualify for most grants. **Even funders in the \$0-\$100,000 category will likely only go as low as \$50,000.**¹⁶⁰

¹⁵⁸ TFE analysis. Note that the large outlier data points of two suppliers looking to raise more than \$15 million are excluded to avoid distortion of averages.

¹⁵⁹ The downside of these small loans is that they often come with high interest rate as explained earlier.

¹⁶⁰ For example, the A2E Fund offers ticket size ranges of \$50,000-\$150,000, Echoing Green in the range of \$80,000 and the Efficiency for Access R&D Fund in the range of \$65,000 to \$300,000.

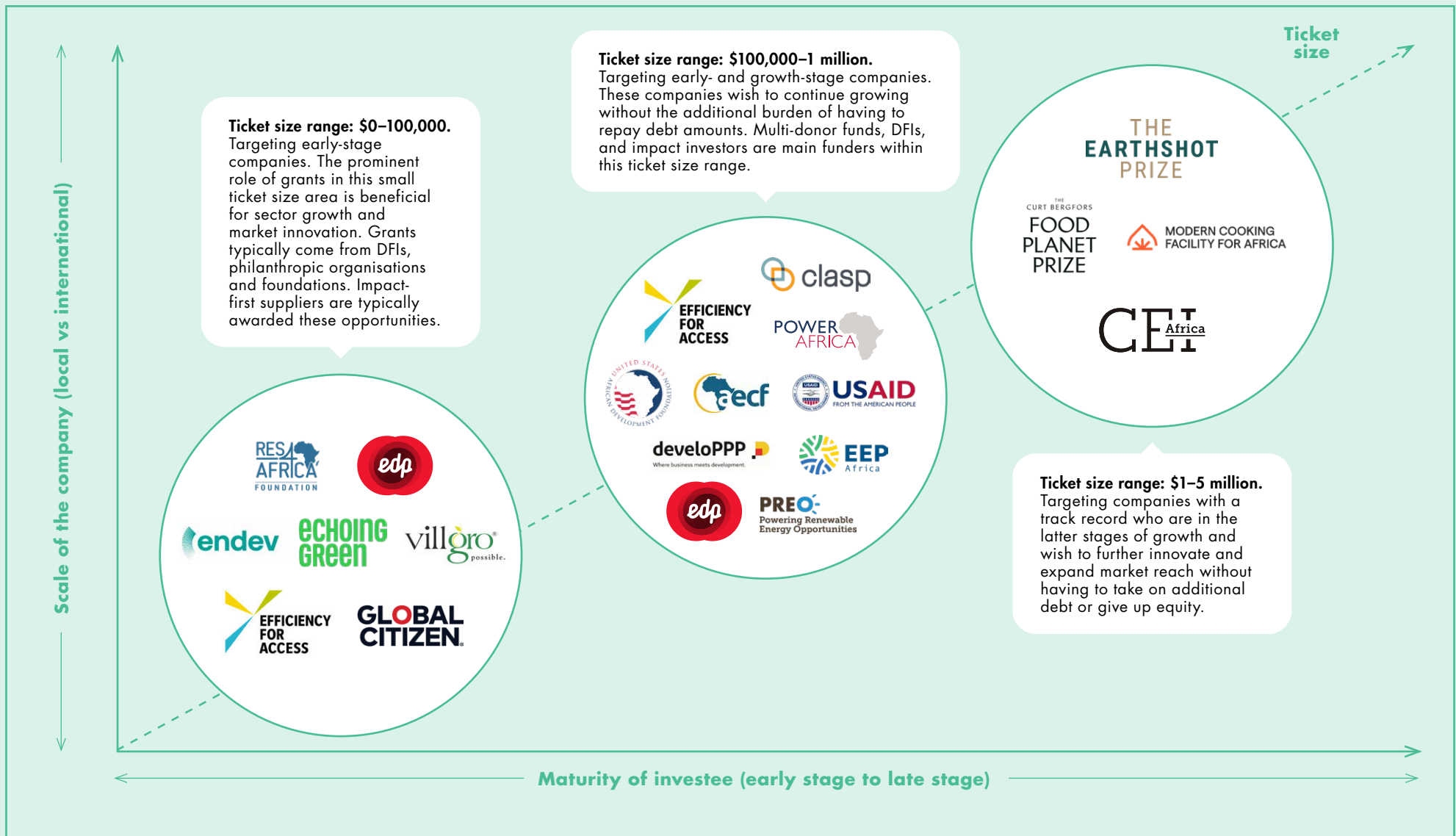


Figure 20: Grant funders in the PUE space in India, Kenya and Nigeria¹⁶¹

¹⁶¹ TFE analysis

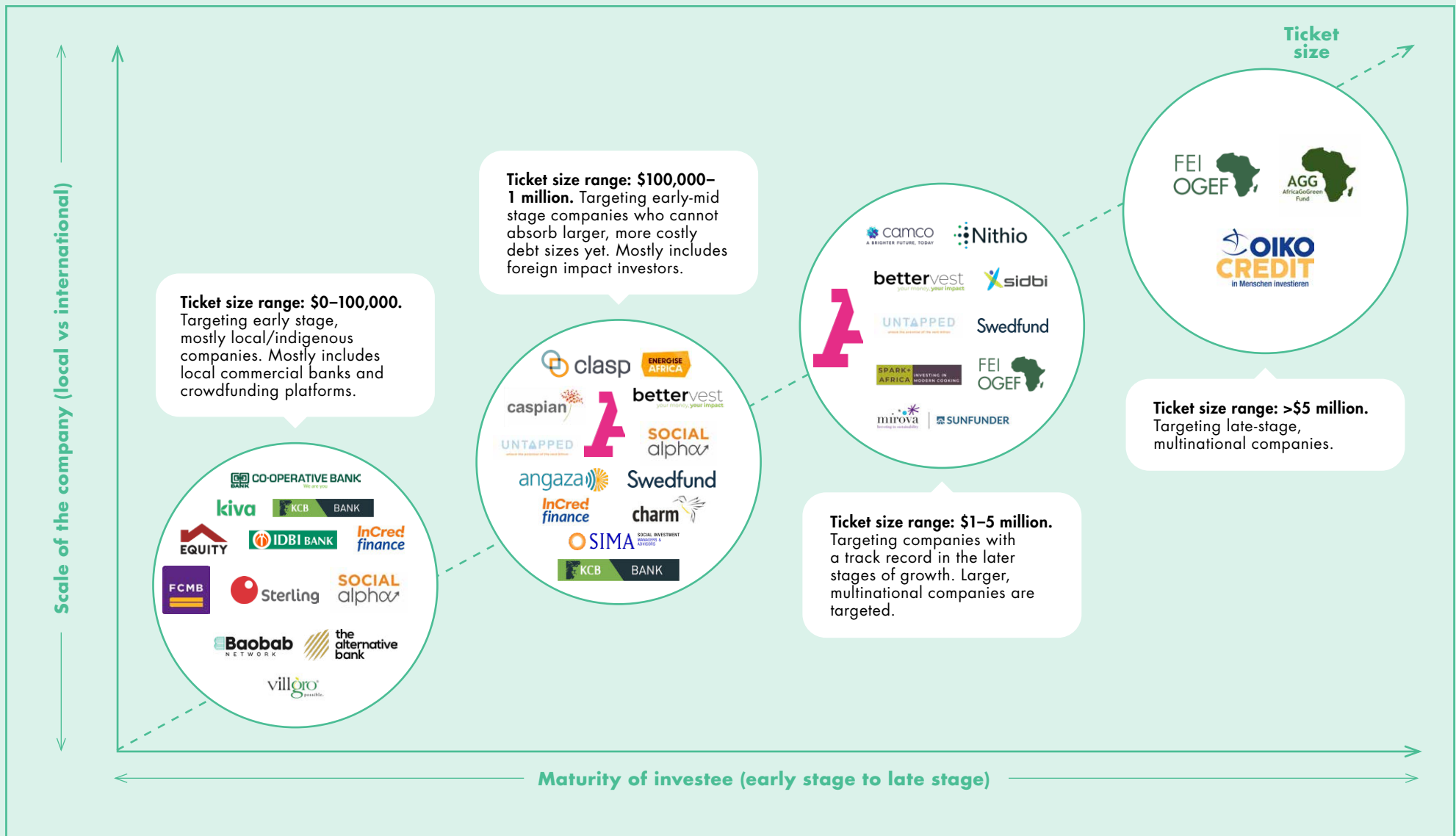


Figure 21: Debt investors in the PUE space in India, Kenya and Nigeria¹⁶²

¹⁶² TFE analysis

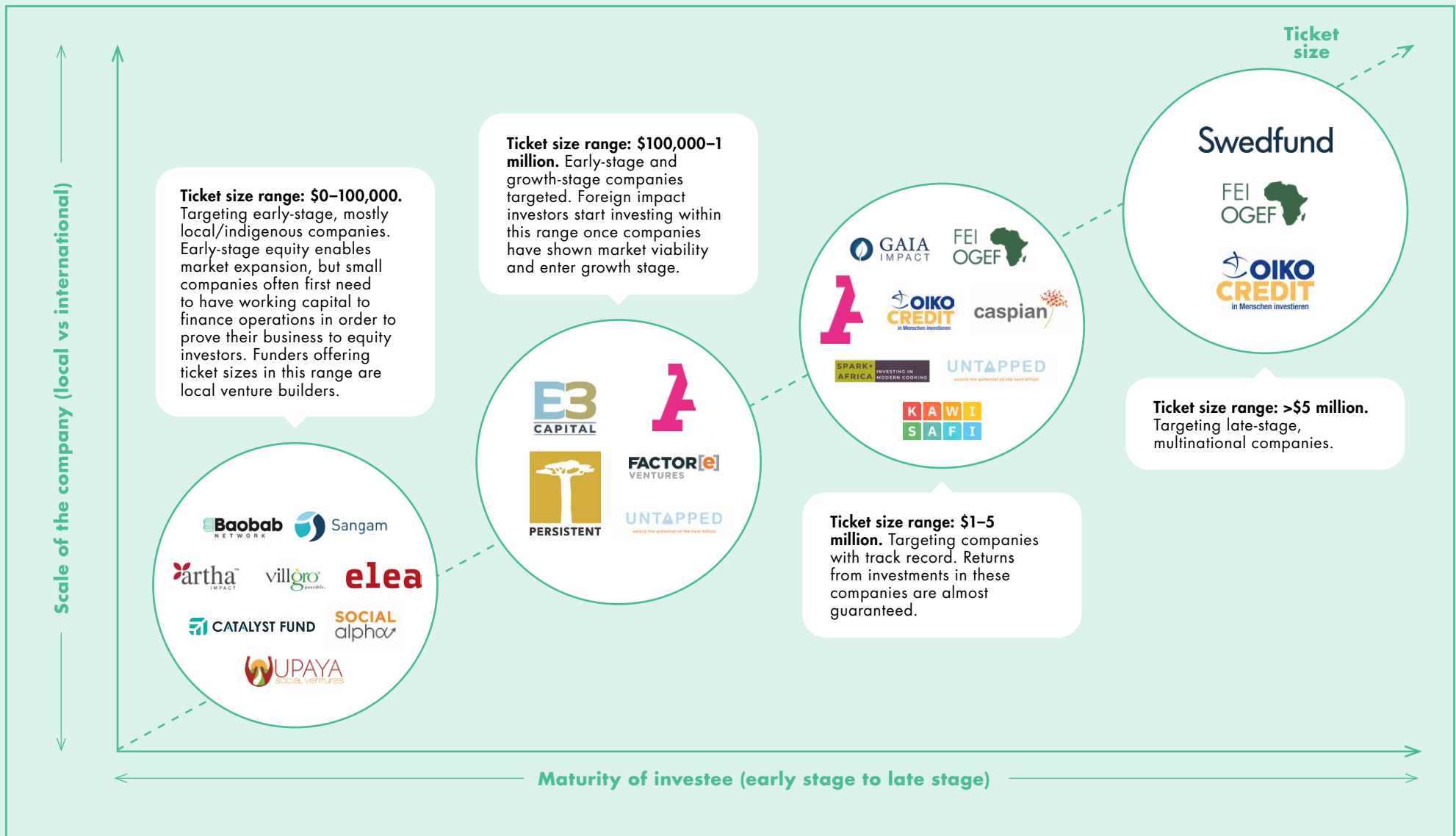


Figure 22: Equity investors in the PUE space in India, Kenya and Nigeria¹⁶³

¹⁶³ TFE analysis

The results of this analysis indicate that there is a need for bridging the gap between what funders are currently offering and what suppliers can absorb or qualify for. Funders that introduce quickly disbursable, smaller ticket size debt and grants are likely to find attractive investment opportunities in the sector. Funding that grows in size and type alongside the investee, for example from small repayable grants to larger debt investments can especially yield results. Investors are also more likely to find investable pipeline by adopting risk assessment methodologies that drill down into the nuances of risks presented by a prospective investee by analysing data in novel ways. If an investor finds that a given supplier presents high risk in some areas, the methodologies and tools presented below offer the opportunity to manage that risk more effectively, in turn enabling the investor to proceed with the investment instead of turning the supplier down:

- Ingesting and creatively analysing data offered by the prospective investee or generating completely new datasets that provide insight into the future of the company's operations, for example:
 - Nithio's Risk Analytics Engine uses customer repayment, socioeconomic and geospatial data to analyse the portfolio performances of prospective borrowers;¹⁶⁴
 - VIDA's geospatial platform identifies the socio-economic health of any location, including hard-to-reach rural villages.¹⁶⁵ Investors could therefore assess the probable ability to pay for PUE solutions of customers in the locations where the supplier operates.
- Predicting future payment behaviour of suppliers' existing customers using historic payment data. Platforms such as Bridgin and the Superpower Africa Fund use historic payment data to predict future payments and analyse the receivables of PAYGO customers. Based on these analytics, suppliers can monetise their future receivables at an appropriate financing cost. This refinancing service allows suppliers to recycle capital faster instead of waiting for the PAYGO contract to elapse to monetise all instalments due by the customer.
- Long range climatic forecasting to assess how future proof the company is against climate shocks. VIDA's platform also assists investors to assess potential impacts of climate events on investment risk.

7.2.2 For go-to-market partners

The gap between suppliers and investors can only be meaningfully closed if work to bridge it is done from both sides. Suppliers therefore have an equally important role to play in closing the gap with funders and investors. Earlier we noted that the market contains many quality suppliers that do not qualify for minimum investor requirements. Despite these suppliers offering high quality products and services to their customers, there is still work that can be done to increase their investability. Investors commonly report that financial reporting and data management is often found to be lacking among suppliers.

- **Improve the accuracy of financial reporting:** Investors often find it hard to accept suppliers' financial statements at face value. While basic financial statements are commonplace among suppliers, they rarely keep record of metrics pertaining to solvency, liquidity and unit economics.¹⁶⁶ Adoption of International Financial Reporting Standards or mere incorporation of industry key performance indicators (KPIs) such as the Global Off-Grid Lighting Association (GOGLA)'s PAYGO Perform KPIs can guide business owners in improving their financial reports.¹⁶⁷
- **Improve data management practices:** It can be difficult to ascertain actual levels of product performance due to the lack of reliable data.¹⁶⁸ Incorporating data management systems that offer coverage on customer performance can thus have a transformative impact on investors' perception of PUE energy solution suppliers. Off-the-shelf data management software such as Bridgin and Angaza can enable suppliers to generate reports on these often-overlooked metrics.

¹⁶⁴ Nithio, Nithio's Risk Analytics Engine 101, 2022 ([link](#))

¹⁶⁵ VIDA, VIDA use case: Sierra Leone, 2023 ([link](#))

¹⁶⁶ USAID, Financial management handbook for off-grid solar companies, 2023 ([link](#))

¹⁶⁷ Reynolds, O., PAYGo PERFORM KPIs, 2024 ([link](#))

¹⁶⁸ Wearne, A., van der Linden, J. & Bloomfield, Z., Energy for Rural Industrialisation: Productive Use of Energy 2.0, 2022 ([link](#))

Box 9: Intended applications of suppliers' funding needs

The key funding needs identified among PUE suppliers during the course of this research encompass a range of operational and developmental aspects. Addressing these financial needs through customised funding offerings could significantly enhance the capability of PUE suppliers. When asked about the intended application of funds required, suppliers mentioned the following:

- **Standard working capital debt to buy and hold more stock and for everyday operations**
- **Subsidisation of product costs for end users**
- **Business process streamlining**
- **Expanding the use of PAYGO:** Especially in Nigeria, where its use is still comparatively low. Solaristique, who recently discontinued the use of PAYGO and lease to own, stated that funding can help them to start new improved approaches to consumer financing. Similarly, HTS Farms would like to offer consumer financing to increase adoption of their egg incubation machines.
- **R&D:** Required to further develop and improve on product and service offerings, and to invest in digital infrastructure. Burn for example noted they are currently developing a tier 4 burner that will use both wood and electricity while Mukuru is developing a mosquito repellent fuel which they intend to sell in parallel to their cookstoves. SaiDhan Industry wants to invest in R&D to reduce the dependence on China for components like controllers for their PUE products.
- **Market expansion:** To grow into new regions or expand product and service offerings. For example, India-based Ksheera Enterprises wants to diversify their product offerings by introducing new PUE appliances. ColdHubs wants to expand the sales of their existing cold room offering to more markets, as well as logistical cooling, while Mukuru Stoves would like to increase their sales from 420,000 to date to 1 million. Omnivoltaic believes they can grow from currently employing 45 employees to 200. They are currently only depending on organic growth, which is a limiting factor to their growth potential.
- **Pilot demonstration projects:** Pushan Renewables noted the importance of pilots to demonstrate the long-term benefits of adopting innovative PUE solutions among end users. The company mentioned the need for training local youth in operation and maintenance of PUE for creation of a local after sales ecosystem in remote regions.
- **Applying for certifications:** Some suppliers are looking to apply for certifications to be able to do business with larger clients. These applications and associated certification are often costly and time consuming. For example, Drop Access is aiming to achieve WHO certification for healthcare fridges.

- **Employ financial aggregation techniques:** There is potential for companies to aggregate their financing needs and collectively apply for funding. Aggregation of suppliers' funding needs into a single large investment can assist suppliers in the same way that it is beneficial in the case of bulk procurement.¹⁶⁹
- **Business model innovation to open up new markets and funding opportunities:** Suppliers operating with deferred payment PAYGO or as-a-service business models are able to open up a larger market and increase their suitability to low-income end users. These business models are, however, capital intensive and present cash flow challenges. Yet in many cases, particularly in Kenya, these cash flows are digital, often via mobile money platform providers. As such, if suppliers can keep standardised records of their digital cash flows, there is a significant opportunity **to leverage these digital cash flows** to open up new sources of finance. If standardised digital cash flows can be aggregated (even across companies and geographies), they can be more accurately risk assessed, derisked (through, for example, their inherent diversity or targeted first loss facilities) and presented to financiers. This **standardised receivables financing** would bring down the cost of capital and provide a source of hitherto unavailable, affordable debt in a manner much more in keeping with the developmental stage and size of the suppliers in question.

7.2.3 For market enablers

India has already taken some steps towards standardised financial records with the national Goods and Service Tax Network (GSTN),¹⁷⁰ which can provide a centralised source of financial data on a company. This is useful to provide some insight into the financial health of a company, but does not allow analysis down to the resolution of individual customers or assets which is critical for assessing

income streams, determining risk and sizing finance accordingly.

There is also value in combining receivables financing and bulk purchasing for suppliers of PUE equipment, which was underlined during one of our interviews with a PUE equipment manufacturer. This company's factory is in India, but their primary markets are in Africa. They used to sell directly to end customers, but now work with networks of distributors across the continent. These distributors often struggle to raise the \$100,000 necessary for a shipping container of products and so are forced to either buy and import products in small quantities at greater expense or wait, in the face of unmet customer demand for their capital to accumulate sufficiently. This manufacturer expressed interest in working directly with a USD-denominated financier to extend lines of credit to these distributors. The selection of which distributors to extend credit to could be partly determined by their payment history to the manufacturer thereby reducing the risk to the financier.

7.3 Subsidies and consumer (demand side) finance to address affordability

7.3.1 For financial institutions

Due to the affordability gap challenge, many of the businesses interviewed offer consumer finance packages, or at the very least expressed a need to do so. The impact on affordability and, in turn, user uptake of PUE technologies is considerable. Data from mini grid sites in Nigeria and Kenya shows for example that energy consumption among productive users increased by 48% after being offered appliance financing to purchase equipment.¹⁷¹ Companies however need extensive working capital and finance skills to extend financing to their customers. This is often enabled by targeted funding support, for example the Odyssey

¹⁶⁹ Troost, A.P., Duby, S., Lotter, A., Makanza, K., Sephelane, N. & Chizema, T.R. *Financial aggregation for distributed renewable energy in East Africa*, 2024 ([link](#))

¹⁷⁰ Clear, *What is GSTN (Goods and Service Tax Network)?*, 2022 ([link](#))

¹⁷¹ Crossboundary, *Appliance financing 3.0 innovation insight*, 2022 ([link](#))

Gender Results Based Financing for Productive Use technologies programme,^{172,173} and others such as the Rural Electrification Agency of Nigeria's Productive Appliances and Equipment for Off-Grid Communities funding initiative and India's Mission for Integrated Development of Horticulture.^{174,175} This approach is however not sustainable in the long run as it depends heavily on the willingness of donors and governments to offer funding. [Section 6.2.2](#) noted the large disparity between subsidies available to different sectors in India. This underscores the need for funders to offer more tailored financing mechanisms that are specifically designed for various PUE applications and sectors, but suppliers should not base their entire financial model on such financial assistance.

7.3.2 For go-to-market partners

Alternative to depending on funding support to extend consumer finance, suppliers can opt to offer demand side financing in partnership with MFIs or banks. Achieving a successful partnership, does, however, require due consideration of potential barriers and pitfalls. Firstly, MFIs and banks are not always best placed to accurately assess the creditworthiness of would-be financing customers. To do so, additional revenues generated from utilisation of the PUE solution need to be included in the assessment. Estimating revenues enabled by the PUE solutions requires specialised, sector-specific knowledge – which banks and MFIs typically do not have. Suppliers would be well advised to ensure that MFIs and banks understand these methodologies. Alternatively, suppliers could take responsibility for creditworthiness assessments. As an example, Husk Power, a mini grid developer and operator in India and Nigeria uses a proprietary credit rating system based on 50 financial and non-financial indicators to assess customer creditworthiness prior to extending appliance financing.¹⁷⁶ Secondly, MFIs typically prefer short repayment periods, and

repayment periods of PUE solutions, especially larger and more expensive ones tend to be longer. Finding a common ground in terms of acceptable repayment periods is critical.

7.4 Building consumer awareness

7.4.1 For market enablers and go-to-market partners

Consumer awareness programs are instrumental in driving the adoption of PUE technologies. They not only increase the uptake of these technologies but also lead to improved business performance, higher electricity consumption, and boost local incomes. This in turn leads to a stimulating local economy creating a sustainable and impactful cycle of growth and development. Government agencies can play a key contributing role as they remain a trusted source of information in the countries studied. Providing demonstration centres for PUE appliances and taking responsibility for other administrative tasks would create the space for suppliers to focus on the technical aspects of delivering demonstrations, saving a significant amount of time in the process.

Despite their efficacy, as a scalable PUE stimulation intervention there are limitations in consumer awareness campaigns:

- **Specificity:** Successful awareness programs must tailor their messaging to address the specific needs and contexts of different user groups;
- **High input requirements:** Practical demonstrations and hands-on training are crucial for building user confidence and showcasing the tangible benefits of PUE technologies;
- **Long term commitment required:** It has been shown that continuous mentoring and support are necessary to address challenges and reinforce the benefits of PUE adoption.

¹⁷² Odyssey, *Gender Results Based Financing for Productive Use technologies* ([link](#))

¹⁷³ The programme aims to incentivise distributors of productive technologies to encourage women to use technologies to improve their livelihoods. This is done by subsidising 30-60% of the cost of PUE solutions.

¹⁷⁴ Bagdia, R., Keche, Y., Agrawal, A., Parakh, A. & Gattu, A., *Assessment of the cold chain market in India, 2023* ([link](#))

¹⁷⁵ The MIDH provides subsidies amounting to 35% of project cost, which increases to 50% of project cost in hard to reach areas. Cold storage solutions and other technologies in the horticultural sector are eligible.

¹⁷⁶ Vrba, J., Miller, C., Carmichael, E. & Day, D., *The road to zero interest: The potential role of concessional consumer financing in energy access, 2023* ([link](#))

Box 10: Case study of the efficacy of consumer awareness programs

The Rural Electrification Densification Project (REDP) Phase 2, implemented by Energy 4 Impact in the Mbeya, Songwe and Arusha regions of Tanzania, was designed to promote the productive use of electricity by stimulating investments in income-generating equipment.¹⁷⁷ A key component of this project was raising consumer awareness about the benefits and practical applications of PUE technologies.

Specifically, E4I provided:

- Business skills training
 - Financial skills training (bookkeeping, revenue, expenses, etc.)
 - Management skills (business plan, strategy, etc.)
 - Sales skills (access to market, marketing, etc.)
- Advice on how entrepreneurs could register and formalise their businesses;
- Links to financial institutions to apply for loans;
- Technical advice on PUE equipment.

Fridges and freezers were by far the most popular PUE technologies bought by entrepreneurs, with blenders and hair clippers coming next.

Outcomes and Impact**Increased Adoption of PUE Technologies:**

- **Higher Sales of PUE technologies:** Despite the fact that no funding was provided directly, as a direct result of the awareness programs, there was a significant increase in the purchase of PUE technologies. 561 technologies were procured by mentored entrepreneurs, surpassing the initial target of 500. Of these 70% were bought with the entrepreneurs' own capital.
- **Broader Range of Applications:** The awareness programs highlighted diverse applications of PUE technologies, leading to a wider variety of equipment being purchased, from electric drills to welding machines and refrigerators.

Improved Business Performance:

- **Increased Profits:** Entrepreneurs who adopted PUE technologies reported substantial increases in their profits. For example, mentored entrepreneurs saw an average profit increase of 112%, with median monthly profits rising from TZS 111,000 to TZS 310,000.
- **Job Creation:** The project facilitated the creation of 739 jobs, significantly exceeding the target of 500.

Enhanced Energy Consumption:

- **Higher Electricity Demand:** The increased use of PUE technologies led to a 102% increase in electricity consumption among mentored entrepreneurs, compared to a 30% increase in the control group. Whilst this is not a direct benefit for the entrepreneurs themselves, this is directly relevant to commercial energy service providers such as mini grid operators as it increases the viability of their businesses.

¹⁷⁷ E4I, From personal correspondence with REDP/E4I consultant Chris Browne, (link)

Consumer protection

Consumer confidence in PUE solutions should be fostered to ensure that a positive reputation develops and the industry grows. Low quality products that underperform will erode consumer confidence and stifle industry growth. Without a standard quality assurance framework for aspects such as electrical safety, guidelines for product performance, viable mechanisms for customers to complain and a system in place to monitor all of this, customers can be put at risk.

In the case of off-grid solar products, GOGLA has published a consumer protection code that outlines principles and indicators of how suppliers can ensure consumer protection in terms of governance, transparency, product quality, data privacy and more.¹⁷⁸ Quality assurance frameworks and testing procedures for a range of off-grid solar products, including PUE solutions, exist.¹⁷⁹ Typically national government-published quality standards also exist for most products. These are especially important in cases where industry quality standards do not exist, as is the case with most non-solar powered technologies covered in this study.

PUE operations depend on collection, processing and storing of data about customers. This includes payment data and personal data (e.g. nature and location of business as well as name, age, gender and contact details of microenterprise owner).

Data protection policies should ensure that this and other sensitive data are protected and data privacy is upheld:

- Personal data should only be collected or processed subject to consent from the customer;
- Customers should have the right to withdraw their consent for processing of their data;
- Data about a customer may only be obtained from a third party (e.g. credit referencing bureaus) under predefined conditions;
- Data should be complete, up-to-date and accurate;

- Data should be accessible to the customer upon request;
- Data should not be stored for periods longer than it is required for;
- Customers should have the right to request erasure and rectification of their data.

7.5 Interventions to increase microenterprises' market access

7.5.1 For market enablers

Microenterprises struggle with connecting to broader markets due to inadequate marketing knowledge and limited use of ICT for marketing their products. This limits their ability to reach new customers and get feedback on their products. This lack of market access has significant knock-on effects on the viability of suppliers servicing these microenterprises. As such an alternative to subsidies involves building a comprehensive ecosystem that includes proper market linkages for end products. Such an ecosystem would help microenterprise users recognise the true value of PUE technologies, thereby supporting a pricing model that reflects fair market value. This shift would not only ensure the financial sustainability of productive energy solution providers but also encourage the adoption of PUE technologies in a way that promotes overall industry growth and sustainability.

The KeyMaker model, developed by INENSUS and piloted in Tanzania with mini grid operator JUMEME is an excellent case study of the efficacy of creating market linkages between rural areas of production and urban areas of consumption.¹⁸⁰ In this case fish from Lake Victoria was frozen using ice created via mini grid supplied solar electricity and, with existing transport infrastructure, delivered to established markets in the capital Dar es Salaam. This end-to-end arrangement ensured a guaranteed off-take market for rural fishermen and provided additional income for JUMEME. Similar models have been implemented elsewhere. In Kenya, Stable

¹⁷⁸ GOGLA, *Consumer protection principles & indicators, 2023* ([link](#))

¹⁷⁹ Atieno, C., Kimathi, K., Lai, C. & Macdonald, R., *Rapid product assessment: A new approach to testing productive use appliances, 2022* ([link](#))

¹⁸⁰ González, G.T. & Peterschmidt, N., *KeyMaker Model Fundamentals: Mini-grids as a tool for inclusion of deep rural communities, 2019* ([link](#))

Foods purchase crops grown by their solar water pump customers,¹⁸¹ while the Charles Stewart Mott Foundation has rolled out an ecosystem approach similar to that of the KeyMaker model.¹⁸²

In a similar fashion, Uganda-based EnerGrow exists to support energy access customers grow their energy consumption through low-interest appliance financing and business support training. Loans offered to customers vary between \$50 and \$5,000 with tenors ranging between 6 months and 3 years.¹⁸³ Incomes of EnerGrow's customers have been reported to increase with approximately 50%.¹⁸⁴

7.5.2 For go-to-market partners

PUE go-to-market partners (e.g. suppliers and distributors) tend to rely on government subsidies and donor support to aid end-consumers. However, even with these demand-side interventions in place, the upfront costs of PUE technologies can be prohibitive, and this model is not sustainable long-term. By providing better market access for microentrepreneurs, and in so doing increase their ability to pay for PUE products and services, the sector at large can become profitable and sustainable. Additionally, promoting the green features of end products using PUE appliances can enhance market reach for microenterprises, making PUE more feasible and attractive.

Tamul Plates in India has achieved success with its innovative two-tier business model, where village-level producers handle production and the firm manages marketing under the Tamul Leaf Plates brand. Targeting the vast market for disposable dinnerware, the firm increased its revenue from ₹12.5 lakh to ₹57 lakh in the first two years of operation. This model has positively impacted the local economy, as 77% of leaf plate producers and many factory workers rely on income from Tamul Plates as their primary source of income, providing a stable and predictable alternative to manual

labour in Northeastern India. For many village production unit owners, operating these units serves as a secondary source of income, complementing their primary agricultural activities. The firm has also addressed seasonal challenges, such as the availability of arecanut leaves, ensuring that raw material collectors can engage in this activity alongside other full-time work.

Similar approaches are emerging in the textile value chain. India-based Resham Sutra has expanded its business model to offer comprehensive support to microenterprises, including training, raw material access, rural business setup, and both offline and online marketplaces for product sales. This end-to-end assistance strengthens the entire production ecosystem. Nigeria-based Zinsutech trains textile microenterprises on how to repair sewing machines in line with international standards, which ensures that these entrepreneurs experience less downtime from their machines. Similarly, India-based Greenwear trains women in yarn-making and sewing using solar-powered machines. The company achieves its zero-emissions goals while enhancing the financial security and stability of its workforce and customers.

7.6 Technical assistance for PUE supplier business development

7.6.1 For financial institutions and market enablers

During interviews suppliers mentioned that they require technical assistance in the following areas:

Baseline studies to understand the addressable PUE market:

- Market research services: Engage expert market research firms to conduct comprehensive baseline studies. These studies should include demand assessment, competitive analysis, and identification of key market drivers and barriers.

¹⁸¹ Charoy, T. & McGrath, L.K., *Under-leveraged best practices for scaling PUE appliances: Part 1 – Sales support and market access*, 2024 ([link](#))

¹⁸² The Charles Stewart Mott Foundation, *DREEM Hub Kenya – Solarizing key agricultural value chains*, 2024 ([link](#))

¹⁸³ EnerGrow, *About Us*, 2024 ([link](#))

¹⁸⁴ NEFCO & TetraTech, *Scaling productive use of energy solutions in sub-Saharan Africa*, 2023 ([link](#))

- Data collection and analysis training: Provide training to local teams on data collection and analysis techniques to enable continuous market assessment and adaptation.

Implementation of digital platforms:

As is evidenced through our interviews, standardised, off-the-shelf digital technologies such as the Angaza platform or PaygOps can reduce the operational burden of smaller companies especially as it relates to tracking of customer interactions, managing sales pipelines and providing customer insights. However the commercial nature of these platform providers means that the cost associated with their use often excludes smaller suppliers. An intervention that subsidises the cost of these services for qualifying small-scale suppliers can greatly address the issue of limited penetration of digital systems among suppliers. Technical support to integrate these digital solutions will also be of use as suppliers might not always be aware of their value add.

Implementation of systems to absorb carbon credits:

- Carbon credit expertise: Partner with digital platform providers to develop and implement systems for tracking and verifying carbon savings. Intermediaries such as Prospect, Solaris Offgrid¹⁸⁵ and others play a critical role in hosting, standardising and aggregating data from PUE and energy access companies. This data can then be verified by carbon verification agencies.
- Financial support and technical assistance for setup: Setting up a carbon credit project is costly, time consuming and not straightforward. Validating a carbon credit project typically ranges between \$12,000 and \$20,000.¹⁸⁶ Financial assistance to cover these costs would be needed if more, especially smaller PUE suppliers are to benefit from the carbon market.

Technical assistance for business development:

- R&D collaboration: Given interviewed suppliers' need for technical assistance in R&D, market enablers could foster partnerships between suppliers and research institutions or technical experts to drive innovation. Many funders and investors offer technical assistance in these and other domains, including the likes of EnAccess, EEP Africa, Bamboo Capital Partners, CLASP and Oikocredit.
- Scoping studies for market expansion: Support suppliers to conduct feasibility studies for market expansion. This includes assessing new market opportunities, optimal site locations, and potential partnerships.
- Marketing campaigns: Assist suppliers and distributors to develop and execute targeted marketing campaigns to raise consumer awareness about PUE products. This includes online marketing, community outreach, and participation in trade shows. Due to the use case sensitivity of many PUE products, suppliers might need different teams or individuals specialising in the different products on offer. Insights from the field indicate that providing potential customers with the opportunity to touch, feel and test products beforehand has a positive impact on customer demand.¹⁸⁷ The Global Distributors Collective for example offers training to last-mile distributors on supply chain management, financial reporting, after sales offerings and agent recruitment among other topics.¹⁸⁸
- Branding and communication training: Train internal teams on effective branding, communication strategies, and digital marketing techniques. This is important not only for marketing of the business, but also for increasing consumer awareness of PUE products.

¹⁸⁵ PaygOps, *Getting clean cooking distributors closer to carbon finance*, 2024 ([link](#))

¹⁸⁶ Van Basten, P., *Integrity is everything: Monitoring and evaluation techniques to build trust and value – takeaways from our carbon finance webinars*, 2024 ([link](#))

¹⁸⁷ Global Distributors Collective, *Selling productive use of energy products to last mile consumers*, 2022 ([link](#))

¹⁸⁸ Global Distributors Collective, *Upskilling the last mile training programme for last mile distributors*, 2024 ([link](#))

- **After-sales infrastructure:** After-sales support can be challenging due to the relative complexity of PUE products and a supplier must have designated teams or individuals trained to assist customers with troubleshooting. There have been examples of suppliers repurposing existing sales agents for after sales support for PUE technologies, which has resulted in failure.¹⁸⁹ It is therefore unsurprising that suppliers have commonly expressed the need for assistance on setting up systems for after-sales support, including customer service hotlines, maintenance services, and feedback mechanisms.

7.7 Improving last mile connectivity

7.7.1 For go-to-market partners

Last-mile connectivity for marketing and after-sales services presents a significant challenge for PUE suppliers. The remote location of most

rural microenterprises complicates logistics and increases costs, especially for low-volume orders. Establishing an effective distribution network and improving product availability are therefore crucial interventions to increase PUE adoption among rural microenterprises.

A promising solution involves go-to-market partners leveraging existing village-level vendors of conventional products, by training them on the benefits of PUE solutions. Local distributors can also facilitate after-sales services, capitalising on their proximity to the deployed assets. This approach not only enhances product credibility but also strengthens the local marketplace and serves as an opportunity for job creation.

Given the importance of upholding a positive reputation when it comes to the performance of PUE technologies, suppliers have attempted multiple approaches to the issue of repair and maintenance. This is also in response to the willingness of customers across markets to have their products

Box 11: AgriVijay's approach to bridging the gap with hard-to-reach customers

AgriVijay's business model in India's agriculture value chain exemplifies the solution that involves local vendors of conventional products. The company has established approximately 80 renewable energy stores by partnering with existing rural retailers – local entrepreneurs with established hardware and pesticide businesses – as franchisees. This creates a 'renewable energy marketplace' serving farmers and rural households. Becoming an AgriVijay franchisee requires an investment of \$300-\$480, and partners undergo comprehensive training to educate farmers, provide product demonstrations, and handle basic maintenance.¹⁹⁰ The approach tackles multiple challenges associated with PUE and in general off-grid renewable energy appliances.

The company proactively educates farmers about products, their applications, and benefits, while ensuring a diverse range of products is available to meet varied rural customer needs. By establishing localised distribution networks, AgriVijay bridges the supply-demand gap, improving accessibility. The company offers comprehensive after-sales support, including maintenance and repairs, backed by multilingual local call centres. Additionally, AgriVijay collaborates with financial institutions to provide flexible financing options, reducing upfront investment barriers for farmers.

¹⁸⁹ Charoy, T. & McGrath, L.K., *Under-leveraged best practices for scaling PUE appliances: Part 1 – Sales support and market access*, 2024 ([link](#))

¹⁹⁰ *Productive Use of Renewable Energy in the Agriculture Value Chain: Market Assessment India*, GOGLA 2024 ([Link](#))

repaired instead of buying new ones.¹⁹¹ Training of in-house technicians is key, but the dispersed nature of rural customers often forces companies to outsource this after-sales sub-component. In Kenya, Solibrium Solar in partnership with myclimate is working on developing an open-source map that shows the location of informal repair services, starting with Kakamega County.¹⁹² Initiatives like this assist suppliers with the intelligence they need to offer maintenance and repair services to their rural customers. Training of these informal repair technicians is however still necessary due to the sophisticated nature of many PUE technologies. It is advisable for suppliers to offer products that are in fact easily repairable – this would require easily accessible spare parts and technical designs that local technicians can easily become familiar with.¹⁹³

7.8 Financial and non-financial support to target structural gender-specific barriers

It is important to note that given the holistic nature of the challenges faced by female-owned suppliers, access to capital is not enough. An ‘ecosystem approach’ is necessary to support women’s enterprise development. A World Bank study on gender equality in the off-grid solar sector notes that women’s businesses need a combination of financial and non-financial products and services, including training, mentoring, networking and other advisory services.¹⁹⁴ The successful [Goldman Sachs 10,000 Women programme](#) provides female entrepreneurs in growing economies around the world with business education, mentor networks and access to external capital in the form of loans specifically tailored for women. These include for example simultaneous personal and business loans and maternity loans. The following actions are proposed to advance female participation in PUE solution suppliers:

7.8.1 For financial institutions and market enablers

Build a more enabling institutional environment for women:

- Provide guarantees/collateral for loans accessed by female-owned suppliers;
- Deploy subsidies for female-owned suppliers;
- Recommend gender screening for investors to ensure gender smart investment, for example: [British International Investment Gender Toolkit](#);
- Support female entrepreneur networks and peer to peer support schemes;
- Facilitate roles for women in the planning, design and execution of PUE support programmes.

Build more enabling environments for women within PUE supplier companies:

- Incentivise the appointment of female role models in technical positions to change cultural perceptions of this being a male domain;
- Increase female educational access to STEM programmes;
- Raise awareness using female role models in technical and leadership roles;
- Train suppliers on the business case for employing women and train female entrepreneurs;
- Implement programmes to support a gender inclusive environment, for example human resources policies that address female-specific issues such as equal pay for equal work, provision of childcare or flexible working hours;
- Apply a gender lens in after-sales service to ensure both female and male customer satisfaction is tracked;
- Increase data collection, using frameworks such as the [ICRW Gender Scoring Tool](#) and the USAID [evidence-based methodology](#) to improve gender dynamics.

¹⁹¹ Global Distributors Collective, Last mile repair innovation spotlight, 2024 ([link](#))

¹⁹² Solibrium Solar, Addressing the information and infrastructure gap in solar e-waste management in Western Kenya, 2024 ([link](#))

¹⁹³ Spear, R., Cross, J., Tait, J. & Goyal, R., Pathways to repair in the off-grid solar sector, 2020 ([link](#))

¹⁹⁴ World Bank, Gender Equality in the Off Grid Solar Sector- Operational Handbook for Gender Equality in the Off Grid Solar Sector, 2022 ([Link](#))

APPENDIX A: SUPPLIERS CONSULTED

Company name	PUE value chain/product offering	Country
AP Poultry	Animal husbandry (poultry): Egg incubation machines	India
Burn	Cooking: Improved- and e-cookstoves	Kenya, Nigeria
Blue Star Auto Machines	Cooking: Roti roller, Banana chip slicer, Vermicelli maker	India
C. Woermann	Metalwork: Welding machines. Carpentry: Angle grinders, side planers, power drills	Nigeria
ColdHubs	Cooling: Walk-in cold rooms	Nigeria
DD Solar	Cooling: Solar chest type refrigerator units of 100-200 litres	India
Dellmarc	Animal husbandry: Egg incubation	India
Eja Ice	Cooling: Cooling-as-a-service cold rooms, logistical cooling services, sales of standalone freezers	Nigeria, Kenya
Energy Excell	Metalwork, Hairdressing, Cooling: Inverter welding machines, hair dryers, standalone fridges and freezers	Nigeria
Engie Energy Access	Metalwork, carpentry	Nigeria, Kenya
Dairy Systems and Services	Animal husbandry: Milking machines	Kenya
Drop Access	Cooling: Solar fridges for clinics	Kenya
Hispecs Innovative Solutions	ICT: Computers and printers	Kenya
HTS Farms	Animal husbandry: Egg incubation	Nigeria
Kuku Farmer	Animal husbandry: Egg incubation	Kenya
Ksheera Enterprises	Animal husbandry: Milking machine	India
Magnum Innovations	Animal husbandry: Egg incubation	India
Mukuru Stoves	Cooking: Improved cookstoves	Kenya
Neochicks	Animal husbandry: Egg incubation	Kenya
Nithya Enterprises	Cottage Industries: Paper plate making machines	India
Omnivoltaic Energy	Textiles, Hairdressing, Cooling: 3-10kW inverter systems	Kenya
Oolu Solar	Cooling: 1-5kW inverter systems	Nigeria
Pushan Renewable Pvt. Ltd	Textile: Sewing machine; Animal Husbandry: Egg incubators	India
S.Y Opayemi Enterprises	Textiles: Sewing machines	Nigeria
SaiDhan Industries	Cottage Industries: plate making machine, cotton wick making machine, masala grinder; Cooking: fryers, roti makers	India
Savanna Circuit Tech	Animal husbandry (dairy), cooling: Mobile cooling-as-a-service for dairy farmers	Kenya
Selco Foundation	Cooling: refrigerator, Cottage Industry: rope making machine, Cooking: roti making machine, Textiles: Sewing machines, Animal Husbandry: Milking machine	India
Solaristique	Cooling: Low cost refurbished freezers	Nigeria
Solar Sister	Cooking: Improved cookstoves	Nigeria, Kenya
Sosai Renewable Energies	Cooling, Cooking: LPG cookstoves and standalone fridges and freezers	Nigeria
SmartBuy	ICT: Laptops and printers	Kenya
Sustain Plus	NGO involved in facilitating PUE technologies	India
Zinsutech	Textiles: Sewing machines	Nigeria
Zuhura Solutions	Cooking: Food heating carts	Kenya

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