Powering Jobs Census 2022:
The Energy Access Workforce

POWER FOR ALL

The ROCKEFELLER FOUNDATION

Good Energies BY PORTICUS

GET.invest Mobilising Renewable Energy Investments

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Foreword

The decentralized renewable energy (DRE) workforce is a jobs engine for emerging economies. According to the estimates detailed in the Powering Jobs Census 2022, there are over half a million direct DRE jobs globally, with 374,000 direct DRE jobs across the African continent, and 80,000 in India. By applying the productive use of energy (PUE) jobs multiplier from the Powering Jobs Census 2019, DRE job numbers could grow to an impressive 1.7 million in 2021 alone.

Generously supported by GET.invest, Good Energies Foundation, and The Rockefeller Foundation, Power for All and the #PoweringJobs partners (see page 38) are pleased to present the second Powering Jobs Census. Hundreds of companies in Ethiopia, India, Kenya, Nigeria, and Uganda were surveyed across the DRE technology spectrum. This report represents the largest DRE jobs dataset in emerging markets known today.

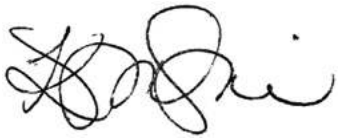
More than just a collection of employment statistics, the Powering Jobs Census 2022 explores the powerful linkages between Sustainable Development Goal or SDG 7 (access to affordable, reliable, sustainable, and modern energy) and SDG 8 (inclusive and sustainable economic growth, employment, and decent work for all). In this 2022 report we return to our baseline countries from prior years (India, Kenya, and Nigeria), as well as adding Ethiopia and Uganda due to growing donor interest in both countries.

Unlike the 2019 report, the 2022 edition focuses solely on direct employment (formal and informal), for increased accuracy of measurement, by relying on information entirely from the survey (not literature review or interviews). The 2019 report emphasized age as a key demographic, while the 2022 version focuses more on gender, in the hope of a more holistic treatment of the issues leading to ongoing pay gaps between men and women. And, of course, the 2022 report directly examines the effects of the COVID-19 pandemic. It is important to note that the DRE sector has proven to be a buffer for the crisis generated by COVID-19 in 2020 and 2021, not only through the direct creation of stable jobs, but also through the impact of access to electricity on the health sector.

Many of the findings in this report—including resilience in the face of COVID-19—suggest there are many reasons to be bullish on the prospect of creating more jobs with each DRE connection. The 2022 census also provides important insights that governments and donors must act on today to ensure the necessary human capital for tomorrow. In addition to addressing the technical, managerial, and organizational training needed to grow the sector, there are structural challenges that limit the DRE sector's ability to accelerate adoption of clean technology and deliver energy access. Ever-changing regulatory environments, inequitable access to subsidies, and cultural norms that often prohibit women from fully participating in the workforce are just a few of the institutionalized biases that govern the pace of change that DRE can deliver to energy poor countries.

#PoweringJobs is a campaign to develop the human capacity needed to deliver SDG 7. Using DRE to provide electricity to nearly 750 million people trapped in energy poverty is a massive opportunity. DRE can create wide-ranging renewable energy jobs and business opportunities in underserved rural areas that need clean energy and economic growth. Many of these rural jobs could be filled by women and youth, who suffer the most from energy poverty and broader economic disenfranchisement. Partnerships with universities and utilities, vocational schools, student organizations, and workforce development boards are all tools that have been used to scale up similar sub-sectors of the energy field, including energy efficiency and utility-scale solar.

In order to have the workforce needed to end energy poverty, there must be a coordinated global effort to develop a DRE-specific human capital pipeline that meets the needs of this rapidly growing sector. I know of no more just transition than what DRE can deliver: a greener economy, good jobs and meaningful work that protects workers, communities, and countries while delivering a more sustainable and resilient future.



Kristina Skierka
CEO, Power for All

About

Coordinated and led by Power for All, the #PoweringJobs campaign and the Powering Jobs Census 2022 are made possible through the generous support and encouragement of The Rockefeller Foundation, Good Energies Foundation, and GET.invest.

Power for All

Power for All is a stakeholder coalition campaigning to rapidly scale the deployment of decentralized renewable energy to achieve universal electricity access before 2030. Decentralized renewables, specifically solar appliances and systems designed for households, businesses, and productive use, offer the fastest, most affordable, and cleanest path to electricity access for all. Power for All brings together more than 300 business, finance, research, and civil society organizations to achieve that goal. **powerforall.org**

The Rockefeller Foundation

The Rockefeller Foundation is a pioneering philanthropy built on collaborative partnerships at the frontiers of science, technology, and innovation to enable individuals, families, and communities to flourish. We work to promote the well-being of humanity and make opportunity universal. Our focus is on scaling renewable energy for all, stimulating economic mobility, and ensuring equitable access to healthy and nutritious food. **rockefellerfoundation.org**

Good Energies Foundation

Good Energies Foundation is a Swiss-based philanthropic organization funding initiatives that work to reverse the impact of climate change in two key areas: access to clean energy and protection of tropical forests. Good Energies is part of Porticus, which manages the private philanthropic endeavors of the Brenninkmeijer family business owners with the aim to help create a just and sustainable future where human dignity flourishes. **goodenergies.org**

GET.invest

GET.invest is a European program which supports investments in decentralized renewable energy. The program targets private sector business and project developers, financiers and regulators to build sustainable energy markets in developing countries. Services include market information, a funding database, matchmaking events and access-to-finance advisory. The program is supported by the European Union, Germany, Sweden, the Netherlands, and Austria, and works closely with initiatives and business associations in the energy sector. **get-invest.eu**

Acknowledgments

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Research Partners

» Africa Minigrid Developers Association (AMDA)
» Africa Solar Industry Association (AFSIA)
» Ashden
» The Center for Law and Social Policy (CLASP)
» CLEAN Network
» Clean Technology Hub
» Council on Energy, Environment and Water (CEEW)
» Ethio Resource Group (ERG)
» GOGLA
» Kenya Renewable Energy Association (KEREA)
» Shortlist
» Uganda National Renewable Energy and Energy Efficiency Alliance (UNREEEA)

Global Steering Committee

» Africa Minigrid Developers Association (AMDA)
» Africa Solar Industry Association (AFSIA)
» Alliance for Rural Electrification (ARE)
» Ashden
» The Center for Law and Social Policy (CLASP)
» GOGLA
» International Renewable Energy Agency (IRENA)
» Sun King
» REN21
» Shortlist
» U.S. Partnership for Education for Sustainable Development
» World Bank – Energy Sector Management Assistance Program (ESMAP)

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Executive Summary

This report presents the findings and implications of Power for All's second #PoweringJobs census for the decentralized renewable energy (DRE) sector, which encompasses a set of technologies that include pico-solar systems, solar home systems (SHS), mini-grids, and standalone commercial and industrial (C&I) solar systems.

The DRE sector has been key in delivering faster, cleaner, and more affordable energy to underserved populations. More than 100 million people in developing countries have access to improved energy via SHS alone [1]. The DRE sector has also been a source of good and stable employment, especially in communities located far away from urban centers. *Powering Jobs Census 2019: The Energy Access Workforce,* featuring employment numbers from India, Kenya, and Nigeria for 2018, showcased the substantial power of the DRE sector to contribute to job creation [2]. This compelling evidence and the positive reactions to it demonstrate the importance of continuing to compile and produce quality data for informed decision-making. In response, Power for All has carried out a new, improved, and expanded version of the census that includes two additional countries: Ethiopia and Uganda.

Powering Jobs Census 2022: The Energy Access Workforce is a bottom-up count of employment in the DRE sector based on a survey of more than 350 companies across five countries: Ethiopia, India, Kenya, Nigeria, and Uganda. Primary data for the period 2019–2023 collected via the surveys, along with existing literature on the DRE sector, was used to estimate the total employment creation in the sector. The data collection and analysis were complemented by five focus group discussions (FGDs), one in each focus country, that helped validate the main results of the census and provided additional qualitative information and context.

This report provides a comprehensive picture of employment in the DRE sector, including recruitment in the sector, the skill levels of the DRE workforce, availability of and investment in training, compensation levels, women's participation, and workforce retention. Drawing from collected evidence and discussions with key stakeholders, the report presents recommendations to help the sector grow and create more and better jobs. Key research findings and recommendations are highlighted below.

1. The DRE sector has continued to be a major driver of employment in emerging markets through 2022. In India, Kenya, and Nigeria, the sector has also demonstrated its resiliency with employment returning to pre-pandemic levels in 2021.

- The DRE sector is a large contributor to job creation in Ethiopia, India, Kenya, Nigeria, and Uganda. The Indian DRE sector is the largest among the countries studied, directly employing more than 80,000 workers.
- In both Kenya and Nigeria, the DRE sector employs close to 50,000 workers. In Kenya, DRE jobs greatly outnumber those of the utility-scale power sector, with estimated employment of no more than 8,000 workers in Kenya Power and Lighting Company (KPLC). In Nigeria, the number of DRE jobs is fast approaching that of the oil and gas sector (currently 65,000) [3].
- In Uganda, the DRE sector directly employed nearly 30,000 workers. Ethiopia registered the lowest employment level among the focus countries of this report, with nearly 14,000 jobs in the DRE sector.
- The pandemic resulted in job losses ranging from 1% (Kenya) to 23% (Ethiopia) in 2020. For the 2019 to 2020 period, India and Ethiopia recorded the highest job losses out of the five focus countries. In addition to the pandemic, other factors such as supply chain disruptions, conflict (particularly in Ethiopia), and foreign exchange (forex) shortages contributed to the decline in direct employment.
- The recovery in jobs (or lack thereof) is largely affected by macroeconomic recovery in domestic markets as well as the severity of COVID-19 restriction measures. In India, Kenya, and Nigeria the DRE sector bounced back strongly and, in 2021, achieved pre-pandemic levels of employment. In comparison, Uganda experienced a slower economic recovery in 2021 due to strict curfews and pandemic-related restrictions which severely dampened employment levels and household income.

2. India, Kenya, and Nigeria are expected to register employment growth in the near term while structural barriers (forex shortages, conflict, etc.) are expected to hinder employment growth in Uganda and Ethiopia.

- Nigeria has seen positive momentum in DRE product demand. This growth has propelled job creation within the sector. By 2023, the sector is expected to create more than 76,000 new jobs, over twice the number of DRE jobs created in 2019.
- India and Kenya are also expected to register employment growth, albeit at a slower pace than Nigeria. In 2023, DRE in India and Kenya is expected to employ nearly 90,000 and 58,000 workers respectively, due to the acceleration of grid electrification (especially in India) and saturation of the off-grid market.
- Uganda and Ethiopia are expected to exhibit contraction in DRE

employment due to declining demand for products in both countries resulting from slow post-pandemic economic recovery and a forex shortage in the case of Ethiopia. Direct market activation measures such as concessional foreign currency loans can stimulate the DRE market and avert the downward trend in employment.

3. The DRE sector has exhibited an increase in the formalization of jobs in all focus countries except for Kenya.

» Compared to the rates seen in the Powering Jobs Census 2019, informality has declined in all focus countries. However, this decline is due at least in part to the disproportionate impact of COVID-19 on informal workers [4].
» In all five focus countries, the share of informal jobs in the DRE sector is lower than the national average—all well above 80%.
» Ethiopia and Uganda have reported the lowest levels of informality in the DRE sector, at 17% and 19% respectively. They are followed by India (23%) and Nigeria (31%).

4. Pico-solar and SHS companies account for the largest share of employment in all four of the African focus countries. However, the share of direct employment from standalone C&I and mini-grid companies is expected to increase in step with increased demand in most markets for larger DRE systems.

» The pico-solar and SHS category comprises the largest share of the DRE labor market in all of the study's focus countries. The pico-solar and SHS category is predominant in the African economies—with employment ranging from 60% in Ethiopia to 99% in Uganda.
» Standalone C&I systems also generate a significant share of jobs, accounting for 47% of total DRE jobs in India, 30% in Ethiopia, and over 10% in Kenya. Mini-grids account for less than 1% of direct DRE employment in all five countries.
» As the DRE sector in each country matures (i.e., demand shifts from pico-solar and SHS to larger systems), the market size of standalone C&I and mini-grids will increase while that of pico-solar and SHS is expected to decline. Since the latter is the most labor-intensive category, a decrease in direct jobs should be expected. However, jobs overall may not decline (and could even rise) as an increase in productive use of energy (PUE) jobs is also expected.

5. More mature DRE markets tend to have a higher percentage of skilled workers compared to emerging DRE markets.

» According to survey respondents, skilled workers comprise 71% of the jobs in the India DRE sector. Similarly, Nigeria and Kenya have high proportions of skilled laborers in the workforce. More than 56% of the DRE workforce in Nigeria is skilled while the equivalent share in Kenya is 43%. In contrast, unskilled workers comprise nearly 75% of the DRE labor market in Ethiopia—the highest share among the countries studied.
» Mature DRE markets tend to have a relatively high share of skilled laborers due to the demand these markets have for advanced technical positions, such as installation technicians and maintenance professionals.
» In countries with nascent DRE markets, such as Ethiopia (where SHS dominates the market), the skills prerequisite is lower.

6. Women's participation in direct employment within the DRE sector recorded a slight improvement but is still far from achieving parity.

» In terms of the share of women in the DRE workforce, Kenya (41%), Ethiopia (37%), and Nigeria (37%) performed substantially better than Uganda (28%) and India (21%). Interestingly, the share of women in the DRE sector closely mirrors the overall share of women in the labor force of each country.
» Women tend to be over-represented in administrative and support functions, such as office assistant, and underrepresented in core functions such as leadership and technical positions. The latter can be attributed to cultural and social norms, which serve as major barriers to women entering the DRE workforce. Fewer women enroll in higher education institutions, which results in fewer women than men applying to these roles [5].

1. Introduction

1.1 Motivation and Research Objectives

Employment is a cornerstone of economic development. Beyond contributing to higher per capita income, inclusive jobs reduce poverty and increase gender equality and independence [6]. The impacts of COVID-19, the surge of artificial intelligence, and the current instability in global markets due to the invasion of Ukraine by Russia, are just a few of the many challenges facing labor markets globally. In sub-Saharan Africa (SSA) and South Asia (SA) preexisting vulnerabilities (including high youth unemployment and widespread energy poverty) combined with strict pandemic lockdowns have resulted in a deterioration of livelihoods and entrenched socio-economic crises.

Decentralized renewable energy (DRE), which includes pico-solar appliances, solar home systems (SHS), commercial and industrial (C&I) standalone systems, and mini-grids, has an important role to play in the current global context. Today, DRE can deliver faster, cleaner, and more affordable energy to underserved populations over the business-as-usual grid-extension approach, while also creating sustainable jobs that help improve local economies. *Powering Jobs Census 2019: The Energy Access Workforce* was the first study of the prevailing employment landscape of the DRE sector and demonstrated the sector's great capacity to contribute to the creation of quality jobs [2]. The report sparked widespread interest, demonstrating the importance and scarcity of quality information for informed decision-making. This led Power for All to carry out a new, improved, and expanded version of the census.

Powering Jobs Census 2022: The Energy Access Workforce is a bottom-up count of employment in the DRE sector, across five emerging economies: Ethiopia, India, Kenya, Nigeria, and Uganda. It consolidates employment information spanning 2019 to 2021 from direct surveys of over 350 DRE companies. The census also includes employment and sales projections for 2022 and 2023. Primary data from the surveys, along with existing literature on the DRE sector, was used to estimate total DRE employment at a national level. The data collection and analysis were complemented by five focus group discussions (FGDs), one in each focus country, that helped validate the main results of the census and obtain additional qualitative information and context.

Powering Jobs Census 2022: The Energy Access Workforce showcases major trends in employment in the DRE sector as well as other relevant dimensions of the sector's labor market, namely the status of the jobs and their distribution in skills; the need for and status of staff training; the size, number, and type of companies in operation; the participation of women and youth in the market; and salaries. This information fills a critical knowledge gap and contributes to understanding the employment potential of the entire DRE sector.

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In providing critical data and insights, the census serves to advance the creation of policies that improve energy access and skills training. By investing in the sector, as well as in the resources to train talent, public and private stakeholders have an opportunity to create millions of jobs while also delivering energy access.

The technologies that comprise the DRE sector are essential to achieving universal energy access (Sustainable Development Goal 7), but the sector also contributes to achieving Sustainable Development Goal 8 through job creation. The magnitude of these challenges has increased significantly, and yet the DRE sector has proven to be a buffer for the crisis generated by COVID-19, not only through the direct creation of stable jobs but also through the impact of access to electricity on the health sector [3], [7]. This report digs deeper into the resilience demonstrated by the DRE sector throughout the global pandemic.

There is still a long way to go regarding DRE job creation information. While there has been increased attention given to jobs in recent publications within the renewable energy community, the existing data is still insufficient—and virtually nonexistent in the countries' statistical offices—to make informed policy decisions. This report is a crucial step towards the goal of reliable, consistent data on job creation within the renewable energy sector. The censuses conducted by Power for All represent the most comprehensive employment surveys to date in the DRE sector. This report summarizes and highlights the main findings of the 2022 census.

1.2 Literature Review: Past Studies on DRE Employment

While there is a growing knowledge base on the relationship between renewable energy and job creation in emerging markets, there are still significant gaps in the existing literature (especially when it comes to DRE) which this report aims to fill.

Renewable Energy

As the world races to achieve net-zero goals, investment in renewable energy technologies is expected to increase, thereby creating additional jobs in the broad renewable energy sector [3]. During the pandemic, the renewable energy sector fared better in terms of employment than the traditional fossil-fuel based energy sector (i.e., fewer layoffs). However, the renewable energy sector is still failing to adequately integrate women into the workforce, and this was only exacerbated by the pandemic.

The most recent *Annual Jobs Review* from the International Renewable Energy Agency (IRENA) shows that within renewable energy the solar photovoltaic (PV) industry has been the largest employer since 2016, with close to 4 million people employed worldwide in 2020 [3], [8]. The global total includes an estimated 342,000 off-grid jobs for South Asia and parts of Africa. Additionally, an IRENA survey found that women represent 32% of full-time employees in renewable energy industries, substantially more than the 22% average in global oil and gas [9]. Women's participation in science, technology, engineering, and mathematics (STEM) jobs in the renewable energy sector is 28% lower than the overall share of women in the renewable energy sector (32%). Women fill larger shares of renewables-related administrative jobs and non-STEM technical jobs: 45% and 35%, respectively.

Ram, Aghahosseini, and Breyer focus on the employment impact of an accelerated uptake of renewable energy generation that sees the world derive 100% of its electricity from renewable sources by 2050 [10]. They find that global direct jobs in the power sector are expected to increase from about 21 million in 2015 to nearly 35 million in 2050. Solar PV, batteries, and wind power are the major drivers of DRE job creation during the envisioned energy transition.

Decentralized Renewable Energy

Additional pieces of literature offer interesting findings on the potential of the DRE sector to create job opportunities. The sector also plays a crucial role in advancing equitable distribution of jobs as a significant share of employment tends to be in remote regions where off-farm job opportunities are scarce.

The Africa Minigrid Development Association (AMDA) claims that mini-grid companies not only create economic opportunities in communities but also provide direct employment across the whole value chain [11]. Their *Benchmarking Africa's Minigrids* report shows that mini-grid developers created 621 local village jobs and 402 central staff jobs from 2010 to 2019 in 288 sites across western, central, eastern, and southern Africa [11]. On average, a mini-grid site creates 0.15 full-time positions for every kW of installed generation capacity. Thus, a standard mini-grid of 20 kW creates around three full-time jobs. Furthermore, a recent report from the Energy Sector Management Assistance Program (ESMAP) reveals that among various power generation technologies, rooftop solar PV creates the most jobs per million dollars of capital investment—specifically, 3 times more jobs compared to other generation technologies and 1.5 times more jobs compared to utility-scale PV [12].

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A Global Off-Grid Lighting Association (GOGLA) report argues that the off-grid solar sector has already created tens of thousands of jobs and is set to create many more in the coming years [13]. In Bangladesh, the off-grid solar industry employs more than 100,000 people with a quarter of them in manufacturing, while in India, it employs 72,000 people.

In addition to direct employment, the DRE sector creates indirect employment. According to GOGLA's estimates, 21 full-time equivalent (FTE) jobs are created in East Africa for every 100 SHS sold. The figures for West Africa and South Asia were 8 and 4 FTE jobs, respectively [14]. A Precise Consult study makes the case that PUE technologies (defined as solar-powered systems that enable agricultural, commercial, or industrial activities) can create around 190,000 jobs across three high-potential value chains in Ethiopia [15].

A recent report by The Rockefeller Foundation estimates that if the required US$130 billion per annum is invested to end energy poverty over the next decade, the power sector will generate 25 million new, direct jobs globally—more than 30 times the number of jobs expected to be created by a comparable investment in fossil fuels [16]. Given the potential to rapidly deploy DRE technologies close to the end-user, the report predicts that around 491 million additional new jobs can be created in downstream applications across agriculture, enterprises, health, and education, among others.

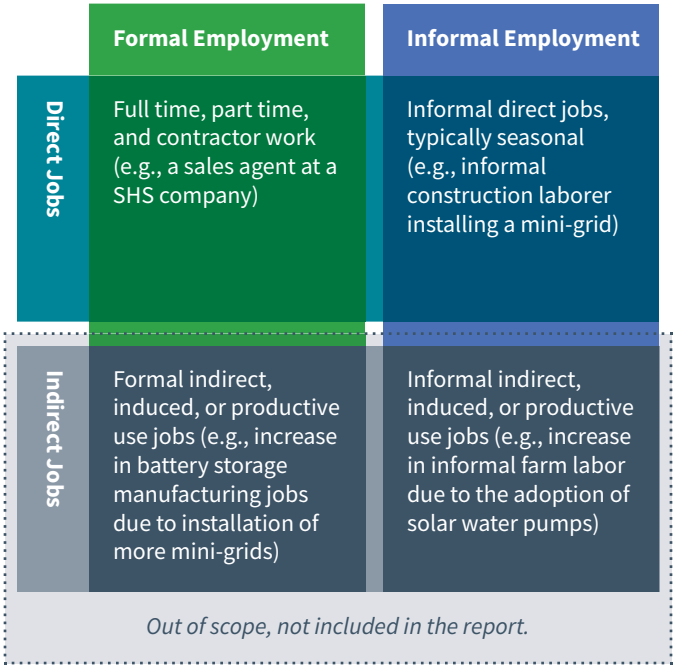
The studies summarized above both support and complement the findings in this report. Taken together, the diverse assessment of jobs by IRENA, AMDA, GOGLA, The Rockefeller Foundation, and Power for All demonstrate the current and potential impact of DRE on jobs and the powerful correlation between ending energy poverty while improving livelihoods.

1.3 Scope of the Analysis

This census uses a bottom-up approach to estimate the employment potential of the DRE sector. This approach consists of a survey of companies in the sector and FGDs to validate the findings. To carry out such a survey and be able to effectively estimate the employment generated by the DRE sector, some methodological and scope decisions were made. The characterization of such decisions is explained in detail below.

Employment type scope: This study only covers direct employment. This report is mostly based on the results of the survey, which asks companies directly engaged in the DRE sector how many people they employ in a given year. It therefore only considers jobs that are created directly by economic activity in the DRE sector. As shown in Figure 1, the survey explores both formal and informal direct employment self-reported by the respondents.

FIGURE 1. SCOPE OF THE SURVEY: EMPLOYMENT TYPE



The DRE sector also creates substantial indirect and induced jobs, but quantifying these would require a different type of survey (e.g., a survey of households, farmers, or other final consumers of PUE appliances). Power for All's Powering Jobs Census 2019 estimated that the sector employed 2–4 times as many people through PUE (as compared to direct jobs) [2].

- **Direct jobs:** Jobs created directly by the economic activity of a DRE company (e.g., jobs at an SHS manufacturing facility).
- **Indirect jobs:** Jobs created by backward and forward linkages (e.g., an increase in agriculture jobs due to an increase in production caused by a solar water pump or an increase in jobs within the restaurant industry due to increased income resulting from access to energy).
- **Formal employment:** Jobs created through legal contractual arrangements by organizations.

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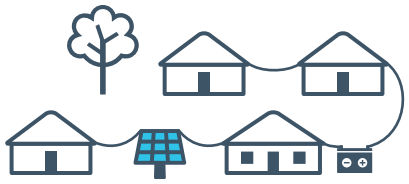
FIGURE 2. SCOPE OF THE SURVEY: TECHNOLOGY TYPE

Pico-solar Appliances	Solar Home Systems	C&I Standalone Systems	Mini-grid Systems
			
< 10 W	10 W+	100 W+	> 1 kW

» **Informal employment:** According to the International Labor Organization (ILO), the informal sector comprises all work for unincorporated enterprises and for which no complete accounts are available that would permit a financial separation of the production activities of the enterprise from other activities of its owner(s). Informal jobs can even include non-remunerative work of contributing family members [17].

Technology scope: The census covers four technology categories in the DRE sector (see Figure 2): small pico-solar appliances of less than 10 W that power a few bulbs or a phone charging station; SHS of up to 100 W that power basic appliances such as TVs and refrigerators; standalone or grid-tied C&I systems that range from 100 W to multiple kW; and mini-grid systems that can be 1 kW up to 10 MW. The survey does not cover clean cooking technologies.

Country scope: The survey was conducted in Ethiopia, India, Kenya, Nigeria, and Uganda. It resulted in over 350 total responses, broken down as follows: Ethiopia (61), India (79), Kenya (72), Nigeria (68), and Uganda (76). The sample size is representative of the overall DRE population in each country.

As the largest DRE market in the world, India is a key country to study [18]. Comparing Kenya's DRE market, which can be considered a stable market with strong sales, with Nigeria, Uganda, and Ethiopia provides insight into the different stages and interrelationships of the national economies with the sector. In addition to this global report, individual country reports will be published that explore each individual market more in-depth. These country-level reports will provide unique insights into the job and skill trends of the DRE markets of each focus country.

2. Labor Market Features

2.1 Employment Estimates

Total Number of Employees

The DRE sector is a large contributor to job creation in Ethiopia, India, Kenya, Nigeria, and Uganda (see Figure 3). Among the countries covered by the survey, the Indian DRE sector boasted the highest level of employment in 2021, surpassing 80,000 workers. This finding was not surprising, given that India has the largest labor force and DRE market in terms of sales. In addition, the employment estimates do not significantly diverge from pre-pandemic employment numbers (95,000 workers in 2018) or from IRENA's DRE employment estimates of around 70,000 workers in off-grid solar PV [19]. India ranks fourth worldwide in the number of renewable energy sector jobs, employing more than 700,000 in 2019; the DRE sector accounts for 11% of India's renewable energy sector employment [3].

Perhaps the most surprising results come from Kenya and Nigeria, two fast-growing DRE markets that have shown massive growth in employment since 2017. Kenya and Nigeria each accounted for about 50,000 direct jobs in 2021, and these numbers are expected to continue growing (see Figure 3). Kenyan DRE jobs greatly outnumber those of the utility-scale power sector, based on an estimated employment of no more than 8,000 workers in Kenya Power and Lighting Company (KPLC). In Nigeria, the number of DRE jobs is fast approaching that of the oil and gas sector (currently 65,000) [3].

In Uganda, the DRE sector directly employed nearly 30,000 workers. Relative to the size of its total labor force, the DRE employment share in Uganda is similar to that of Kenya. On the other hand, Ethiopia, with nearly 14,000 jobs in DRE, exhibits the lowest employment numbers, both in absolute terms and in relation to the size of its labor force. This is despite having the second-largest SHS market in East Africa after Kenya. According to input from the study's FGDs, a potential reason for the underwhelming employment in the Ethiopian DRE sector is a tendency among DRE companies to underreport actual jobs—something common in informal economies dominated by small businesses. Another explanation posited by the FGD participants was Ethiopian DRE companies' perceived reliance on small and medium enterprises (SMEs) and retail shops to sell their products, thus limiting visibility into the level of employment in those companies. Still, direct employment in the Ethiopian DRE sector represents a third of the employment in the large hydropower segment, which currently provides 90% of the national generation capacity [19].

While the total number of workers directly employed in DRE can clarify the contribution of the sector in each country, it does not capture the full picture. The employment factor, which measures how many workers are employed per thousand units sold for SHS and installed capacity (in MW) for mini-grids and C&I, is a measure of how labor-intensive each country's DRE sector is. Uganda has the

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largest employment factor among the focus countries, which reveals several dynamics of the sector ranging from market maturity to the use of mobile money (see Box 1). While countries with more labor-intensive activities are more likely to employ more workers, ultimately employment levels also depend on the overall size of the market. India has the largest market size, based on employment levels, followed by Nigeria and Kenya. Ethiopia has a large SHS market, but a small C&I and mini-grid market.

Type of Employment

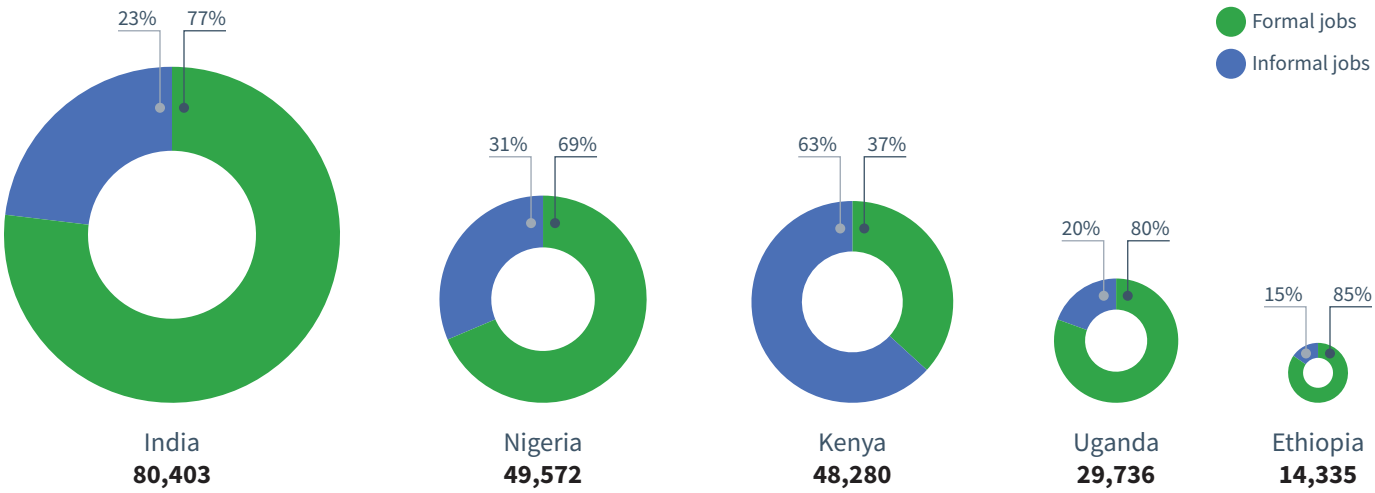
In all of the focus countries, except Kenya, the majority of the DRE sector jobs are formal (see Figure 3). Interestingly, Ethiopia and Uganda have the lowest shares of informal jobs in the DRE sector, at 17% and 19% respectively. They are followed by India (23%) and Nigeria (31%). This is a striking finding, considering the labor markets in all of these economies are predominantly informal with economy-wide shares of informal labor well above 80% and as high as 93% in Nigeria [20]. Even in Kenya, the country with the highest level of informal DRE employment, informality in the DRE sector is 30 percentage points lower than the national average.

Informality in the DRE labor market reflects country-specific characteristics, among which the type of work and technology (e.g., pay-as-you-go, or PayGo) plays a dominant factor. The role of PayGo is explored in subsection 2.3: Employment by Technology Type.

Compared to the Powering Jobs Census 2019 rates, shares of informal labor have declined in all focus countries [2]. There may be multiple reasons for this. According to the ILO, 94% of informal workers in developing countries were adversely affected by COVID-19 policies, implying a much higher job loss for this group compared to formal workers [4]. In addition, the definition of formal employment used within this census includes direct full-time employment, direct part-time employment, and independent contractors. Several DRE companies mentioned that due to COVID-19's impact, some employees' statuses were shifted to independent contractors to gain flexibility. The popularity of these types of contracts has likely reduced the incentives to hire informally.

It is important to note that informality in the DRE sector is substantially lower than the national average of each country. In some cases, such as Uganda and Nigeria, the differences are very large and reflect the good quality of jobs the DRE sector provides compared to the rest of the economy. In addition, despite most of the decline in informal employment being attributed to COVID-19-induced job displacement, the sector still achieved an increased level of formalization. For example, in Nigeria, the estimated number of direct employees increased from 4,000 in 2018 [2] to over 30,000 in 2020. This can be lauded as a huge accomplishment for the sector.

FIGURE 3: NUMBER OF PEOPLE DIRECTLY EMPLOYED IN THE FIVE FOCUS COUNTRIES IN 2021



Source: Powering Jobs Census 2022 data (Power for All) and market size estimates (GOGLA and IRENA)

2. Labor Market Features

Box 1: Employment Factors and Job Creation

The employment factor is defined in this study as the number of employees per 1,000 units sold (for pico-solar and SHS) or as the number of employees per MW installed (for standalone C&I systems and mini-grids). This provides a measure of the labor intensity of each DRE technology and is used—together with market size estimates—to compute the total employment numbers. For a given size of the market, a higher employment factor will translate into higher employment numbers. Similarly, for a given employment factor, a larger market size will result in more jobs.

There are two main aspects by which the employment factor affects overall job creation:

1. **The type of DRE technology:** Pico-solar and SHS technologies are more labor intensive than the other DRE technologies (i.e., have a higher employment factor). This is due to higher sales volumes compared to the other technologies, which require customer service both at the time of the sale as well as later (after-sales services). Thus, countries with a less mature DRE market (i.e., serving the lowest tiers of energy access with solar lamps and small SHS) tend to be more labor intensive.
2. **The degree of technology/AI adoption in the country:** The use of virtual wallets has changed the way of doing business in many developing countries, particularly in Africa. In countries such as Rwanda or Kenya, with very high adoption rates of PayGo business models, the use of mobile money to make payments has superseded the role of salespeople. Respondents to this latest census suggested that salespeople are critical to first purchases, but not for subsequent transactions. This has contributed to a decline in labor intensity, even within pico-solar and SHS technologies.

The average employment factor is calculated using the SHS employment factor as a proxy. This is because SHS accounts for a majority share of employment in all focus countries except for India. With this approach, Uganda and Nigeria have the highest employment factors of 112 and 75 respectively. India, Kenya, and Ethiopia have medium to low employment factors of 53, 24, and 19 respectively. Considering the degree of technology adoption and the type of DRE technology helps to explain, for instance, why Uganda, which serves the lowest tiers of energy access with pico-solar and SHS and is still mostly a cash market, has the highest employment factor. Technology adoption also explains why Kenya, which also primarily serves the lowest tiers but where PayGo is used for half of the sales, has a much lower employment factor.

2.2 Employment Trends

The focus countries studied in this report exhibit varying DRE employment trajectories. Using data from both the Powering Jobs Census 2022 and reliable market estimates, annual DRE employment from 2019 to 2023 in each country is estimated in order to understand the recent past, present, and near-future levels (and trends) of employment. Based on this analysis, the five focus countries can be grouped into three archetypes.

Strong rebound from COVID-19 and rapid near-term growth in employment (Nigeria): Out of the five countries studied, Nigeria was the only one to register a fast recovery and growth in DRE jobs. Nigeria lost almost 2,000 jobs in 2020 from a short-term demand shock caused by uncertainty due to the pandemic. However, the sector bounced back strongly in 2021, registering approximately 50,000 jobs, nearly twice the number of jobs observed in 2020. The demand for SHS products was already on a fast upward trajectory before the pandemic, which was key to the rapid recovery of the DRE sector. This upward trajectory is expected to lead to increased employment opportunities for Nigerian youth. By 2023, the sector is expected to create more than 76,000 jobs.

Strong rebound from COVID-19 but slow near-term growth in employment (India and Kenya): India and Kenya, two major DRE markets, faced labor market contractions in 2020. India's DRE market lost 5,000 jobs in 2020, most likely due to strict lockdowns and the inability of firms to operate, while Kenya's DRE market

experienced a slight decline in employment, losing fewer than 500 jobs at the height of the pandemic. However, both countries are expected to turn this around and achieve pre-pandemic levels of employment in 2022. In 2023, the DRE sector is expected to employ nearly 90,000 and 58,000 workers in India and Kenya respectively.

Contraction in employment (Uganda and Ethiopia): Uganda and Ethiopia registered a significant decline in job creation. Ethiopia recorded 5,000 fewer jobs in the DRE sector in 2020, while Uganda lost 3,000 jobs—the latter is associated with prolonged lockdowns that affected mostly informal employment. Despite macroeconomic recoveries in both countries, the total job creation of their DRE sectors is still expected to exhibit negative growth unless existing market activation strategies such as RBF are strengthened. In Ethiopia, the ongoing Tigray war also stiffens job creation.

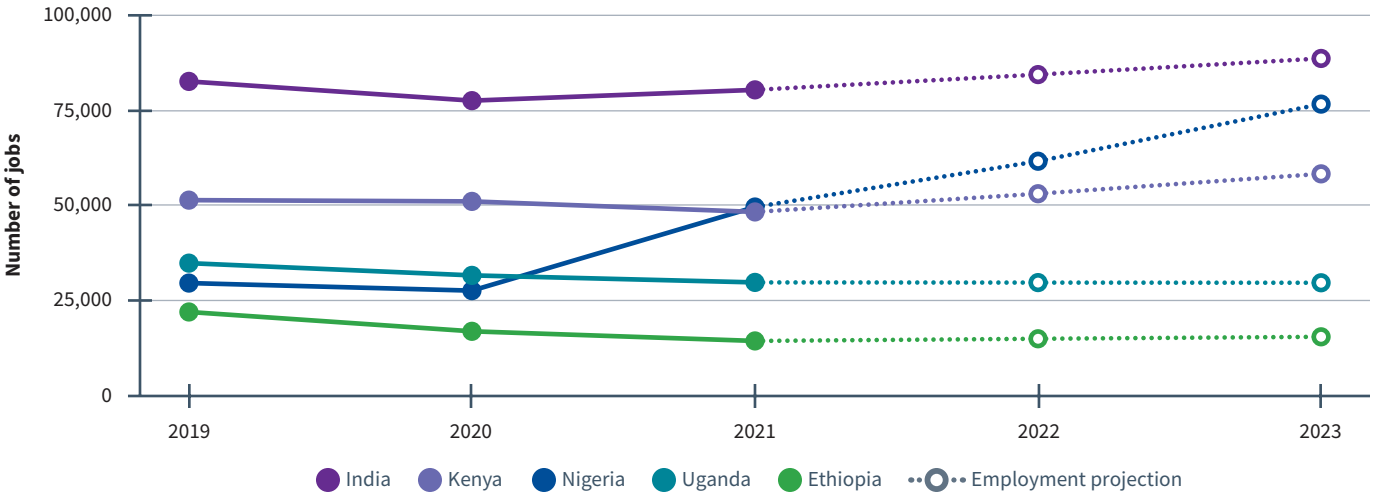
Three main factors account for the major differences in employment trends observed between the surveyed countries' DRE sectors:

1. COVID-19 induced economic recession: The pandemic may have caused 10 to 15 million people and 300,000 to 450,000 enterprises to miss out on improved energy access [1]. Similarly, the pandemic had an adverse effect on all five countries studied in this report. In 2020, all five countries registered a decline in DRE employment as they implemented strict safety measures to combat the pandemic. This led to a decline in the sales of SHS products, which is a major contributor to DRE employment. However, the intensity of restriction measures related to COVID-19 and the pace of economic recovery resulted in varying job creation trajectories. Uganda, for instance, was one of the worst-hit countries, with its GDP contracting by 1.1% in 2020 [21]. Uganda put in place strict curfews and restrictions which directly hit farmers' income. The slow recovery of the economy in 2021 also affected households' income, which reduced the demand for SHS.

2. Grid electrification status: The grid electrification status was another factor that affected job growth in the DRE sector. Some countries have pushed for expanding the grid network. India was able to expand its national grid to all villages in 2019. As of 2020, 97% of Indian households are connected to the grid [22]. Focus group participants in India mentioned that, due to this fast electrification process, the opportunities for DRE sector growth lie in commercial and industrial applications, as well as increasing and supporting grid reliability, rather than in sales of SHS [23]. This is expected to shift employment in the Indian DRE sector from SHS and pico-solar products to C&I and mini-grids. However, this transition is not expected to be fast since there are households living under the grid (i.e., within grid-connected areas but lacking access themselves) that will continue to use pico-solar and SHS technologies.

3. Saturation of the off-grid market status: Another factor affecting employment trends in the sector is the saturation of the off-grid

FIGURE 4: DRE EMPLOYMENT TRENDS IN THE FIVE FOCUS COUNTRIES



Source: Powering Jobs Census 2022 data (Power for All) and market size estimates (GOGLA and IRENA)

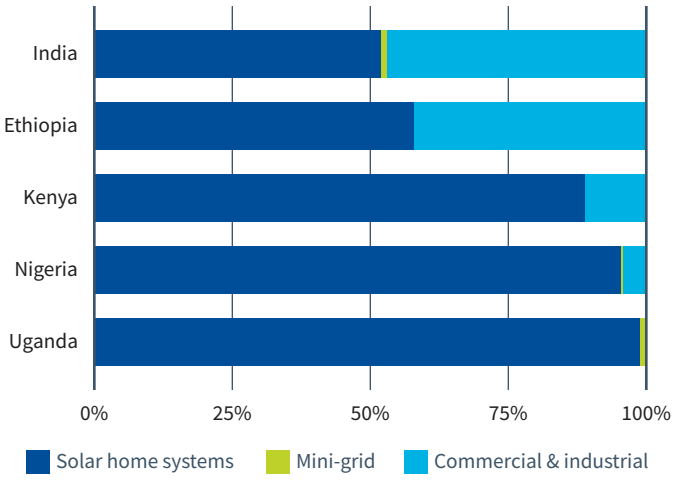
market, especially with SHS technology. In India, the most mature off-grid market, the demand for DRE products is shifting towards higher capacity products such as C&I and mini-grids. However, C&I and mini-grid technologies tend to create less direct jobs and more productive use jobs. So although there has been a recovery in jobs, further job growth is expected to be realized in indirect and PUE jobs. On the other hand, SHS sales in Kenya are expected to remain high—with households transitioning to larger systems and purchasing more appliances in the years to come. In addition, some countries are implementing market activation interventions to boost demand for DREs. In 2020, the Government of Nigeria committed US$24 million to finance the assembly and deployment of 200,000 SHS across the country [24]. This program is expected to create 250,000 new jobs in the DRE sector.

The DRE sector has demonstrated resilience in job creation despite the challenges faced due to the COVID-19 pandemic and the associated supply chain disruptions. The renewable energy sector, in general, and particularly DRE, fared better than the traditional fossil fuel-based energy sector during the pandemic [3]. The resilience of the DRE sector is most impressive in the African countries.

Using the employment factors for 2021 and available market estimates, Power for All conducted a projection of DRE employment for 2022 and 2023 (see Appendix B). As shown in Figure 4, in 2023 job creation in the DRE sector is expected to increase to employ 89,000 workers in India, 58,000 in Kenya, and 76,000 in Nigeria. The fast DRE employment growth seen in Nigeria is expected to continue, bolstered by the expansion of the DRE market.

For Uganda and Ethiopia, the DRE sector is expected to employ 30,000 and 15,500 workers, respectively. If the results from the survey hold true, this would imply that total employment in Ethiopia will be slashed by nearly half compared to 2019, while in Uganda the total employment in 2023 will reach 80% of the pre-pandemic level. The main reasons for the contraction of the DRE labor market are declining demand for products in both countries (due to slow post-pandemic economic recovery) and a forex shortage in the case of Ethiopia. In 2020 the World Bank supported a credit facility that provided Ethiopians with concessional foreign currency loans and is estimated to have contributed 90% of the investment in standalone solar systems. The facility is currently exhausted and has led to a new forex shortage in the sector [25]. This case speaks to the importance of direct market activation measures to stimulate the DRE market and avert downward trends in employment.

FIGURE 5. DRE EMPLOYMENT BY TECHNOLOGY TYPE



Source: Powering Jobs Census 2022 data (Power for All)

2.3 Employment by Technology Type

The Powering Jobs Census 2022 analysis identifies four different DRE technologies, which can be grouped into three categories: pico-solar and SHS products, mini-grids, and standalone C&I systems.

The pico-solar and SHS category is the largest employer in all of the survey focus countries, but most predominantly in the African nations—with employment in SHS ranging from 60% in Ethiopia to 99% in Uganda (see Figure 5). Standalone C&I systems also generate a significant number of jobs, accounting for 47% of total DRE jobs in India, 30% in Ethiopia, and over 10% in Kenya. Mini-grids account for less than 1% of direct employment in all five countries.

Mini-grids, while large contributors to electrification in SSA and India, are currently very small generators of direct employment in these countries. This is expected, as most mini-grid direct jobs are for the development and installation of the assets and, therefore, temporary in nature. After the installation, only a few full-time people are needed for maintenance. The AMDA estimates that three direct, full-time jobs are created for every 20 kW deployed [11]. In addition, the global pandemic has slowed down the deployment of mini-grids in Africa and reduced their employment share [11]. Box 2 summarizes the current state of the African mini-grid market.

These direct employment shares are, however, more informative of

the nature of the DRE technologies than of the employment opportunities in the different countries. For instance, pico and SHS are labor-intensive segments—not only in SSA and India but globally—as they involve a vast array of activities (including design, manufacturing, marketing, installation, maintenance, etc.). In SSA and India, the bulk of employment within these technologies is related to sales. These roles are common and growing in SSA, but the share of sales jobs is expected to decrease in the medium to long term due to two main factors: (1) the rapid growth of digital payments (i.e., PayGo), and (2) the energy access growth to higher tiers in each country (which is accompanied by transitions in DRE technology).

The increased use of PayGo across SSA—already representing half of the lighting sales in Kenya—is shifting the nature of employment from sales jobs to after-sales, logistics, and technical jobs [26]. But the largest disruption will most likely come from the maturity of the DRE sector. As the sector transitions towards larger systems in each country, the market size (and therefore employment share) of pico-solar and SHS is expected to decline, and the shares of standalone C&I and mini-grids are expected to increase. Note that this transition is not expected to occur in the short or medium run for most countries (from this survey sample, only India can be considered to have peaked), but it will have a direct impact on the quantity and quality of jobs created.

On the one hand, the transition towards more capital-intensive technologies may result in a drop in direct employment. As stated earlier, mini-grids employ fewer people per MW compared to other technologies. According to Power for All's analysis, SHS creates 10–100x more jobs per MW of power produced or installed compared to mini-grid and C&I systems. On the other hand, however, it is important to note that most of the mini-grid employment and standalone PUE appliances come in the form of SME employment, such as a village retail store or other value-added services. Therefore, while direct employment might decrease, job creation in DRE overall is expected to rise through the increased productivity multiplier. Powering Jobs Census 2019 identified a 4x productive-use multiplier, which is in line with the insights gathered from this survey's recent focus group discussions. Furthermore, the type of jobs created in C&I solar rooftop, standalone PUE, and mini-grids are more technically complex than those in SHS as they require more installation and maintenance functions (and fewer sales).

The Indian market proves an interesting case study. The Indian DRE sector in 2017 and 2018 was less mature than it is today. The market looked similar to the current status of Kenya or Nigeria, with over 95% of direct employment attributable to pico-solar and SHS technologies. At the time, the Indian Ministry of New and Renewable Energy (MNRE) had set very ambitious targets for mini-grid expansion, from 3.5 MW operated to 500 MW installed by 2023 (see *Powering Jobs Census 2019: Focus on India* [27]). While it seems unlikely that the target will be reached by next year, there has been a massive adoption of solar mini-grids both in rural and urban settings. As a result, not only has the share of pico-solar and SHS in direct employment dropped by half, but the employment factor has also declined. This is a reflection of how DRE market maturity, by privileging less labor-intensive technologies, can change the nature of employment from direct, basic sales jobs to more indirect and induced jobs like local village jobs.

For a better understanding of what a transition to market maturity would entail, Box 2 provides insights on the performance of the mini-grid industry and the main challenges facing the region in 2020 and 2021, drawn from the second edition of AMDA's *Benchmarking Africa's Minigrids* [11].

2.4 Employment by Firm Size

The DRE market is populated by a broad range of companies. In a given country there are both very large multinational companies with huge sales volumes across several locations and smaller companies with only local operations. This section provides a snapshot of the scale of employment by size of DRE companies compared across countries (see Figure 6).

In this study, DRE companies are classified into three categories. The first category is large DRE companies, defined in this report as those companies employing more than 100 full-time employees. The second category is medium-sized companies that employ more than 25 but less than 100 workers. The last category is small companies that employ less than 25 workers. Figure 6 shows the distribution of employment by company size for each of the focus countries. Large companies account for a significant share of employment in India, Kenya, and Nigeria. On the other hand, the share of employment in Uganda and Ethiopia is more or less equally distributed between the three different types of companies.

Consolidation Trends

In India, Kenya, and Nigeria, a few large companies comprise the majority of the DRE sector employment, indicating the beginning

Box 2: A Summary of AMDA's *Benchmarking Africa's Minigrids* Report

Current Status of the African Mini-grid Sector

Mini-grids, together with off-grid solar systems, are expected to be the least-cost solution for approximately 450 million people by 2030 [28]. Between December 2019 and December 2021, the African mini-grid industry managed to increase the number of connections by 95% (from 40,700 to more than 78,000). In addition, the number of operational private mini-grids grew by 39%, from 288 sites in 2019 to 400 sites in 2021, resulting in over half a million people gaining access to electricity.

Mini-grid revenues are increasing while operational costs are decreasing. Recent estimates suggest that the average revenue per user (ARPU), a key metric of industry sustainability and business success, has grown significantly over the past few years. In addition to increased revenues, operational expenditures are gradually declining. Scale and efficiency, combined with increased revenue and consumption, suggest a future of financial viability.

In terms of consumption, results reveal that the longer customers are connected to mini-grids, the more power they are likely to consume. For sites where year-over-year data was available and connections were stable, the average kWh consumed per month increased by 60% between 2019 and 2020. While not all sites experienced overall revenue improvements, more than 70% of sites experienced increased consumption.

Barriers to Growth in the African Mini-grid Sector

Non-equity funding for the mini-grid industry peaked in 2017 at US$17.4 million but fell to US$10 million in 2020 [11]. Despite encouraging business metrics, the disbursement of concessional funding is hindered by risk perception, complex fund designs, and regulatory hurdles. As of June 2020, only 13% of the US$1.6 billion committed to the mini-grid industry had been deployed [11]. Concessional capital is crucial to unlocking commercial investments (by de-risking these projects) while supporting the reduction of connection costs and tariffs (in the form of capital expenditure subsidies and demand-side subsidies, respectively).

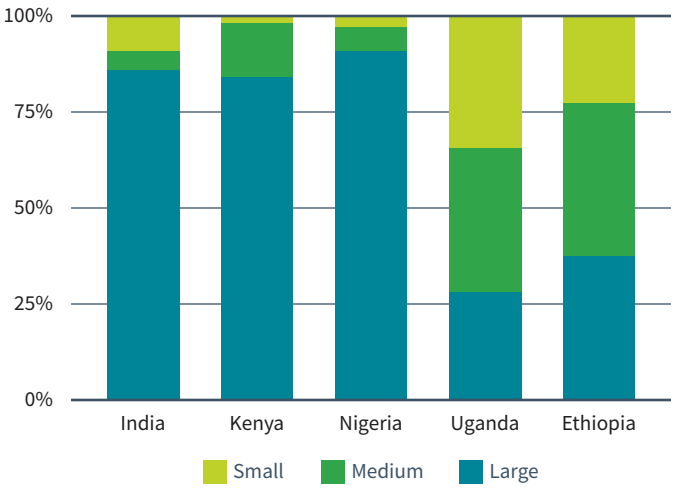
Regulatory and compliance processes remain a critical barrier to accelerating the deployment of mini-grids at scale. National regulatory bodies approve licenses, tariffs, and rights to operate mini-grids in African countries. Unlike traditional utilities, mini-grid developers are required to go through the entire licensing process for every site.

Potential of Mini-grids

Mini-grids continue to outperform national and sub-national utilities on service metrics. Some estimates reveal that national grids experience 75% more outages than mini-grids every month. AMDA's data suggest that mini-grid systems have a service uptime of 99% for most of the reporting sites. To tap into the full potential of the mini-grid industry and scale up the electrification rates in marginalized communities, the sector requires increased concessional funding, reduced capital flow barriers, enhanced regulatory frameworks and processes, reduced regulatory compliance timelines and costs, and a holistic approach when planning and funding electrification projects.

2. Labor Market Features

FIGURE 6. SHARE OF EMPLOYMENT BY SIZE OF FIRMS



Source: Powering Jobs Census 2022 data (Power for All)

of a consolidation of the DRE market. Note that DRE market maturity has usually been led by a handful of large companies, which dominate the market (at least) in the short run. This pattern seems to hold for early adopters of off-grid technology (i.e., India and Kenya). Following a similar trajectory, consolidation of the DRE market is expected to be seen in both Uganda and Ethiopia. This consolidation is likely to result in an increased share of employment held by large companies in the future. While it is uncertain when the consolidation will happen in either country, this pattern could be considered positive for the industry since companies will have the necessary capital to scale up their operations. This will ensure the viability and sustainability of the DRE sector as a whole [29].

3. Workforce Profile

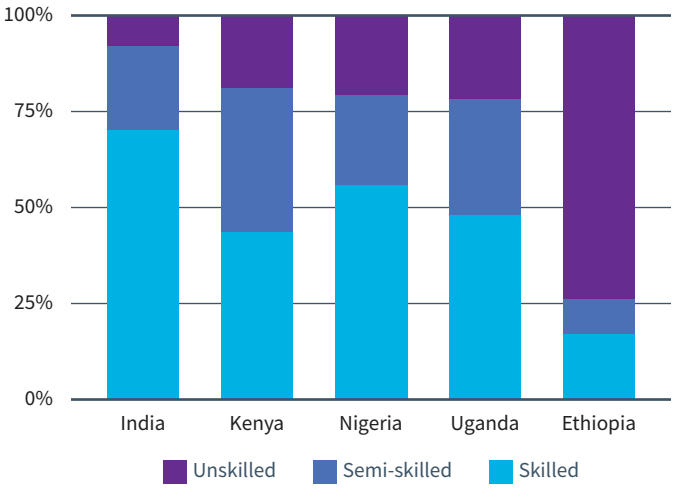
3.1 Workforce Skill Levels

The DRE sector employs workers with varying skill levels. This report uses the ILO's classification of employment, which is based on the level of skill required to complete the assignment [30]. Following is a description of each category:

- **Skilled work:** Leadership, management, and professional positions. Typical positions in a DRE company include CEO, any C-level executives, and technical jobs such as installation technicians or engineers.
- **Semi-skilled work:** Requires paying attention to detail and protecting against risks but does not include complex job duties. Semi-skilled work does not require advanced training or education. Typical positions in a DRE company include office assistants and sales agents.
- **Unskilled work:** Involves simple tasks that require only limited judgment to perform and that can be learned on the job. Typical positions include cleaners, cashiers, and guards, among others.

The composition of the DRE labor market in terms of skill levels varies from country to country. In India, 71% of the jobs are skilled according to survey respondents. Similarly, skilled workers account for a high proportion of the workforce in Nigeria and Kenya. In Nigeria, more than 56% of the workforce is skilled while the equivalent share in Kenya is 43%. On the other hand, Ethiopia's share of unskilled workers is close to 75%, making it the labor market with the highest share of unskilled workers among the focus countries of this study. Figure 7 describes the composition of DRE employment by skill level in each country.

FIGURE 7. COMPOSITION OF DRE EMPLOYMENT BY WORKER SKILL LEVEL



Source: Powering Jobs Census 2022 data (Power for All)

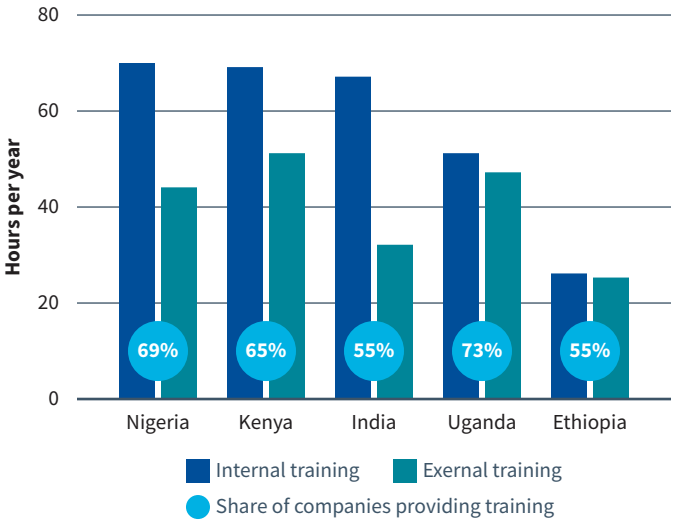
3. Workforce Profile

The share of skilled versus unskilled workers is correlated to the level of maturity of the DRE sector. In India—the most mature of the focus markets as defined by the share of larger systems—there is a growing demand for labor from advanced DRE technologies such as C&I and mini-grids. Both technologies require workers with advanced technical skills, such as installation technicians and maintenance professionals. In contrast, in countries with nascent DRE markets such as Ethiopia (where pico-solar and small SHS dominate the market), the skills prerequisite is lower as the majority of employees tends to be sales agents. However, it is expected that as the sector matures, future jobs will become more skilled. Based upon Power for All's FGDs, installation, data analysis, and after-sales service are all expected to be in high demand.

3.2 Training

Companies in the DRE sector use internal training programs to reskill and upskill their workers. Reskilling will enable DRE workers to perform different roles. The future of the DRE workforce is expected to be increasingly skilled as the sector adopts more advanced technologies, including mini-grids and power management units that integrate solar power generation and battery storage [7]. In addition, more countries are likely to become interested in the assembly and manufacturing of DRE technologies, which will require sophisticated design and engineering skills [31]. Thus, reskilling DRE workers will be paramount. In addition, many DRE companies surveyed have indicated that there are critical skills gaps that need to be addressed through upskilling, including sales, installation, and after-sales services.

FIGURE 8. AVERAGE HOURS OF TRAINING FOR COMPANIES SURVEYED



Source: Powering Jobs Census 2022 data (Power for All)

According to the #PoweringJobs survey, over 50% of DRE companies currently provide some type of training to their employees. Kenyan workers receive the most training, with the average DRE employee participating in 120 hours of internal and external training per year, while Ethiopian DRE workers receive just 50 hours of combined internal and external training (see Figure 8). In part, this may be explained by the low share of companies in Ethiopia that provide any type of training (55%). But even for those that do provide training, the hours are quite limited—on average less than for all other countries, both in internal and external training. In this context, it is unsurprising that Ethiopia's DRE workforce is the least skilled among this report's focus countries. With Ethiopia's low investment in training, the country might struggle to close the skills gap compared to peer countries. Thus, a concerted effort is required by Ethiopian DRE sector stakeholders to improve the quality and quantity of the sector's training.

The global renewable energy sector, which includes the DRE sector, employed 12 million workers in 2020 [3]. Even though there is limited data in terms of the quality and quantity of training in the renewable energy sector, some reports suggest that the supply of training is more limited in developing countries [32]. Despite their vast renewable energy resources, African countries are lagging in the development of appropriate training programs to adequately equip their renewable energy workforces. The main factors for the limited availability of training in Africa are a lack of resources, especially financial, and a shortage of qualified trainers.

Powering Jobs Census 2022 focus groups and expert interviews identified similar challenges in training the DRE workforce. Many DRE companies report they lack financial resources to provide training to their employees. The short retention period of employees may hamper companies from providing training. In addition, a shortage of appropriate training programs was mentioned as the main constraint by DRE companies. DRE companies that participated in this census's focus group discussions also indicated that most of their staff in remote locations don't receive training provided by DRE companies themselves or external organizations. In addition, they mention a lack of standardized curriculum with which they

could train their staff. Most of the training material has to be tailor-made, which requires significant financial and human resources. The success of recent training and workforce-matching initiatives, like the one described in Box 3, indicates an opportunity within the sector to attract and retain the talented workforce that is required to foster its growth.

3.3 Women's Participation

Women's participation in labor markets is crucial to advancing gender equity and overall better economic opportunities, especially in developing countries [33]. There is growing evidence that building a gender-balanced workforce results in positive company performance by employing innovation, resilience, quality of service, reduced financial and reputational risk, and improved environmental standards [5]. In the DRE sector, countries show varying performance in integrating women into their workforce. Across all countries, women tend to be mostly employed in administrative and support functions (such as assistant and office management) rather than core functions such as management and technical positions.

In terms of women's share of the DRE workforce, Kenya (41%), Ethiopia (37%), and Nigeria (37%) performed substantially better than Uganda (28%) and India (21%). Interestingly, the share of women in the DRE sector closely mirrors the share of women in the overall labor force of each country. Among the focus countries, Kenya has the highest national share of women in the workforce at 49%, while Ethiopia and Nigeria's shares are 46% and 44% respectively [34]. On the other hand, India has the lowest share of women in the workforce, at 20%. Uganda is the outlier having achieved parity in the national economy with women accounting for 49% of the workforce; however, women comprise only 28% of the DRE workforce [34].

Compared to women's share of jobs in the overall global economy, women's participation in the traditional energy sector is paltry, with only 22% of all jobs held by women [35]. This figure seems

Box 3: Youth Employment in the DRE Sector: Lessons Learned from the Off-Grid Talent Initiative

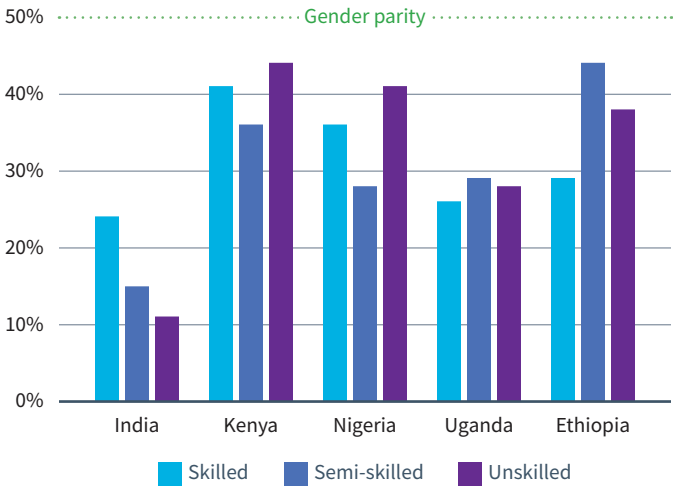
From 2019 to 2021, Shortlist and the African Management Institute implemented the Off-Grid Talent Initiative (OGTI), with the objective of strengthening the energy access workforce in sub-Saharan Africa by enhancing mid-level management skills and attracting and retaining more youth in energy sector jobs. Since its launch, OGTI has engaged with over 100,000 young people on careers in the green economy and ultimately has created more than 400 jobs across 36 clean energy companies spanning nine countries in Africa. In addition, the African Management Institute trained over 470 mid-level managers, working in DRE companies across 23 countries in Africa, to enhance these workers' management and leadership skills.

Under OGTI, Shortlist focused on raising awareness among young people in SSA of potential careers in DRE during job fairs and campus visits (which switched to virtual in 2020) and provided no-cost recruiting services to DRE companies to help them find high-quality, junior-level candidates with zero to two years of work experience. In addition to recruiting services, Shortlist implemented 12-month stipend payments as a time-bound, partial wage subsidy to incentivize and de-risk hiring recent graduates and to accelerate the job creation process. The idea was both to allow employers to be more flexible with their hiring requirements and also to give young people a significant runway to learn on the job and grow into their roles. In the end, these factors greatly contributed to the success of the OGTI program.

At the beginning of the program, the majority of OGTI hires cited concerns that their theoretical knowledge may not translate directly to the skills needed to excel in their roles. Interestingly, 83% of their line managers indicated the hires were "ready to hit the ground running." They did, however, identify gaps primarily in soft skills, including verbal and written communication, time management, prioritization, and multitasking. Notably, almost all hires were invited to stay with their host companies beyond the subsidized period, and 193 accepted and continued in full-time positions, representing a 94% conversion rate to sustainable jobs after OGTI. These results suggest that most technical skills are learned on the job and that youth can be better prepared to enter the workforce if universities and other learning institutions offer both theoretical and practical educational opportunities.

3. Workforce Profile

FIGURE 9. SHARE OF WOMEN WORKERS ACROSS DIFFERENT SKILL LEVELS



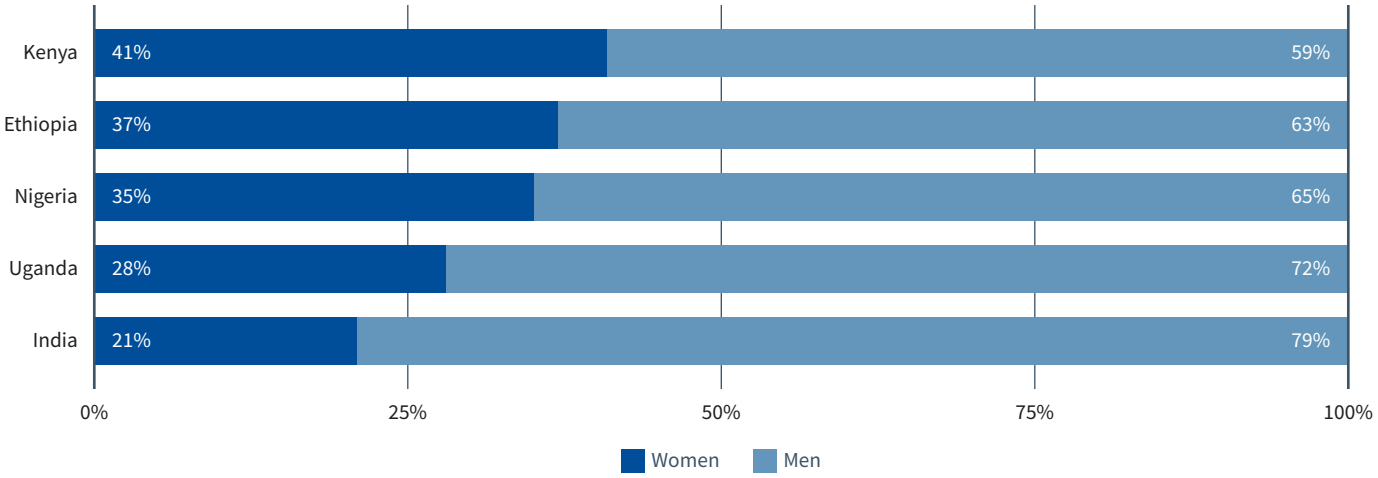
Source: Powering Jobs Census 2022 data (Power for All)

aligned with women's share in some African countries. A recent survey revealed that, on average, women constitute 21% of the overall workforce in energy utilities across Ethiopia, Kenya, and Zambia [36]. While they are more likely to assume mid-management roles—accounting for 25% of these positions—the average share of women working in skilled positions is only 15% for the three African countries [36]. Women account for less than 10% of the workforce in the traditional energy sector in India, and in Nigeria and Uganda, there is a lack of data on women's participation [37].

According to IRENA, women constitute—on average—around 40% of all renewable energy full-time jobs worldwide [9]. However, women's participation varies according to the nature of the job: women represent 58% of all administrative-related jobs, 35% of non-STEM technical positions (such as lawyers or procurement experts), and only 32% of STEM jobs [9]. While the gender outlook for renewable energy seems more promising than the traditional energy sector, women's participation in the DRE sector is still less than 50% across all the focus countries. A recent study revealed that the share of women in renewable energy is around 33% in Nigeria, but the percentage of Nigerian women is highest in non-STEM positions at 64% while women's participation in administrative and STEM jobs represents 28% and 8%, respectively [38].

As discussed above, women are overrepresented in office jobs and are underrepresented in technical ones. There are several barriers that women face that result in lower participation in the workforce and concentration of women in specific jobs. A study by the International Finance Corporation (IFC) highlighted the distance from home to work, challenging physical conditions, and fewer women with the required level of technical specialization as the main barriers to building a gender-diverse workforce [5].

FIGURE 10. WOMEN'S PARTICIPATION RATE IN THE DRE SECTOR



Source: Powering Jobs Census 2022 data (Power for All)

3. Workforce Profile

While Kenya and Nigeria have registered significant growth in women's participation across the DRE sector, the pace in India has stalled. Survey results estimate women's participation at around 40% in Kenya (compared to 23% in 2018) and Nigeria (compared to 27% in 2018). In contrast, the survey estimates women's participation in the Indian DRE sector at around 20% (compared to 23% in 2018). Existing literature at the granular level adds evidence to the low participation of women in the Indian renewable energy sector. For instance, a recent survey revealed that 42 DRE organizations created 392 new job opportunities in India, but only 20% of the jobs were filled by women [39].

Increasing women's participation in the renewable energy sector brings several benefits. Besides expanding the talent pool for the renewables sector, engagement of women brings new perspectives to the workplace and improves collaboration [5]. Additionally, increasing the number of qualified women in an organization's leadership team has been showing to yield better organizational performance overall [5]. Several DRE companies reported implementing initiatives aimed at increasing diversity to increase women's participation. However, several challenges and barriers still impede the increase of women's participation in the renewable energy sector. Power for All's forthcoming country reports will offer additional insights into these challenges.

3.4 Retention and Level of Engagement

The average tenure of employment is strongly related to the interaction between specific characteristics of national DRE labor markets and the sharp contraction of their respective economies due to the COVID-19 crisis. Although several factors contribute to the retention rate in any sector, the most important ones in the DRE sector are related to the type of employment (direct, indirect, formal, informal, contractual, etc.), level of compensation, and job satisfaction.

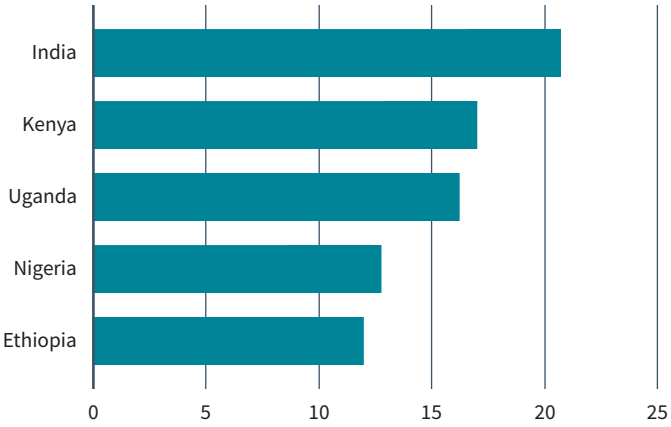
In the previous census, the average tenure of employment for direct, formal, full-time DRE employees in India, Kenya, and Nigeria was more than 30 months. The results of this survey revealed lower retention rates for all countries. (This contraction could be due, in part, to the effects of COVID-19.) In this census, the average retention rate for direct, formal, full-time employment was 24 months. In contrast, commission-only or informal employment averaged only 12 months. According to the survey, the average retention time in India was highest, at almost 21 months. Uganda and Kenya averaged nearly 17 months; the average retention time in Nigeria was 13 months. Although Ethiopia was the country with the lowest retention time at only 12 months, it also presented the highest proportion of informal jobs (83%).

As in the previous census, the level of engagement for direct, formal employees is defined by whether they are full-time employees, part-time employees, or contractors (full or part-time). The survey revealed that the level of engagement varies considerably across the proportion of skilled employment and the amount of training given. The survey results indicate that there is a positive correlation between retention rate and level of skill of DRE employees; causality is yet to be proven. As discussed in earlier sections, India has the highest share of skilled workers and provides the most training among the countries studied. This may have contributed to higher employee satisfaction and resulted in employees staying with a company longer. On the contrary, Ethiopia, with the lowest level of training, has the lowest tenure period among its employees.

3.5 Levels of Compensation

Based on the #PoweringJobs survey responses, the average annual wage in the sector ranged from US$16,000 for a top manager in India to US$450 for an unskilled worker in Uganda or Ethiopia. India and Kenya were the highest paying countries in the DRE sector across all levels of skills, while Uganda and Ethiopia were found to be the lowest paying countries. The salary differential between the highest and lowest-paying countries can be tied to the presence

FIGURE 11. AVERAGE RETENTION RATE IN THE DRE SECTOR PER COUNTRY (IN MONTHS)



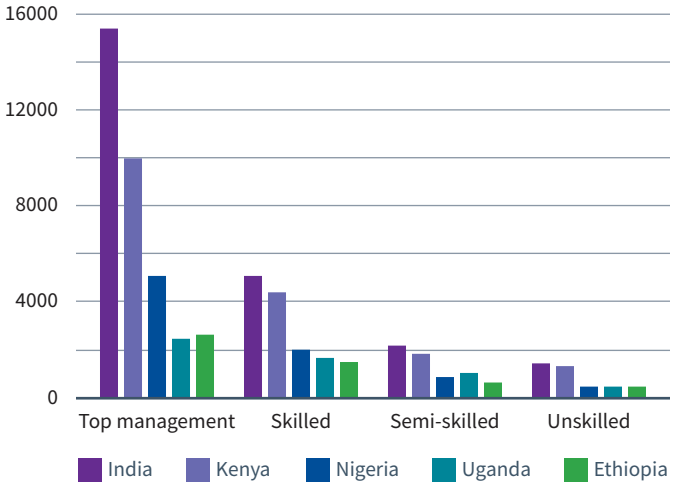
Source: Powering Jobs Census 2022 data (Power for All)

of international companies, especially in the countries with the highest wages. In addition, the DRE markets in India and Kenya are dominated by larger companies that tend to have more attractive compensation packages for their employees compared to smaller and medium-sized companies.

Wage disparity is also evident between the different DRE technology categories. The survey results indicated that the average wage for the mini-grid sector is higher than that of C&I and SHS sectors. While there are multiple factors affecting wages, like country-specific labor supply and demand dynamics, one of the main explanations is the very specific (technical) know-how requirement of mini-grid companies. Installation and management of mini-grids are more technical than other tasks in the DRE sector, and thus pay higher wages.

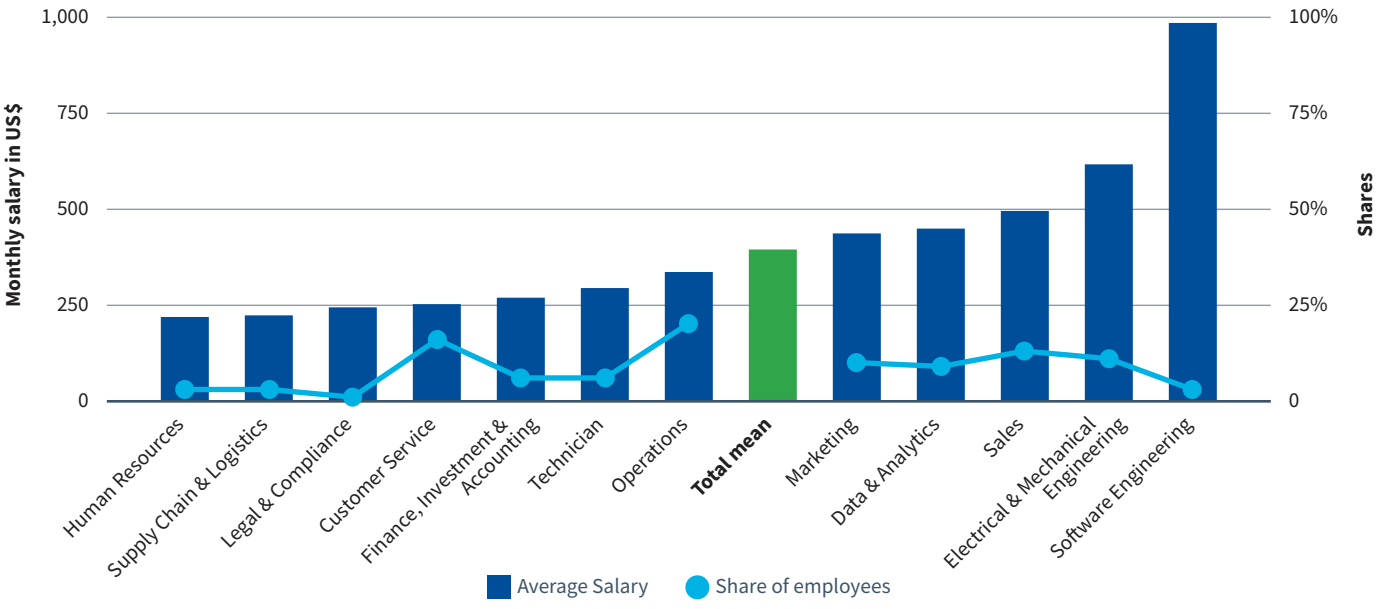
To gain a deeper understanding of which types of jobs are paid the most, and to complement the data gathered through the survey, an analysis was conducted of average salaries against the distribution of roles and functions in the sector. The data was shared by Shortlist, a talent matching and employability platform, and covers eleven countries in Africa for the latest year available. Figure 13 shows a mean monthly salary of US$396, with the average salaries and labor

FIGURE 12. AVERAGE ANNUAL WAGE FOR DIFFERENT ROLES IN THE DRE SECTOR IN 2021 (IN US$)



Source: Powering Jobs Census 2022 data (Power for All)

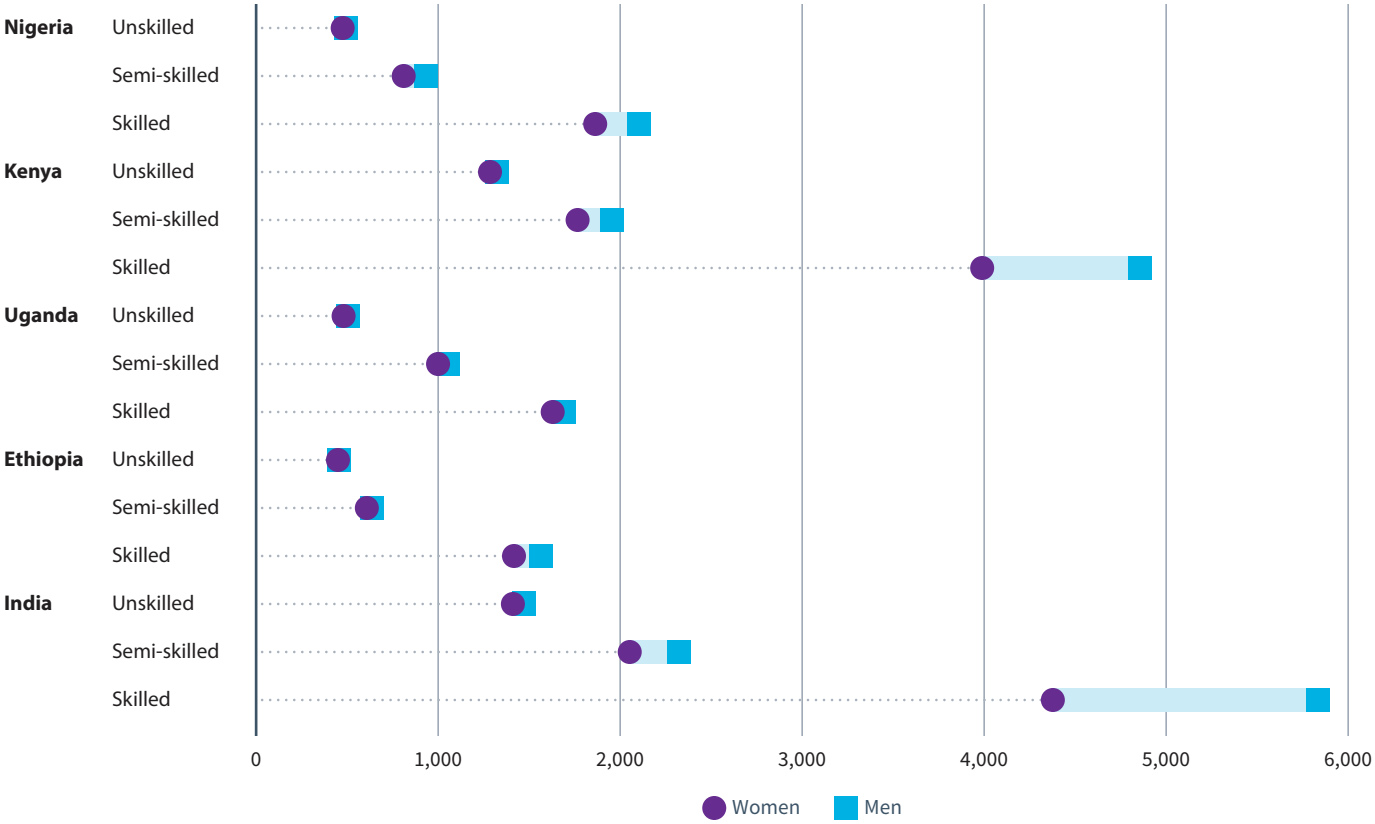
FIGURE 13. AVERAGE SALARY AND SHARE IN LABOR FORCE PER ROLE FUNCTION



Source: Power for All's elaboration based on Shortlist data

3. Workforce Profile

FIGURE 14. THE GENDER PAY GAP IN THE DRE SECTOR



Source: Powering Jobs Census 2022 data (Power for All)

shares of each role over total employment. For example, for operations roles, the average monthly salary is US$334 and represents 20% of all employees in the DRE sector, ranking as the role with the highest proportion within the sector. Notably, sales, operations, and customer service roles represent practically 50% of the total number of employees in the sector.

Finally, as with many other sectors in developing (and developed) countries, there is a sizable pay gap between men and women employees in the sector (see Figure 14). The gender pay gap is different for various skill levels and countries. Generally, the gender pay gap seems to be larger for skilled workers, including top management, and smaller for unskilled workers. There is an inverse and strong correlation between women's representation and the gender pay gap. Women are overrepresented in sales agents and office jobs, and the wage parity is smaller. On the other hand, women are underrepresented in skilled jobs, and there is higher pay parity in wages. The report also found that the wage differences in the DRE sector are smaller than national wage differences for all focus countries except for Ethiopia.

The survey results showed that the average wage for unskilled workers is higher than the average rural wage. Hence, the DRE sector, and renewable energy more generally, appear to provide decent paying, off-farm jobs especially for rural youth and can play a role in addressing unemployment in rural areas.

The average wage for the DRE sector is expected to grow in the coming years as the majority of the new jobs in the sector are projected to require more technical depth compared to contemporary jobs in the sector. This trend is observed in the broader renewable energy sector. According to IRENA's recent projections, shortages of well-trained and experienced workers may occur, despite the increase in wages [3].

3.6 Recruitment Challenges

The DRE sector is currently a significant job creator, especially for non-agricultural employment in the rural economy, and has immense potential to increase job opportunities in the future. As the demand for DRE products increases, the sector is expected to create additional jobs. In addition to the number of jobs, the sector is expected to create well-paying and decent jobs as demand for advanced DRE technologies, such as standalone rooftop solar for business, increases. However, survey responses and focus group participants alike indicated that DRE companies struggle to attract skilled workers. The challenges of recruitment are also more pronounced when it comes to recruiting women.

Challenges in Hiring Skilled Workers

Many studies, including this study, indicate that the employment potential for DRE in particular, and renewable energy in general, is expected to grow as the world transitions away from fossil fuels. However, the sector is also expected to face shortages of skilled workers in the future.

DRE companies surveyed as part of this study have indicated that they struggle to fill critical roles due to a lack of qualified applicants. The types of roles that are hard to fill differ between countries. Roles in project development, operations and maintenance, and business management are some of the positions that DRE companies in most of those countries mentioned as hard to fill. DRE companies' job offers to skilled talent also tend to be outpriced by organizations in established industries such as telecom companies, which can afford to pay more. Project development that includes a site feasibility study and system and grid design is a critical skill for mini-grid developers, similar to operations and maintenance. Both require some level of technical expertise. The focus countries have a shortage of educated workers across all sectors, but this challenge is exacerbated for the DRE sector as most of the jobs tend to be located far away from where the bulk of job applicants are.

Challenges in Recruitment of Women

The DRE sector in SSA is more gender diverse than energy companies worldwide. While globally only 27% of full-time, off-grid energy jobs are currently held by women, all the focus countries except India have gender participation rates above 27% [9]. This is a laudable achievement, but more work needs to be done in the DRE sector to build a gender-diverse workforce.

Multiple real and perceived barriers hinder the greater participation of women in the DRE sector. One of the challenges mentioned by DRE companies is the limited pool of women applicants for vacancies. Despite targeted recruitment of women, the number of applicants remains low. Women applicants may be less inclined to apply as most DRE jobs, especially sales agent jobs, require travel [40].

Cultural and social norms serve as a major barrier to women entering the DRE workforce. In many energy-poor countries, women spend a significant amount of their time on household work and childcare, which limits their ability to pursue education and career opportunities [5], [41]. Hence, very few women attend school, and fewer women enroll in university STEM programs [5]. Due to this, there are fewer women applicants for technical positions, which in return reinforces the stereotype that women are not capable of working in those positions [5].

Once women join the DRE workforce, they continue to face challenges that hinder them from accessing opportunities. A study by the IFC highlighted a lack of gender-responsive workplace cultures and policies as a key barrier to female workforce retention [5]. Some of those include the absence of a family-friendly workplace culture, explicit and subtle workplace discrimination, sexual harassment and violence in the workplace, and lack of access to mentoring and training opportunities.

4. Conclusions

4.1 Key Insights

1. The DRE sector drives job creation and can play an important role in alleviating unemployment while ending energy poverty.

The DRE sector is a significant job creator in the countries studied. With the support of public and private stakeholders, DRE can play an important role in alleviating unemployment. The DRE sector created 80,000 direct employment jobs in India and 50,000 jobs each in Nigeria and Kenya. The sector employed nearly 30,000 people in Uganda and 11,000 in Ethiopia.

This report quantifies direct employment opportunities, yet the DRE sector unlocks job creation in other industries—especially in rural areas—through improved access to energy. This enables businesses to expand their products and services, which in turn stimulates economic growth. So far, there is limited literature to understand the indirect employment caused by the DRE sector but the impact on job creation is expected to be larger than direct employment.

In addition to the total number of jobs created, employment in the DRE sector itself has a far-reaching impact. Most of the jobs are created in rural areas where the bulk of the demand for DRE products exists. This demand stimulates the economic growth of rural areas and provides an off-farm employment alternative for rural youth.

2. Decentralized renewable energy is a resilient sector, as shown by job recovery and growth during the COVID-19 pandemic.

In 2021 total employment in the DRE sector rebounded in three of the five focus countries: India, Kenya, and Nigeria. Strong demand for DRE products is expected to boost job creation in the Nigerian DRE market over the coming years. On the other hand, Uganda and Ethiopia have struggled to achieve pre-pandemic levels of DRE-based employment due to COVID-19 and other factors. The employment trajectories of the focus countries have varied, but, in general, the DRE sector has shown its resiliency by regaining within a year most of the jobs lost due to the pandemic.

Rooftop systems are still major drivers of job creation within the sector, but C&I and mini-grids will likely become more important. Altogether, SHS accounted for at least 80% of the job creation in the four SSA countries studied in this report. On the other hand, in India, total employment in the SHS and C&I sectors are roughly equal. When Powering Jobs Census 2019 came out, the pico-solar and SHS sector was a dominant job creator in India.

As customers gain access to basic electricity, they are largely expected to demand products with expanded capacity. Hence, as the DRE sector matures it transitions into mini-grids, standalone solar systems, and C&I, which usually meet the need for improved

4. Conclusions

electricity access. This results in most of the job creation transitioning away from SHS to bigger DRE systems.

The transition away from SHS to larger DRE systems will have a direct implication on the quality and quantity of jobs created in the sector. The type of employment created by mini-grids and C&I requires better technical capability. Jobs such as installation and maintenance technicians will be more important compared to sales agents' jobs.

3. Pico-solar and SHS companies are still the engine of DRE employment in Africa, but the market is expected to mature over the medium to long term as in the case of India.

Pico-solar and SHS technologies account for the majority of employment in all countries. However, as the market matured in India, partly due to a nationwide electrification effort, shares of sales and employment shrank considerably. Powering Jobs Census 2019 found that pico-solar and SHS companies accounted for 97% of India's total direct employment. By 2021, that share dropped to 53% and the difference was mostly taken over by C&I systems.

African markets are expected to go through a similar transition, though in the medium to long term. While standalone C&I systems currently generate 30% of employment in Ethiopia and over 10% in Kenya, mini-grids still account for a tiny share of employment. In addition, there is still a margin for growth within smaller technologies, especially SHS, as families and businesses exchange small systems for larger ones and purchase more appliances.

The lower labor intensity of larger technologies (like C&I systems and mini-grids) as compared to pico-solar and SHS technologies is expected to lead to an overall drop in direct employment as markets mature. However, total jobs are likely to rise as these technologies create disproportionately more indirect and induced jobs (than direct ones) such as local retail stores or restaurants.

4. Women's participation in direct employment recorded slight improvement but is still far from achieving parity.

Women's participation rates in Kenya and Nigeria were recorded at 40% and 35% respectively. Powering Jobs Census 2019 reported women's participation in 2018 at 23% and 27% for Kenya and Nigeria respectively. Hence, both countries have registered impressive growth. On the other hand, India has stalled in creating job opportunities for women. Women's participation rate in India has declined from 23% in 2018 to 20% in 2021.

Women tend to be overrepresented in office and desk jobs and underrepresented in technical jobs. This has partly led to the pay gap in the sector.

4.2 Recommendations

This report has highlighted the immense potential of the DRE sector in supporting the job creation agenda of developing countries. As the world transitions away from fossil fuels into renewable energy including DRE, preparing the workforce for the future is also critical. To support the sector in achieving its full potential, a concerted effort by stakeholders in the public, private, and non-profit sectors is required.

1. Adopt market interventions to boost demand for DREs and create more jobs.

Supporting the DRE sector will not only accelerate developing countries' energy access agenda but will also play an important role in alleviating the challenges of unemployment, especially in rural areas. The DRE sector has improved access to electricity for more than 400 million people since 2010 [1]. To maintain this momentum and reach more people who currently lack access to electricity, countries need to adopt market activation interventions. The subsequent growth in the DRE sector will directly translate into jobs. The type of market activation interventions countries adopt must be specific to the circumstances of the country, but there are proven best practices that have worked in multiple countries.

Donor-supported programs have also been effective in boosting demand for DRE products. Examples of such initiatives include Kenya's Social Impact Incentives Pilot Project and Uganda's Beyond the Grid Fund for Africa. Both programs provide RBF to DRE companies. It is premature to determine the impact of these programs in increasing energy access, but they have provided DRE companies with growth capital to expand their operations. Expanding such programs into other developing countries will grow the market size of DRE and support job growth.

In some instances, governments have actively intervened to support the off-grid sector by designing initiatives that aim to provide electrification to remote locations using off-grid technologies. One

such initiative is a Nigerian government program called Solar Power Nigeria. The program aims to electrify 5 million off-grid Nigerian households through SHS and mini-grids [1].

2. Design appropriate reskilling and upskilling programs to address current and future skills shortages in the sector

As many as 4.5 million DRE jobs could be created globally by 2030. This number is expected to account for more than one-sixth of the global renewable energy workforce [3]. However, the lack of a skilled workforce can derail the job creation potential of the sector.

The reskilling and upskilling of the DRE workforce requires the collaboration of various stakeholders—education institutions; technical and vocational education and training (TVET) companies; DRE companies; and non-profit organizations. This report examines the current skills shortage in the sector, but a more detailed analysis needs to be conducted to understand the current level of hard and soft skills of DRE employees. Other forms of reskilling and upskilling programs such as short-term internships, apprenticeships, and experience sharing need to be integrated.

3. Positive progress has been made in increasing women's participation but more needs to be done especially in increasing the number of women in technical jobs

Women's participation in the DRE sector has improved in all focus countries but India. While this achievement needs to be lauded, more needs to be done in closing the gender gap. Achieving gender parity in the DRE sector is expected to have a far-reaching impact. Unemployment rates are higher among women in many developing countries, including the five focus countries studied in this report. In addition, creating employment opportunities for women will improve the welfare of families as women are more likely to reinvest their income in their families and communities [42]. Women also have more to gain from improved access to energy as it will reduce time spent on household chores, which frees up time for them to use for other purposes such as furthering their education.

The gender gap in the DRE sector is usually a product of societal norms and values. Through increased education, those social norms are expected to evolve, creating better opportunities for women. DRE stakeholders can consider implementing short- and long-term interventions to close the gender gap. Short-term interventions can include expanding efforts to recruit women candidates and increasing the participation of women in reskilling and upskilling programs. In the meantime, the DRE sector can adopt sector-specific, long-term interventions such as increasing the availability of capital to women DRE entrepreneurs or adopting gender-equality-based selection criteria for grants and tenders.

4.3 Limitations of the Study

The study has the following limitation that can impact the interpretation of results.

Comparability of direct, formal, informal, and PUE jobs: Direct jobs cannot be aggregated. Due to a lack of data about the nature and time involved in work, direct, informal, and PUE jobs are not readily translated into FTE terms and therefore cannot be compared in scale to direct, formal jobs. Further study is required.

Representation of DRE companies: The Power for All research team tried to reach out to as many DRE companies as possible, but it is possible that smaller companies were excluded due to a lack of contact information or formal addresses. This could result in an underestimation of the total job creation by the sector as the employment by smaller companies is undercounted.

Consideration of job displacement: Given the lack of available data, the study does not explore past, current, or future job displacement that may result from fuel switching or automation. The net employment impact of the DRE sector across direct, indirect, and PUE job categories will be significantly influenced by displacements elsewhere in the economy. This is a major limitation to understanding the scale of net employment. Broader macroeconomic studies are required.

Indirect job estimates: Indirect jobs are out of the scope of this report. There is limited qualitative data in the literature to estimate indirect jobs. It is also difficult to attribute employment in these sectors directly to DRE companies. Further research into in-country and external supply chains is required.

Productive use job estimates: Productive use jobs were also not included in this report as the survey targeted DRE companies. These companies do not usually know the number of PUE jobs created as a result of their products. Furthermore, PUE employment factors from the literature are often anecdotal or based on limited studies not involving randomized controls.

4. Conclusions

The availability of high-quality market estimate data: To scale survey results to the national level, the study applies employment factors derived from the survey data to future market estimates. For some DRE technologies, such as C&I, product-aggregated market data may not be available. Furthermore, where future market estimates exist, they differ between governments and the private sector. The most recent and best available estimates are used.

Consideration of the role of private and foreign investments: This iteration of the census does not consider the role of investment in growth. Depending on international trends in investment, certain technologies may grow more quickly or may have better-paying jobs. On the other hand, if sufficient private financing is not leveraged, ambitious expansion targets, like those in India, will not be achieved. Thus, both current and future employment estimates depend heavily on investment and financing.

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Appendix A. Glossary

ARPU	Average revenue per user
C&I	Commercial and industrial
COVID-19	Coronavirus disease 2019
DRE	Decentralized renewable energy
FGD	Focus group discussion
FTE	Full-time equivalent
Forex	Foreign exchange
ILO	The International Labor Organization
KPLC	Kenya Power and Lighting Company
MNRE	The Indian Ministry of New and Renewable Energy
OGTI	Off-Grid Talent Initiative
PayGo	Pay-as-you-go
PUE	Productive use of energy
RBF	Results-based financing
SHS	Solar home systems
SSA	Sub-Saharan Africa
STEM	Science, technology, engineering, and mathematics

Appendix B. Methods

This appendix provides the formulae and assumptions used in each analysis, including formulae for translating different types of work into FTE terms; for estimating direct, formal, informal, and PUE jobs; and for projecting future jobs based on available market forecasts. In the body of the report, all analysis results were rounded to two significant figures for readability.

1. Total Direct, Formal Jobs in 2021

The table below includes the employment factor used for direct full-time employment, part-time employment, and the market size for the different types of technologies. Total direct, formal jobs are calculated for each country in 2021 by applying the following formulae to each practitioner grouping:

Employment factor = total number of direct, formal jobs ÷ total number of products sold*
Total direct, formal jobs = employment factor × 2021 market estimate

TABLE 1. ESTIMATES FOR DIRECT, FORMAL JOBS IN 2021

	Unit	India	Kenya	Nigeria	Ethiopia	Uganda
Employment factor for pico-solar and SHS companies	Jobs per 1,000 products sold	39	8.2	51.2	15.5	90.1
Pico-solar and SHS market estimate for 2021	Total products sold	786,000	1,769,000	628,000	440,000	263,421
Pico-solar and SHS direct, formal jobs estimate	**Jobs**	**30,637**	**14,506**	**32,150**	**6,833**	**23,728**
Employment factor for mini-grid companies	Jobs per MW installed	46.83	84.11	65.72	197.85	83.8
Mini-grid market estimate for 2021	MW installed	9.48	1.08	2.06	0.02	1.82
Mini-grid direct, formal jobs estimate	**Jobs**	**444**	**91**	**135**	**4**	**153**
Employment factor for C&I	Jobs per MW installed	42.7	100.69	57.02	438.92	157.96
C&I market estimate for 2021	MW installed	720.13	31.39	30.47	12.05	0.43
C&I direct, formal jobs estimate	**Jobs**	**30,752**	**3,160**	**1,737**	**5,291**	**67**
Total direct, formal jobs	**Jobs**	**61,833**	**17,757**	**34,022**	**12,128**	**23,948**

**Different employment factor figures per year are used based on the prevailing situation of labor and market size. The Powering Jobs Census 2022 only shows the employment factor for 2021. The employment factors for the remaining years are presented in the individual country reports.*

Appendix B. Methods

2. Total Direct, Informal Jobs in 2021

Total direct, informal jobs are calculated for each country in 2021 by applying the following formulae to each practitioner grouping:

Informal employment factor = total number of direct, informal jobs ÷ total number of products sold
Total direct, informal jobs = informal employment factor × 2021 market estimate

TABLE 2. ESTIMATES FOR DIRECT, INFORMAL JOBS IN 2021

	Unit	India	Kenya	Nigeria	Ethiopia	Uganda
Employment factor for pico-solar and SHS companies	Jobs per 1,000 products sold	14.3	16	24.1	3.3	21.8
Pico-solar and SHS market estimate for 2021	Total products sold	786,000	1,769,000	628,000	440,000	263,421
Pico-solar and SHS direct, informal jobs estimate	**Jobs**	**11,232**	**28,304**	**15,151**	**1,446**	**5,753**
Employment factor for mini-grid companies	Jobs per MW installed	7.03	71.3	26.09	61.91	13.55
Mini-grid market estimate for 2021	MW installed	9.48	1.08	2.06	0.02	1.82
Mini-grid direct, informal jobs estimate	**Jobs**	**67**	**77**	**54**	**1**	**25**
Employment factor for C&I	Jobs per MW installed	10.1	68.25	11.32	63.07	24.53
C&I market estimate for 2021	MW installed	720.13	31.39	30.47	12.05	0.43
C&I direct, informal jobs estimate	**Jobs**	**7,271**	**2,142**	**345**	**760**	**10**
Total direct, informal jobs	**Jobs**	**18,570**	**30,523**	**15,550**	**2,207**	**5,788**

3. Total Direct, Formal and Informal Job Estimates for 2022–23

Power for All's projections of DRE employment for 2022 and 2023 are based upon conservative market estimates, used to arrive at the near-term future market size for DRE products, and the 2021 employment factor. This assumes that any change in the employment factor through the projection period is anticipated to be insignificant.

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