

SUPPLEMENTAL MATERIALS

A. Analysis Methods

In this section we provide 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 productive use jobs, and for projecting future jobs based on available market forecasts. In the text we round all analysis results to two significant figures for readability.

A.1. FTE Job Calculation

We calculate full-time equivalence by using the following formulae to equate part-time and contract work with the workload of a full-time job.

$$FTE, \text{ part - time job} = \frac{\text{part time working hours}}{\text{full time working hours}} \quad FTE, \text{ contract job} = \frac{\text{average length of contract}}{\text{full time retention}}$$

A.2. Total Direct, Formal Jobs in 2017–18

We calculate total direct, formal jobs for each country in 2017–18 by applying the following formulae to each practitioner grouping:

$$\text{Employment factor (formal) for group} = \frac{\text{total person employed (direct, formal) in year}}{\text{total volume of product sales in year}}$$

$$\text{Total direct, formal jobs for group} = \text{group's employment factor} \times \text{2017 market estimate}$$

Table S1. Method for Calculating Direct, Formal Jobs in 2017.

	Kenya	Nigeria
Employment factor for pico-solar appliances and SHS companies	8.2 jobs per 1,000 products sold	5.0 jobs per 1,000 products sold
Pico-solar appliances and SHS market estimate for 2017	915,643 products sold [53], [54]	215,575 products sold [53], [54]
Pico-solar appliances and SHS direct, formal jobs estimate	7,508 jobs	1,067 jobs
Employment factor for C&I companies	120.4 jobs per MW installed	132.7 jobs per MW installed
C&I market estimate for 2017	15 MW [55]	20 MW [55]
C&I direct, formal jobs estimate	1,806 jobs	2,654 jobs
Employment factor for mini-grid companies	4.0 jobs per system operated	3.9 jobs per system operated
Mini-grid market estimate for 2017	65 systems operated [56]	30 systems operated [57]
Mini-grid direct, formal jobs estimate	260 jobs	117 jobs
Employment factor for solar water pump companies	9.5 jobs per 1,000 pumps sold	N/A
Solar water pump market estimate for 2017	10,000 pumps sold	N/A
Solar water pump direct, formal jobs estimate	95 jobs	N/A
Total direct, formal jobs in 2017	9,669 jobs	3,838 jobs

A.3. Total Direct, Informal Jobs in 2017–18

We calculate total direct, informal jobs for each country in 2017–18 by applying the following formulae to each practitioner grouping:

$$\text{Employment factor (informal) for group} = \frac{\text{total person employed (direct, informal) in year}}{\text{total volume of product sales in year}}$$

$$\text{Total direct, informal jobs for group} = \text{group's informal employment factor} \times \text{2017 market estimate}$$

Table S2. Method for Calculating Direct, Informal Jobs in 2017.

	Kenya	Nigeria
Employment factor for pico-solar appliances and SHS companies	16.0 jobs per 1,000 products sold	38.8 jobs per 1,000 products sold
Pico-solar appliances and SHS market estimate for 2017	915,643 products sold [53], [54]	215,575 products sold [53], [54]
Pico-solar appliances and SHS direct, informal jobs estimate	14,650 jobs	8,364 jobs
Employment factor for C&I companies	13.2 jobs per MW installed	19.5 jobs per MW installed
C&I market estimate for 2017	15 MW [55]	20 MW [55]
C&I direct, informal jobs estimate	198 jobs	390 jobs
Employment factor for mini-grid companies	4.5 jobs per system operated	0.3 jobs per system operated
Mini-grid market estimate for 2017	65 systems operated [56]	30 systems operated [57]
Mini-grid direct, informal jobs estimate	293 jobs	9 jobs
Employment factor for solar water pump companies	N/A	N/A
Solar water pump market estimate for 2017	10,000 pumps sold	N/A
Solar water pump direct, informal jobs estimate	N/A	N/A
Total direct, informal jobs in 2017	15,141 jobs	8,763 jobs

A.4. Total Productive Use Jobs in 2017–18

We calculate total productive use jobs for each country in 2017–18 by applying the following formula to each practitioner grouping:

$$\text{Total productive use jobs for group} = \text{group's productive use employment factor} \times \text{2017 market estimate}$$

Table S3. Method for Calculating Productive Use Jobs in 2017.

	Kenya	Nigeria
Employment factor for pico-solar appliances and SHS companies	70 jobs per 1,000 products sold [58]	70 jobs per 1,000 products sold [58]
Pico-solar appliances and SHS market estimate for 2017	915,643 products sold [53], [54]	215,575 products sold [53], [54]
Pico-solar appliances and SHS productive use jobs estimate	64,095 jobs	15,090 jobs
Employment factor for C&I companies	N/A	N/A

C&I market estimate for 2017	15 MW [55]	20 MW [55]
C&I productive use jobs estimate	N/A	N/A
Employment factor for mini-grid companies	9 jobs per system operated [59]	9 jobs per system operated [59]
Mini-grid market estimate for 2017	65 systems operated [56]	30 systems operated [56]
Mini-grid productive use jobs estimate	585 jobs	270 jobs
Employment factor for solar water pump companies	N/A	N/A
Solar water pump market estimate for 2017	10,000 pumps sold	N/A
Solar water pump productive use jobs estimate	N/A	N/A
Total productive use jobs in 2017	64,680 jobs	15,360 jobs

A.5. Total Direct, Formal Jobs in 2022–23

We calculate total direct, formal jobs for each country in 2022–23 by applying the following formula to each practitioner grouping:

$$\text{Employment factor for grouping} = \frac{\text{total person employed (direct, formal) in year}}{\text{total volume of product sales in year}}$$

$$\text{Total direct, formal jobs projection for grouping} = \text{group's employment factor} \times \text{2022 market projection}$$

Table S4. Method for Calculating Direct, Formal Jobs in 2022–23.

	Kenya	Nigeria
Employment factor for pico-solar appliances and SHS companies	8.2 jobs per 1,000 products sold	18.8 jobs per MW sold
Pico-solar appliances and SHS market projection for 2022–23	1,490,000 products sold (1,100,000 private sector-driven sales and 390,000 public sector-driven sales) [13], [16], [48], [49]	108 MW sold [50]
Pico-solar appliances and SHS direct, formal jobs projection	12,218 jobs	2,030 jobs
Employment factor for C&I companies	120.4 jobs per MW installed	132.7 jobs per MW installed
C&I market projection for 2022–23	N/A	N/A
C&I direct, formal jobs projection	N/A	N/A
Employment factor for mini-grid companies	36.9 jobs per 1,000 connections operated	123.4 jobs per MW operated
Mini-grid market projection for 2022–23	135,000 connections operated [13]	405 MW operated [50]
Mini-grid direct, formal jobs projection	4,982 jobs	49,977 jobs
Employment factor for solar water pump companies	9.5 jobs per 1,000 pumps sold	N/A
Solar water pump market projection for 2022–23	N/A	N/A
Solar water pump direct, formal jobs projection	N/A	N/A
Total direct, formal jobs in 2022–23	17,200 jobs	52,007 jobs

A.6. Total Direct, Informal Jobs in 2022–23

We calculate total direct, informal jobs for each country in 2022–23 by applying the following formula to each practitioner grouping:

$$\text{Employment factor (informal) for group} = \frac{\text{total person employed (direct, informal) in year}}{\text{total volume of product sales in year}}$$

$$\begin{aligned} \text{Total direct, informal jobs projection for group} \\ = \text{group's informal employment factor} \times \text{2022 market projection} \end{aligned}$$

Table S5. Method for Calculating Direct, Informal Jobs in 2022–23.

	Kenya	Nigeria
Employment factor for pico-solar appliances and SHS companies	16.0 jobs per 1,000 products sold	131.5 jobs per MW sold
Pico-solar appliances and SHS market projection for 2022–23	1,490,000 products sold (1,100,000 private sector-driven sales and 390,000 public sector-driven sales) [13], [16], [48], [49]	108 MW sold [50]
Pico-solar appliances and SHS direct, informal jobs projection	23,840 jobs	14,202 jobs
Employment factor for C&I companies	13.2 jobs per MW installed	19.5 jobs per MW
C&I market projection for 2022–23	N/A	N/A
C&I direct, informal jobs projection	N/A	N/A
Employment factor for mini-grid companies	42.9 jobs per 1,000 connections operated	23.4 jobs per MW operated
Mini-grid market projection for 2022–23	135,000 connections operated [13]	405 MW operated [50]
Mini-grid direct, informal jobs projection	5,792 jobs	9,477 jobs
Employment factor for solar water pump companies	N/A	N/A
Solar water pump market projection for 2022–23	N/A	N/A
Solar water pump direct, informal jobs projection	N/A	N/A
Total direct, informal jobs in 2022–23	30,270 jobs	23,662 jobs

B. Key Assumptions for Future Jobs Projections

B.1. Key Policies and Market Assumptions for Kenya Jobs Projections

National strategies and planned policy interventions: In its recently released Kenya National Electrification Strategy (KNES), the Kenyan government aims to achieve universal electrification by 2022 [13] via several electrification programs that will finance grid extension, intensification, and densification. This includes the deployment of DRE solutions where the national grid cannot reach, such as the Last Mile Connectivity Program, Global Partnership of Output Based Aid, and the Rural Electrification Program,

among others. The KNES envisions that 269,000 new connections will be added through grid extension. A further 2.77 million connections, including 100,000 mini-grid connections, will be added through grid intensification and densification, 35,000 through 147 new mini-grids, and 1.96 million through standalone SHS [13].

Pico-solar appliance and SHS deployment and job projection: GOGLA reported in 2018 that the Kenya off-grid solar market sold 750,000 units of product [48], [49]. On average, the annual growth rate of the Kenyan off-grid solar market was 11% between 2014–16 [16]. By 2022, assuming this growth rate holds, 1.1 million pico-solar appliances and SHS will be sold in Kenya. Assuming that private sector sales projections and publicly financed SHS deployment are mutually exclusive, and that the 1.96 million SHS are deployed evenly throughout the next four years, the Kenya DRE sector is projected to be selling 1.5 million pico-solar appliances and SHS annually. To achieve this sales projection, the Kenya pico-solar and SHS sectors will need to provide 12,000 direct, formal jobs and 24,000 direct, informal jobs.

Mini-grid deployment and job estimate: By 2022, 135,000 new mini-grid connections will be added to existing and new mini-grids [13]. To operate these additional connections, approximately 5,000 direct, formal jobs and 5,800 informal jobs need to be created.

Job projection insights: By 2022–23, the DRE sector will be employing more than 17,000 direct, formal employees and 30,000 informal workers. While the mini-grid sector is growing fast, pico-solar appliance and SHS companies would still be the main source of jobs in the sector.

B.2. Key Policies and Market Assumptions for Nigeria Jobs Projections

National strategies and planned policy interventions: The Nigerian government announced Vision 30:30:30, which aims to achieve a 90% electrification rate, with a generation capacity of 30,000 MW, 30% from renewable energy sources, by the year 2030 [50]. To achieve this goal, Sustainable Energy for All (SEforALL) built a model to estimate the growth of each type of energy technology required to achieve Vision 30:30:30. However, according to current market estimates, Nigeria will need an adequately trained workforce if it is to meet the needed growth rate [50].

To address this gap, the Nigerian government rolled out several incentive programs to encourage private sector participation and the use of DRE solutions. The Nigeria Electrification Project aims to incentivize the deployment of 1 million SHS, 44 standalone solar systems, and 330,000 households and local enterprises connected to mini-grids [51]. In addition, the Energizing Economies Initiative identified 340 economic clusters such as market and agro-processing plants, with a cumulative demand of 4 GW. If electrified, these alone could create 2,500 jobs [52].

Pico-solar appliance and SHS deployment and job projection: As estimated in Nigeria's SEforALL Action Agenda, 108 MW of SHS should be sold in the year 2022 [50]. To achieve this, the sector will need to provide 2,000 direct, formal jobs, doubling the pico-solar appliances and SHS jobs created in 2017. In addition to direct, formal jobs, the sector would need another 14,000 informal workers to support its activities by 2022.

Mini-grid deployment and job estimate: By the year 2022, in the SEforALL Action Agenda, a cumulative capacity of 405 MW of mini-grids will need to be operational in Nigeria [50]. To do so, the sector will need to provide about 50,000 direct, formal jobs and 9,500 informal jobs. However, the mini-grid sector may fall short of this projection. SEforALL estimated that in 2017, Nigeria should have installed 50 MW of mini-grids.

Unfortunately, the Rocky Mountain Institute estimated that only 30 solar mini-grids with a total installed capacity of 1 MW were operational by 2017.

Job projection insights: Assuming that current direct, formal employment factors remain unchanged, Vision 30:30:30 should result in more than 52,000 direct, formal jobs and 24,000 direct, informal jobs by 2022–23.

C. Statistical Tests

This section provides insight into the relationships between various surveyed variables. In terms of direct, formal jobs in Kenya, the number shows a positive relationship with reported units of product sales. By grouping the companies by the number of different DRE technologies they work with (e.g., pico-solar appliances, SHS, solar water pumps, standalone and grid-tied C&I systems and mini-grid), the t-test results show that companies engaged in two or more technologies provide a significantly larger number of direct formal and informal jobs than companies that only focused on one technology. Women’s participation shows a slight correlation with company type, with project developers and installers employing far fewer women (19%) than other groups on average. Male, nonmanagerial wage also varies significantly between company types, such that project developers and installers earn much lower average wages than others. Full-time retention and youth participation do not seem to show strong relationships with any of the variables analyzed.

Table S6. Kenya: p-value results for t-test with select survey variables.

	Company type	Number of technologies	Local vs. foreign company	Sales units	Years in operation
Direct, formal jobs (FTE)	0.116	0.0392	0.935	0.000	0.972
Informal jobs	0.368	0.0265	0.202	0.0156	0.563
Full-time retention (months)	0.972	n/a	0.753	n/a	n/a
Women's participation	0.0445	n/a	0.323	n/a	n/a
Youth participation	0.556	n/a	0.804	n/a	n/a
Male, nonmanagerial employee's wage	0.0413	n/a	0.0495	0.0503	0.204

In Nigeria, direct, formal jobs show a positive relationship with the age of the companies. The older a company is, usually the more direct, formal jobs it provides. Women’s participation shows correlation with company types, with end-user product providers employing much more women than other groups on average. Youth participation shows correlation with local and foreign companies, with local companies employing more young people than foreign ones. There were, however, only four foreign companies who responded to this question. Informal jobs, full-time retention and male, nonmanagerial wage do not seem to show strong relationships with any of the variables analyzed.

Table S7. Nigeria: p-value results for t-test with select survey variables.

	Company type	Number of technologies	Local vs. foreign company	Sales units	Years in operation
Direct, formal jobs (FTE)	0.652	0.439	0.475	0.748	0.000
Informal jobs	0.557	0.881	0.725	0.643	0.630
Full-time retention (months)	0.174	n/a	0.545	n/a	n/a
Women's participation	0.0045	n/a	0.845	n/a	n/a
Youth participation	0.937	n/a	0.0097	n/a	n/a
Male, nonmanagerial employee's wage	0.887	n/a	0.387	0.787	0.346

D. Survey Questions

1. What country(ies) are you currently working in?
2. How many years has your company been in operation in the country?
3. Do you share labor resources across countries? If yes, what percentage of human resource do you share internationally? (e.g. 10% of your employees in Kenya works across different countries)
4. What type of service(s) does your company offer? (Manufacturing/importing and wholesale/product assembly/retail sales and distribution/engineering, procurement and construction (e.g. civil work and installation)/project development (e.g. system design, site feasibility study)/project operation and/or maintenance/software and/or other services (e.g. PAYG software, asset monitoring services)
5. Which of the following decentralized renewable energy (DRE) technology(ies) do you have expertise in? (Pico-solar appliances/SHS/productive use systems (e.g. solar water pumps)/standalone and grid-tied solar systems/mini-grids (solar/hydro/biomass-based)
6. How many people are currently working in your organization? (Full-time/part-time/contract/informal workers for 2017/2018/2019)
7. Assuming a full-time employee has a 40-hour workweek, how many hours per week on average does a part-time employee work in your organization?
8. Of those working with your organization, please provide average retention time (in months) for full-time/part-time/contract/informal workers.
9. Please identify the number/percentage of employees in each job function. (Business development and administration/project finance and legal/project development (site feasibility study; system and grid design)/product assembly or manufacture/sales and distribution/product/project Installation/after sales service/operation and maintenance/other)
10. Could you roughly estimate how many informal jobs (excluding commission jobs) exist because of your business?
11. Could you roughly estimate what percentage of your customers use your products and services in their current business, to start a business, or to grow their business?
12. Given your answer in the previous question, please estimate how many people might have new jobs as a result, over the past year.

13. What percentage of those working in your organization (managerial and nonmanagerial employees) are local in 2017/2018/2019?
14. What percentage of those working in your organization (managerial and nonmanagerial employees) are female in 2017/2018/2019?
15. What percentage of your commission agents are female?
16. What percentage of those working in your organization are youth?
17. Please roughly estimate the average hourly wage of your employees (whether full- or part-time, or contractors) for male/female/managerial/nonmanagerial.
18. Roughly how much do your commission agents (male/female) earn per month from working with your organization.
19. What percentage of those working with your organization (full-time, part-time or contractor) are skilled? (2017/2018/2019)
20. Thinking of the workers that you have hired at your organization over the last 12 months, please indicate your level of difficulty finding qualified applicants to fill the positions (male/female/youth).
21. How challenging are the following concerns in attracting or retaining needed talent (male/female/youth) in your country of operation? (Salaries too expensive/limited talent pool/lack of work ethic/no relevant experience/ineffective recruitment system/unattractive perception of the DRE industry/family obligations/location of talents is far from customer needs/other)
22. How difficult is it to fill positions in each of the following business functions? (Business development and administration/project finance and legal/project development (site feasibility study; system and grid design)/product assembly or manufacture/sales and distribution (all, including field sales agents, who may work on commission-only, or part-time, or on a contract basis)/product/project Installation/after sales service (customer service, call centers)/operation and maintenance)
23. What is the past, current and projected sales performance of your organization (2017/2018/2019) in terms of total capacity and number of products sold?
24. What is the past, current and projected scale of your pico-, micro- and/or mini-grid installation/operation activity (2017/2018/2019) in terms of total capacity installed and operated/number of systems/number connections?