EFFICIENCY FOR ACCESS

UKaid from the British people

OFF-GRID APPLIANCE MARKET SURVEY

OCTOBER 2020 EFFICIENCY FOR ACCESS COALITION

FOURTH EDITION

CONTEXT

This report was authored by **CLASP** as part of the **Low Energy Inclusive Appliances** initiative, a flagship programme of the **Efficiency for Access Coalition** (EforA). EforA is a global coalition working to promote high performing appliances that enable access to clean energy for the world's poorest people. It is a catalyst for change, accelerating the growth of off-grid appliance markets to boost incomes, reduce carbon emissions, improve quality of life and support sustainable development.

Since its founding in 2015, EforA has grown from a year-long call to action and collaborative effort by the **Global LEAP Awards** and **Sustainable Energy for All** (SEforALL), to a partnership of 16 donor organisations which aim to scale up markets and reduce prices for super-efficient off- and weak-grid-appropriate products, support technological innovation, and improve sector coordination. Current EforA member initiatives span three continents, 47 countries and 25 key technologies. EforA is jointly coordinated by CLASP—an international appliance, energy efficiency and market development not-for-profit organisation—and the United Kingdom (UK)'s **Energy Saving Trust** (EST), which specialises in energy-efficient product verification, research, advice, data and insight.

The 2020 Off-Grid Appliance Market Survey was developed by CLASP and SEforALL. EST, the **Clinton Health Access Initiative** (CHAI), the **World Bank Group**, **Modern Energy Cooking Services** (MECS) and the **African Minigrid Developers Association** (AMDA) provided expert review. CLASP conducted the analysis. We are especially grateful to Lindsay Caldwell (the World Bank), Brian Dean (SEforALL) and Clotilde Rossi di Schio (SEforALL) for their input on this report.

This report was funded by the Government of the United Kingdom's UK aid. The views expressed do not necessarily reflect the UK Government's official policies.

ABBREVIATIONS

AC	Alternating Current
COVID-19	2019 Novel Coronavirus
DESCO	Distributed Energy Service Company
EPC	Electric Pressure Cooker
ICT	Information and Communications Technology
LED	Light-Emitting Diode
PV	Photovoltaics
SHS	Solar Home System
SME	Small to Medium Enterprise
SSA	Sub-Saharan Africa
SWP	Solar Water Pump
TV	Television
USD	United States Dollar

TABLE OF CONTENTS

Introduction

This 2020 edition of the Off-Grid Appliance Market Survey offers a unique snapshot of the fast-evolving off-grid appliances sector. The survey responds to the growing need for more nuanced insights into the demand[1] for and potential impact[2] of household appliances, business/ productive use appliances, and health clinic infrastructure needed to advance access to modern energy services and promote sustainable economic development.

Building on the previous three editions (**2014**, **2016** and **2018**) of the Off-Grid Appliance Market Survey, the 2020 edition equips sector stakeholders with insights to accurately assess the market's needs and shift activities accordingly. This report series—the only repeat survey of its kind—provides a unique perspective on how demand and impact perceptions of off-grid appliances have changed over time. The results serve to complement consumer feedback, which is also critical to increasing the use and effectiveness of appliances.

As with past editions, this Off-Grid Appliance Market Survey will contribute a key piece of market intelligence that will enhance global understanding of the market and provide a framework for identifying business opportunities and high-impact interventions. Notably, the 2020 edition expands its analysis to include a more comprehensive snapshot of the perceived demand and impact of business/productive use appliances by geographic region and end user gender, allowing for a more comprehensive snapshot of the market today.

Spurred by the COVID-19 crisis, the 2020 edition also includes a first-ever look into the needs of healthcare facilities during public health crises and pandemics. Past editions showcased equipment needs for health service delivery in un- and under-electrified areas. The 2020 survey builds on this work by examining pandemic-specific healthcare needs. The insights presented in this report will be especially valuable in the global COVID-19 response as healthcare professionals work to secure energy access for interventions. We hope these findings will also bolster preparations for future pandemics.

1. Demand is used in this report and survey to estimate the overall off-grid consumer demand over the next three to five years.
2. Impact is used in this report and survey to estimate the potential positive impact on socioeconomic development and poverty reduction over the next three to five years.

Key Takeaways

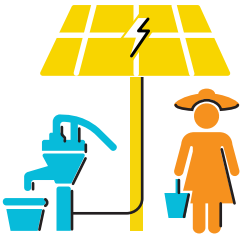
The 2020 edition of the Off-Grid Appliance Market Survey uses data collected from 133 industry, policy and development stakeholders to offer unique insights into the dynamic needs of consumers and the potential positive socioeconomic impacts of off-grid appliances.

2020 survey results are consistent with shifting sector priorities and global market trends.

Credit: Dan Odero

Practitioners' views on the development impact potential for LED room lighting have shifted, but lighting remains a vital first step for consumers onto the energy ladder.

LED room lighting dropped from first to fourth in development impact potential for household appliances for the first time, reflecting a growing interest in larger appliances like solar/electric water pumps. However, survey results also reinforce the need for basic, affordable lighting solutions to remain an essential pathway to universal energy access, particularly for bottom of the pyramid households. LED room lighting ranks first in perceived consumer demand for household appliances and is the highest-ranked clinic infrastructure technology by a significant margin.



Income-generating productive use appliances demonstrate high impact potential in the agriculture sector; however, there remains a critical gap between theoretical impact and market reality.

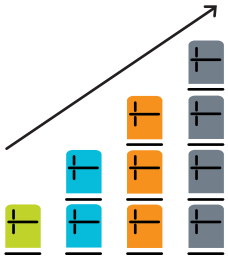
Solar/electric water pumps rank first in perceived development impact for households and businesses. This trend may indicate overall market maturity for solar/electric water pumps, reflected by a larger obtainable market size[3] and higher sales volumes.[4]

Similarly, milling equipment, grain processors, food drying units and milk chilling units all rank among the top ten business/productive use appliances, reflecting a growing interest in prioritizing larger productive use appliances along agricultural value chains. However, the market for these appliances remains nascent. Businesses must further improve the quality and accessibility of their technologies and refine how they distribute and sell larger, more expensive appliances to resource-constrained consumers. Greater policy action, financing incentives, consumer awareness and coordination between the energy and agriculture sectors on market development are also needed to drive market growth.[5]

3. Based on estimates provided by Efficiency for Access and Lighting Global. See Efficiency for Access (2019), State of the Off-Grid Appliance Market Report; and Lighting Global (2019), and Lighting Global (2019), Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Sub-Saharan Africa.

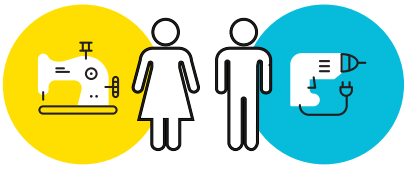
4. An estimated 25,000 solar water pumps were sold in the second half of 2019, compared to 5,000 refrigerators. See GOGLA and Lighting Global (2020), Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data H2 2019.

5. Please reference The Role of Appliances in Achieving Gender Equality and Energy Access for All and market research on Productive Use Leveraging Solar Energy (PULSE) for more on how to scale the market for off-grid productive use appliances.



Sustained demand for refrigerators may help drive the market closer to scale.

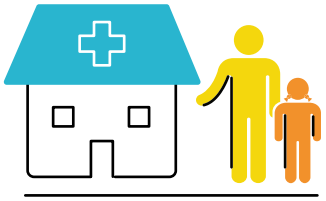
Refrigeration technologies for business/productive use applications rank high in perceived consumer demand and development impact. This trend may reflect a maturing market for refrigerators. Evidence suggests the diversity of brands and models available on the market has increased, improving the variety of products available to consumers.[6]



Gender is not a strong influencing factor in the perceived consumer demand for, or impact of, off-grid household appliances and business/productive use appliances.

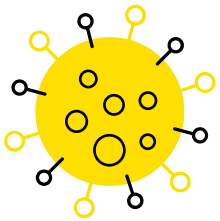
Most respondents did not expect consumer demand or development impact rankings to change on the basis of the end user's gender. However, when they did report a difference in user preferences for men and women, a stark contrast in development impact potential emerged. Refrigerators and sewing machines emerge as more impactful for women, while hand power tools and mills/grinders are more important to men.

6. According to data collected through the Global LEAP Awards refrigerator competition.



Demand for basic healthcare infrastructure and medical devices in rural clinics persists, corroborating existing evidence in support of greater intervention.[7]

Nearly 60% of rural clinics in low- and middle-income countries have no access to modern energy services.[8] Survey results reflect this need. LED lighting remains the most in-demand infrastructure technology, followed by energy storage and backup, ICT equipment and water purifiers. Basic medical devices—including vaccine refrigerators, patient monitors and oxygen concentrators—ranked highest in perceived demand. These technologies can dramatically improve the quality and safety of medical care, as well as the working conditions for personnel, an important factor in hiring and retention.



Clinics require different healthcare infrastructure to respond to the challenges of a global pandemic.

When asked what key technologies would help alleviate the COVID-19 pandemic,[9] respondents identified water pumps, energy storage and backup, sterilisers, water purifiers and ICT equipment as the most important infrastructure technologies. The COVID-19 pandemic may also explain changes in the perceived importance of medical devices used to treat respiratory illness. Oxygen concentrators ranked third in perceived importance (compared to 6th in 2018), while ventilators ranked sixth (not included in 2018).

7. Sustainable Energy for All and United Nations Foundation (2019), Lasting Impact: Sustainable Off-Grid Solar Delivery Models to Power Health and Education.

8. Cronk, R. & Bartram, J. (2018), "Environmental conditions in health care facilities in low- and middle-income countries: Coverage and inequalities", International Journal of Hygiene and Environmental Health, 221(3): 409-422.

9. Questions about clinic needs during a pandemic were included in response to the COVID-19 health crisis, which has exposed inequities in global healthcare delivery.

The perceived demand for, and impact of, off-grid appliances is consistent across geographic regions.

For household appliances, LED room lighting, televisions and mobile phones ranked highly in perceived consumer demand while SWPs, mobile phones and refrigeration ranked highly in perceived development impact. SWPs and agricultural cold storage/cold chain technologies ranked highly in perceived consumer demand and development impact potential across all geographic regions. Although there was little variation in rankings across regions, demand for fans was particularly high in tropical regions, including South Asia and West Africa.

Highest Ranked Appliances in 2020

The 2020 edition of the Off-Grid Appliance Market Survey uses data collected from 133 industry, policy and development stakeholders to offer unique insights into the dynamic needs of consumers and the potential positive socioeconomic impacts of off-grid appliances. The following tables summarize the ten highest-ranked household, business/productive use, and health care appliances.

Household Appliances

84 Respondents

	PERCIEVED CONSUMER DEMAND
1	LED room lighting
2	Televisions
3	Mobile/Smart phones
4	Refrigeration
5	Fans
6	Solar or electric water pumps
7	Computers
8	Radios
9	Micro mills / grinders
10	Air conditioners

	DEVELOPMENT IMPACT POTENTIAL
1	Solar or electric water pumps
2	Mobile/Smart phones
3	Refrigeration
4	LED room lighting
5	Micro mills/grinders
6	Computers
7	Modems, web routers, internet/connectivity equipment
8	Sewing machines
9	Televisions
10	Electric pressure cookers

Business / Productive Use Appliances

109 Respondents

	PERCIEVED CONSUMER DEMAND
1	Solar Water Pumps
2	Agricultural Cold Storage/ Cold Chain Technologies
3	Light Commercial/SME Refrigeration/Freezer Units
4	Mills/Grinders
5	LED Room Lighting Appliances
6	Mobile Phone Charging Banks
7	Televisions
8	Computers
9	Milk Chilling Units
10	Grain Polishers / Threshers / De-Hullers

	PERCIEVED CONSUMER DEMAND
1	Solar Water Pumps
2	Agricultural Cold Storage/ Cold Chain Technologies
3	Mills/Grinders
4	Light commercial/SME refrigeration/Freezer units
5	LED room lighting appliances
6	Computers
7	Milk chilling units
8	Grain polishers/Threshers/De-hullers
9	Food drying units
10	Sewing machines

Healthcare Appliances

35 Respondents

	PERCIEVED DEMAND (CLINIC INFRASTRUCTURE)
1	LED Room Lighting
2	Energy Storage and Backup
3	ICT Equipment
4	Water Purifiers
5	Water Pumps
6	Sterilizers/Autoclaves
7	Fans
8	Air Conditioners
9	Water Heaters

	PERCEIVED DEMAND DURING PANDEMIC (CLINIC INFRASTRUCTURE)
1	Water Pumps
2	Energy Storage and Backup
3	Sterilizers/Autoclaves
4	Water Purifiers
5	ICT Equipment
6	LED Room Lighting
7	Fans
8	Water Heaters
9	Air Conditioners

	PERCEIVED DEMAND (MEDICAL DEVICES)
1	Vaccine and Blood Bank Refrigerators
2	Patient Monitors for Vital Signs Measurements
3	Oxygen Concentrators
4	Viral Load Testing Equipment for HIV, HCV, HBV, and HPV
5	Portable Ultrasound Machines
6	Ventilators
7	Neonatal Infant Warmers
8	Fetal Heart Monitors
9	Pulse Oximeters
10	X-ray Machines

Results & Analysis

HOUSEHOLD USE APPLIANCES

This section provides rankings for 20 household appliances in terms of anticipated off-grid consumer demand, impact on socioeconomic development, and potential for poverty reduction. Some appliance categories were added, removed, combined or disaggregated in the 2020 survey.

FOR THE HOUSEHOLD USE APPLIANCES SEGMENT, THE KEY CHANGES ARE:

- Solar/electric water pumps, air coolers/evaporative coolers and micro mills/grinders were added as new product categories, since these are recent technologies that can be used in household settings
- Mobile phone charging banks were removed from the household appliance segment, but remain in the productive use segment
- Tablets and laptops were combined into a single category due to their similarities
- Refrigeration and freezer units were disaggregated into two categories due to the growing variety of cooling products

To assess perceptions of the current and future household off-grid appliance market, respondents were asked to rank the top five product categories for anticipated consumer demand and potential impact on socioeconomic development and poverty reduction.

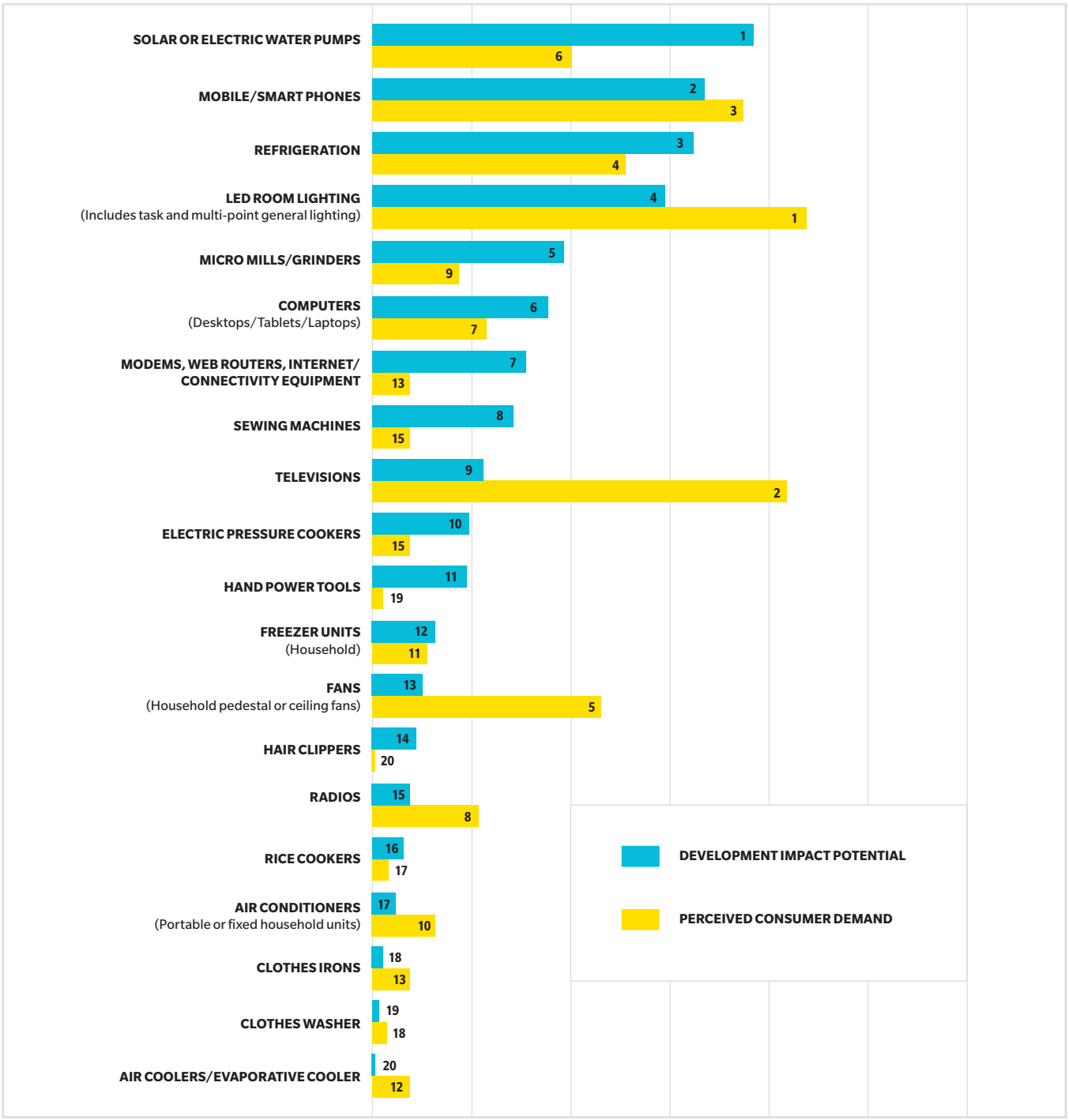
Perceived Consumer Demand and Development Impact Potential

This section summarises the perceived off-grid consumer demand and potential socioeconomic impact of household appliances (Figure 1).

The top five products in the consumer demand category (LED room lighting, televisions, mobile/smart phones, refrigeration and fans) appear in the same order as they did in 2018, indicating little change in the most desired energy service solutions across the market.

Figure 1: Comparative Rankings of Consumer Demand vs. Development Impact Potential of Household Appliances

84 Respondents



LED room lighting remains the highest-ranked household appliance in terms of perceived consumer demand. Access to lighting enables families to extend working hours after sunset, increasing productivity and financial resilience.[10] The COVID-19 pandemic amplifies the value of lighting: with many people around the world spending more time at, home access to lighting has become even more essential to households wishing to work at night.

The perceived development impact ranking of LED room lighting, however, dropped for first time in the survey series from first to fourth, while solar/electric water pumps rose to first. This monumental shift represents a growing sector trend toward larger systems and appliances. However, for un-electrified, bottom-of-the-pyramid consumers, LED room lighting is still considered a critical entry point to modern energy services. Evidence shows that simple lighting solutions still yield significant impact, perhaps even greater than higher-capacity energy systems.[11]

Solar/electric water pumps, previously only featured in the productive uses segment, were included in the household appliance segment of the survey for the first time. Survey results accurately reflect the state of the market. While solar/electric water pumps rank first in development impact potential, they rank sixth in anticipated consumer demand. Evidence validating the transformative impact solar and electric water pumps on rural subsistence farming households is growing. Water pumping can increase yields as much as three-fold, providing households with more predictable and disposable income.[12] However, the high purchase cost of a solar pump continues to inhibit consumer demand and use. In India, 60% of pumps observed in the retail market cost more than $1,000 USD.[13]

Household refrigeration ranks fourth in perceived consumer demand and third in development impact potential. These relatively high rankings indicate that the benefits of refrigerators—preventing food spoilage, reducing time spent food shopping, etc.—are well-understood. However, refrigerators remain an emerging household appliance that consumers are likely to purchase a refrigerator only after more their basic energy service needs are satisfied. Research indicates that, even with financing, the down payment for an average-sized refrigerator (150 litres) can equal up to five times a rural customer's disposable monthly income.[14]

Fans rank fifth in terms of perceived consumer demand, but tenth in development impact potential. Fans are one of the most common household appliances in hot and humid climates like South Asia due to their relatively low price. In India, 69% of rural and semi-urban households own fans.[15] While it can be difficult to quantify the impact of fans, a 2020 report found that 92% of surveyed super-efficient off-grid fan owners in Bankgladesh reported a positive impact on their families' health.[16] Respondents reported they sweated less and felt less dehydrated, both strong indicators of health improvements and reduced risk for serious health conditions.[17] Anecdotal evidence also suggests fans can help prevent overheating, particularly in infants, and improve overall quality of life.

Micro-mills/grinders, a new addition to the 2020 survey, are an emerging appliance for community and household-use. Micro-mills/grinders rank ninth in perceived consumer demand, but fifth in development impact potential. Milling and grinding—either manually at home or by transporting produce to the nearest mill—is time-consuming, labour-intensive work generally performed by women and children. Electric micro-mills and grinders have the potential to improve productivity. According to Agsol, if the 250 million women who lack electricity could save an hour each day on food processing, 100 billion hours of new productivity could be realised each year, the equivalent to a year's worth of full-time work for 50 million people.[18] Despite this potential, milling and grinding machines are not typically designed for household use and typically come with high costs, a potential explanation for their low perceived consumer demand ranking.

Computers and laptops rank sixth in perceived consumer demand and seventh in development impact potential. Though the impacts of these products are not well documented, information technologies may help transform the lives of off-grid households through increased access to e-learning, data and information, and expanded business opportunities through e-commerce.[19]

10. 60 Decibels & Efficiency for Access, (2020), Why Off-Grid Energy Matters.
11. 60 Decibels & Efficiency for Access, (2020), Why Off-Grid Energy Matters.
12. Efficiency for Access (2019), Solar Water Pump Outlook 2019.
13. Efficiency for Access (2020), Off- and Weak-Grid Appliance Market in India.
14. Efficiency for Access (2020), State of Off-Grid Appliance Market 2019.
15. Efficiency for Access (2020), Off- and Weak-Grid Appliance Market in India.
16. Efficiency for Access (2020), The Socio-Economic Impact of Super-Efficient Off-Grid Fans in Bangladesh.
17. Efficiency for Access (2020), The Socio-Economic Impact of Super-Efficient Off-Grid Fans in Bangladesh.
18. Agsol. https://agsol.com/innovation/
19. Mir, W. A. and Rakesh, K. (2017), "A Study on Role and Applications of ICT in Development of Rural Areas", International Journal of Scientific Research and Management, 5(8): 6758-6763.

Televisions rank second in perceived consumer demand but ninth in development impact potential. TVs are among the most coveted appliances among off-grid consumers, yet their impact has not been widely explored. The socioeconomic benefits of having access to a TV—including educational benefits—have never been fully measured or documented. This dearth in literatures may explain the low development impact ranking TVs received in the survey. However, recent events—like the COVID-19 pandemic—may be changing this narrative. At a time when people are required to shelter-in-place, solar TVs help keep families together and provide critical access to news and health information.

Consumer Insights: Televisions

TVs are typically not considered to be an appliance with high development impact potential. However, consumers' perspectives may prove otherwise. Efficiency for Access surveyed over 2,300 TV customers in 2020 and 93% of respondents reported an improvement in their quality of life after purchasing a TV. 50% stated their TV had "very much improved" their quality of life.[20] 25% of respondents reported increased access to information and education, and 10% felt their family connections had improved.

20. More data is being collected to increase the sample size and offer more robust insights. The report will be published in 2021.

Ranking Changes Over Time

One of the more interesting changes observed through the different editions for the Off-Grid Appliance Market Survey is how the perceived importance of specific appliances evolves over time. These perceptions might change due to a combination of ecosystem variables. For example, falling solar PV prices, combined with the rise of vertically integrated distributed energy services companies (DESCOs) using an "energy as a service" business model, make energy-consuming appliances available and affordable for end-users living in off- and weak-grid environments. As consumers access more energy services, their aspirations and ability to pay may change, resulting in different demand priorities.

Table 1 showcases observed changes over the four editions. Because survey categories have changed, the following analysis is not a direct comparison. Rather, it is a glimpse into how market trends have evolved over time.

Table 1: Perceived Consumer Demand And Development Impact Potential Rankings Over Time For Household Appliances

Perceived Consumer Demand

	2020 SURVEY RESULTS	2018 SURVEY RESULTS	2016 SURVEY RESULTS	2014 SURVEY RESULTS
1	LED room lighting	LED room lighting	LED room lighting	LED room lighting
2	Televisions	Televisions	Televisions	Mobile phone charging banks
3	Mobile/Smart phones	Mobile/Smart phones	Mobile/Smart phones	Televisions
4	Refrigeration	Refrigeration/Freezer units	Mobile phone charging banks	Radios
5	Fans	Fans	Refrigeration (household)	Refrigeration
6	Solar or electric water pumps	Mobile phone charging banks	Fans	Fans
7	Computers	Radios	Radios	Laptops
8	Radios	Electric cookstoves	Laptops	Solar water pumps
9	Micro mills / grinders	Tablets/Laptops	Hand power tools	Tablets
10	Air conditioners	Modems, web routers, internet/ connectivity equipment	Small speaker systems	Rice cookers

Development Impact Potential

	2020 SURVEY RESULTS	2018 SURVEY RESULTS	2016 SURVEY RESULTS	2014 SURVEY RESULTS
1	Solar or electric water pumps	LED lighting appliances	LED lighting appliances	LED lighting appliances
2	Mobile/Smart phones	Mobile/Smart phones	Mobile/Smart phones	Refrigeration
3	Refrigeration	Refrigeration/Freezer units	Mobile phone charging banks	Mobile phone charging banks
4	LED room lighting	Modems, web routers, internet/ connectivity equipment	Televisions	Solar water pumps
5	Micro mills/grinders	Televisions	Refrigeration (household)	Televisions
6	Computers	Tablets/Laptops	Hand power tools	Laptops
7	Modems, web routers, internet/ connectivity equipment	Sewing machines	Sewing machines	Radios
8	Sewing machines	Hand power tools	Radios	Fans
9	Televisions	Electric cookstoves	Laptops	Rice mills
10	Electric pressure cookers	Fans	Fans	Rice cookers

The top five household appliances in the **perceived consumer demand** category have not changed since 2018. New products that rank in the top ten in 2020 include: computers (ninth in 2018 and seventh in 2020), air conditioners (eleventh in 2018 and tenth in 2020), solar/electric water pumps (not included as a household appliance in 2018), micro mills/grinders (not included in 2018).

Electric cooking equipment dropped from eighth in 2018 to fifteenth in 2020. This significant decline may be a result of a narrower categorisation of cooking appliances. The 2018 survey included electric cookstoves. The 2020 survey included only electric pressure cookers. Internet/connectivity equipment also experienced another noticeable drop in the rankings from tenth in 2018 to thirteenth in 2020.

The most notable change in the **development impact potential** category is the abrupt drop of LED lighting from first to fourth. With the exception of mobile/smart phones, other development impact potential rankings vary considerably year by year. For instance:

- **Micro mills/grinders** rank in the top ten, reflecting their potential to increase productivity through reduced labour and processing time
- **Computers/laptops** climbed into the top ten over internet/connectivity equipment
- **Fans,** which ranked tenth in 2016 and 2018, dropped to thirteenth place in 2020

Differences by Gender

A growing body of research suggests that the use and impact of appliances is gendered and that addressing gendered preferences is essential to engaging women in the clean energy transition. The risk of not doing so may further exclude women from the clean energy transition. As in 2018, the 2020 survey asked respondents if their perceived consumer demand or development impact potential rankings would change based on the end user's gender.

Of the 84 respondents who answered this question for household appliances, more than half (53%) reported that they would not change their ranking based on the end user's gender, while 15% of answered "unknown."

32% of respondents, down from 37% in 2018, stated they would change their ranking based on the end user's gender. This sub-group found LED room lighting, solar/electric water pumps, refrigeration, mobile/smart phones and micro mills/grinders have high development impact potential for men and women (Figure 2). Excluding refrigerators, there is little deviation (less than 40%) among products across genders.

According to practitioners, refrigerators and sewing machines rank among the top five appliances for women. Similar to the 2018 survey, the deviation between perspectives among men and women was largest for hand power tools, electric pressure cookers, rice cookers and sewing machines. Electric cookstoves had a large deviation between the development impact potential rankings in 2018, a difference now reflected in the electric pressure cooker and rice cooker appliance categories.

Top 5 Development Impact Rankings of Household Appliances by Gender

WOMEN

1. LED Room Lighting Appliances
2. Refrigeration
3. Sewing Machines
4. Solar or Electric Water Pumps
5. Mobile/Smart Phones

MEN

1. Solar or Electric Water Pumps
2. LED Room Lighting Appliances
3. Mobile/Smart Phones
4. Hand Power Tools
5. Micro Mills/Grinders

Products that showed a large deviation between men and women in potential development impact include:

SEWING MACHINES:
Rank **third** for women and **10th** for men

HAND POWER TOOLS:
Rank **19th** for women and **fourth** for men

ELECTRIC PRESSURE COOKERS:
Rank **sixth** for women and **15th** for men

REFRIGERATION:
Ranks **second** for women and **sixth** for men

Figure 2: Relative Rankings of the Development Impact Potential of Household Appliances by the Gender of the End User

Differences by Region

We examined product rankings by region, looking for variations in **perceived consumer demand**. Overall, the rankings across regions were remarkably similar, with respondents consistently ranking LED room lighting, televisions and mobile/smart phones highly in the perceived consumer demand category (Figure 3).

However, some rankings do reflect distinctive regional characteristics. These differences suggest that regional preferences are important, and should be considered by industry, policymakers and other stakeholders. For example:

- In Africa, refrigeration, solar/electric pumps and fans rank highly in perceived consumer demand. Fans rank fourth across West, Central and North Africa, but not in East and Southern Africa. This is likely due to different climate conditions. Solar/electric water pumps rank fifth only in East and West Africa. Only in Central Africa, do refrigerators drop below fifth.
- Fans are no longer the top-ranking appliance in South Asia, but they still rank among the top five. GOGLA affiliate sales data show fan sales remain steady in South Asia. Between July and December 2019, more than 111,000 fans were sold, compared to less than 500 solar TVs.[21]
- Southern Africa is the only region where computers rank among the top five.

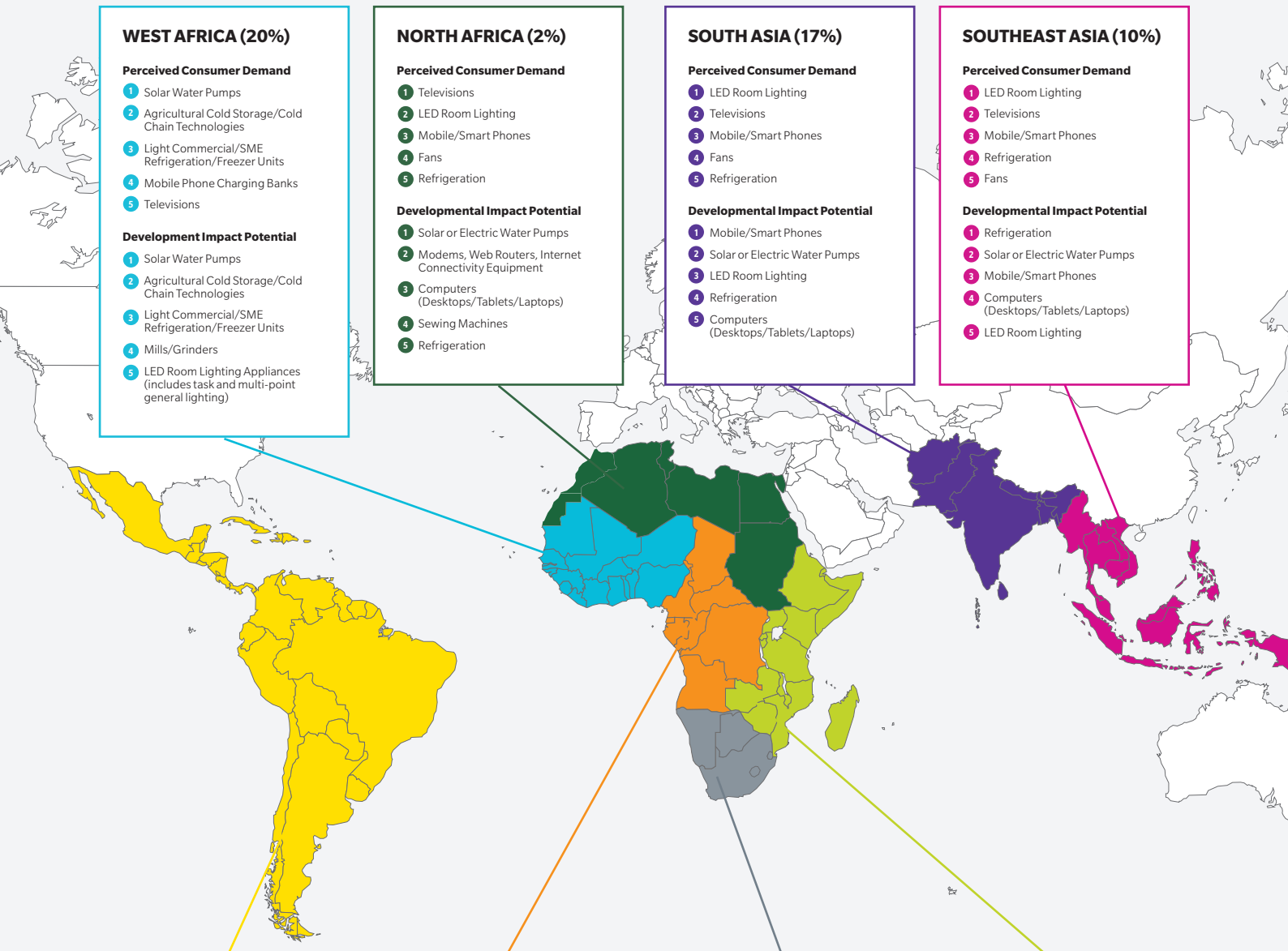
Refrigeration and SWPs rank in the top five household appliances for **development impact potential** across all regions. However, different regional priorities became more evident for other appliances (Figure 3). For example:

- Southern Africa's top five appliances—which include clothes irons and clothes washers—stand out as unique. The relatively high electrification rates in the region may explain this phenomenon. Advanced developed markets in the region, such as South Africa, may be driving demand for high energy consuming products.
- Sewing machines and hand power tools rise in the regional rankings, particularly in North Africa and Latin America.

21. GOGLA (2019), Global Off-Grid Solar Market Report H2 2019 (Sales and Impact Data)

Figure 3: Relative Perceived Consumer Demand and Development Impact Potential for Productive Use Appliances Ranked by Region

Number of Respondents = 133
(%) shows percentage of survey respondents from that region.



WEST AFRICA (20%)

Perceived Consumer Demand

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. Mobile Phone Charging Banks
5. Televisions

Development Impact Potential

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. Mills/Grinders
5. LED Room Lighting Appliances (includes task and multi-point general lighting)

NORTH AFRICA (2%)

Perceived Consumer Demand

1. Televisions
2. LED Room Lighting
3. Mobile/Smart Phones
4. Fans
5. Refrigeration

Developmental Impact Potential

1. Solar or Electric Water Pumps
2. Modems, Web Routers, Internet Connectivity Equipment
3. Computers (Desktops/Tablets/Laptops)
4. Sewing Machines
5. Refrigeration

SOUTH ASIA (17%)

Perceived Consumer Demand

1. LED Room Lighting
2. Televisions
3. Mobile/Smart Phones
4. Fans
5. Refrigeration

Developmental Impact Potential

1. Mobile/Smart Phones
2. Solar or Electric Water Pumps
3. LED Room Lighting
4. Refrigeration
5. Computers (Desktops/Tablets/Laptops)

SOUTHEAST ASIA (10%)

Perceived Consumer Demand

1. LED Room Lighting
2. Televisions
3. Mobile/Smart Phones
4. Refrigeration
5. Fans

Developmental Impact Potential

1. Refrigeration
2. Solar or Electric Water Pumps
3. Mobile/Smart Phones
4. Computers (Desktops/Tablets/Laptops)
5. LED Room Lighting

LATIN AMERICA (7%)

Perceived Consumer Demand

1. Televisions
2. LED Room Lighting
3. Mobile/Smart Phones
4. Refrigeration
5. Solar or Electric Water Pumps

Developmental Impact Potential

1. Solar or Electric Water Pumps
2. Refrigeration
3. Mobile/Smart Phones
4. LED Room Lighting
5. Hand Power Tools

CENTRAL AFRICA (10%)

Perceived Consumer Demand

1. Solar Water Pumps
2. Light Commercial/SME Refrigeration/Freezer Units
3. Agricultural Cold Storage/Cold Chain Technologies
4. Televisions
5. LED Room Lighting Appliances (includes task and multi-point general lighting)

Developmental Impact Potential

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. LED Room Lighting Appliances (includes task and multi-point general lighting)
5. Milk Chilling Units

SOUTHERN AFRICA (7%)

Perceived Consumer Demand

1. Solar Water Pumps
2. LED Room Lighting Appliances (includes task and multi-point general lighting)
3. Agricultural Cold Storage/Cold Chain Technologies
4. Mobile Phone Charging Banks
5. Light Commercial/SME Refrigeration/Freezer Units

Developmental Impact Potential

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. LED Room Lighting Appliances (includes task and multi-point general lighting)
4. Light Commercial/SME Refrigeration/Freezer Units
5. Computers (Desktops/Tablets/Laptops)

EAST AFRICA (32%)

Perceived Consumer Demand

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. Mobile Phone Charging Banks
5. LED Room Lighting Appliances (includes task and multi-point general lighting)

Developmental Impact Potential

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. Mills/Grinders
5. LED Room Lighting Appliances (includes task and multi-point general lighting)

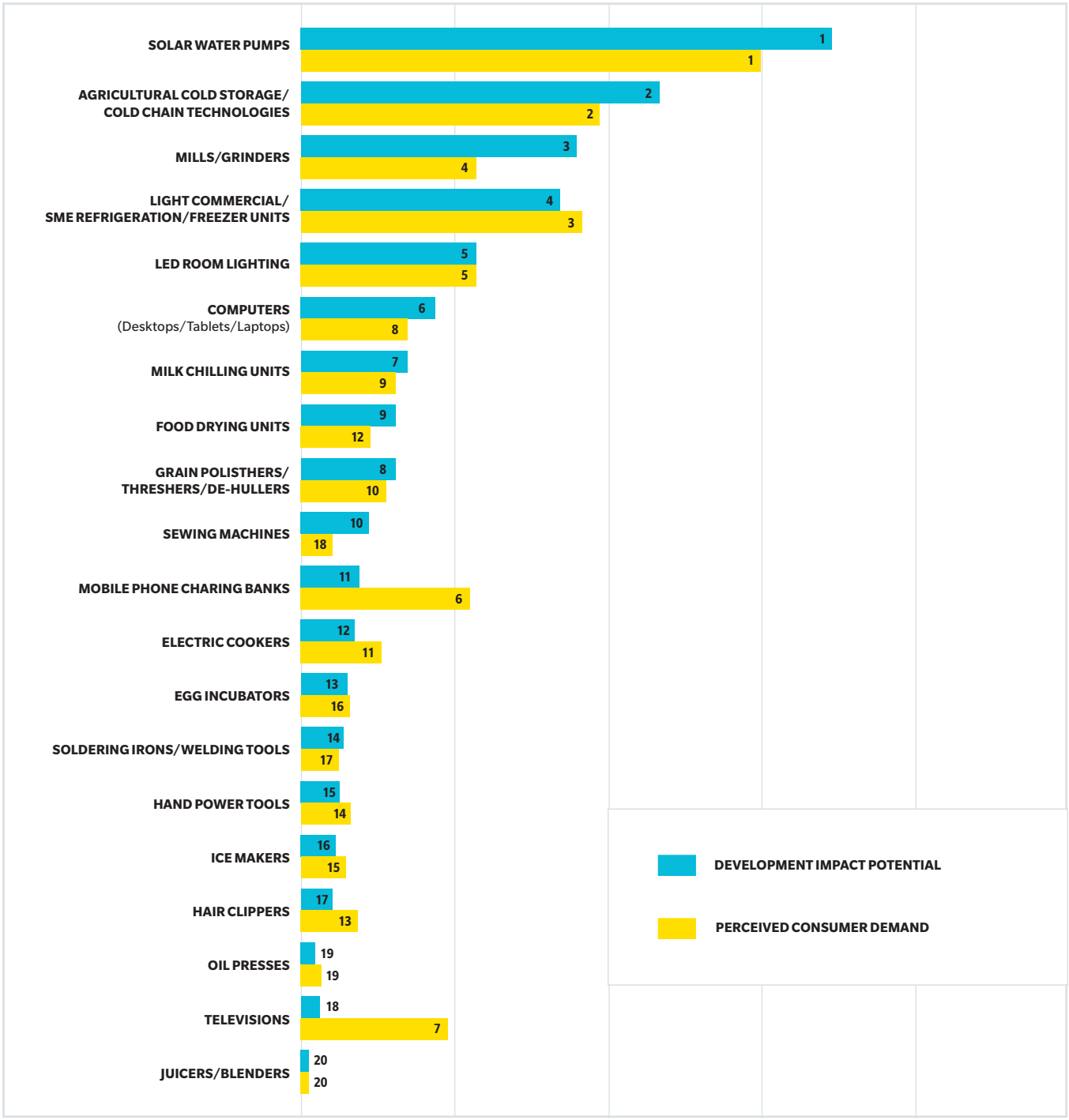
PRODUCTIVE USE APPLIANCES

This section describes rankings of the perceived consumer demand and potential development impact of 20 business/productive use appliances (Figure 4). The Off-Grid Appliance Market Survey differentiates between household use and productive use technologies; although some appliance categories overlap, direct comparison between these two use cases is not always possible.

The 2020 edition of the survey introduced small changes to the productive use appliances list. Juicers/blenders, egg incubators, grain polishers/threshers/de-hullers, oil presses and electric pressure cookers were added to the survey while tea kettles, industrial fans and mobile phones were removed due to low priority scoring in past iterations. Mills and grinders were combined into one category due to their similarities. The tablet/laptop category was renamed “computers”, and now includes desktop machines.

Figure 4: Comparative Rankings of Perceived Consumer Demand vs. Development Impact Potential for Business/Productive Use Appliances

109 Respondents



Perceived Consumer Demand and Development Impact Potential

Survey results indicate that the business/productive use appliances with the highest impact potential correspond closely to consumer demand, with the exception of mills/grinders.

Solar/electric water pumps and agricultural cold storage/cold chain technologies maintained their respective first and second place rankings in the perceived consumer demand and development impact potential categories. This trend reflects the industry's growing commitment to provide off-grid consumers with new technologies that enable more productive working hours and higher earning potential.

Mills/grinders rank fourth in perceived consumer demand and third in development impact potential, up from their respective 2018 rankings of sixth and fourth. Despite equal rankings in development impact potential, household demand for **micro-mills/grinders** is ranked significantly lower than productive use/business demand for mills/grinders. Grinders are a relatively new entry into the off-grid appliance marketed for home use. They have low market penetration, are marketed mostly to consumers in urban and peri-urban locations. However, given their potential to deliver development impacts, we may see demand grow as mills/grinders become more widely available.

Mobile phone charging banks and **televisions** rank sixth and seventh in perceived consumer demand, but show significant deviation between demand and development impact rankings. The low ranking in perceived consumer demand and development impact potential for TVs may be due to the small percentage of these appliances sold for business use[22], coupled with low returns from commercial activities like video halls.

Of the newly added categories, **juicers/blenders** and **oil presses** rank low in the perceived consumer demand and development impact potential categories. However, a recent report noted the high profit potential for oil presses and juicers on mini grids in Tanzania. While not reflected in the regional rankings of this report, these findings demonstrate the importance of context when making decisions and predictions about productive use appliances.[23]

22. Only 9% of consumers use their solar TVs at their businesses or to supplement their incomes at home. Efficiency for Access, The Use and Impacts of Solar TVs.
23. Unpublished report by A2EI, Evaluation of Solar Powered Agricultural Technologies for Productive-Use Applications: A Modeling Approach.

"Getting this fridge has helped because if a child asks me to buy them a book, I can take money from what the fridge has earned us. The money is there, and I use it."

PROSCOVIA NAMUGGA
SolarNow Refrigerator Customer

"The [off-grid] refrigerator has helped me get my life back to normal. I have not always been able to afford my medication. Now, with the added income of my fridge, I'm taking my medicine and no longer have the pressure of wondering what to feed my kids."

NABBOSA TEDDY
Masaka, Uganda

Credit: Village Energy

Refrigeration provides a wide range of benefits. It improves health and productivity, and enables income-generation for small retailers by providing a place to store cold drinks, food, medicine and other perishable items. For women, refrigerators preserving food and reduce the number of trips to the market. They may also offer an opportunity for women to earn additional income. A recent study found that 81% of off-grid refrigerator customers use their appliance at a place of business, often run out of their homes.[24] The additional income allows families to diversify their diets and pay for school fees.[25]

24. Unpublished data from Efficiency for Access research on the use and benefits of off-grid refrigeration. Final report to be published in 2021.
25. Efficiency for Access and ENERGIA, The Role of Appliances in Achieving Gender Equality and Energy Access for All.

Ranking Changes Over Time

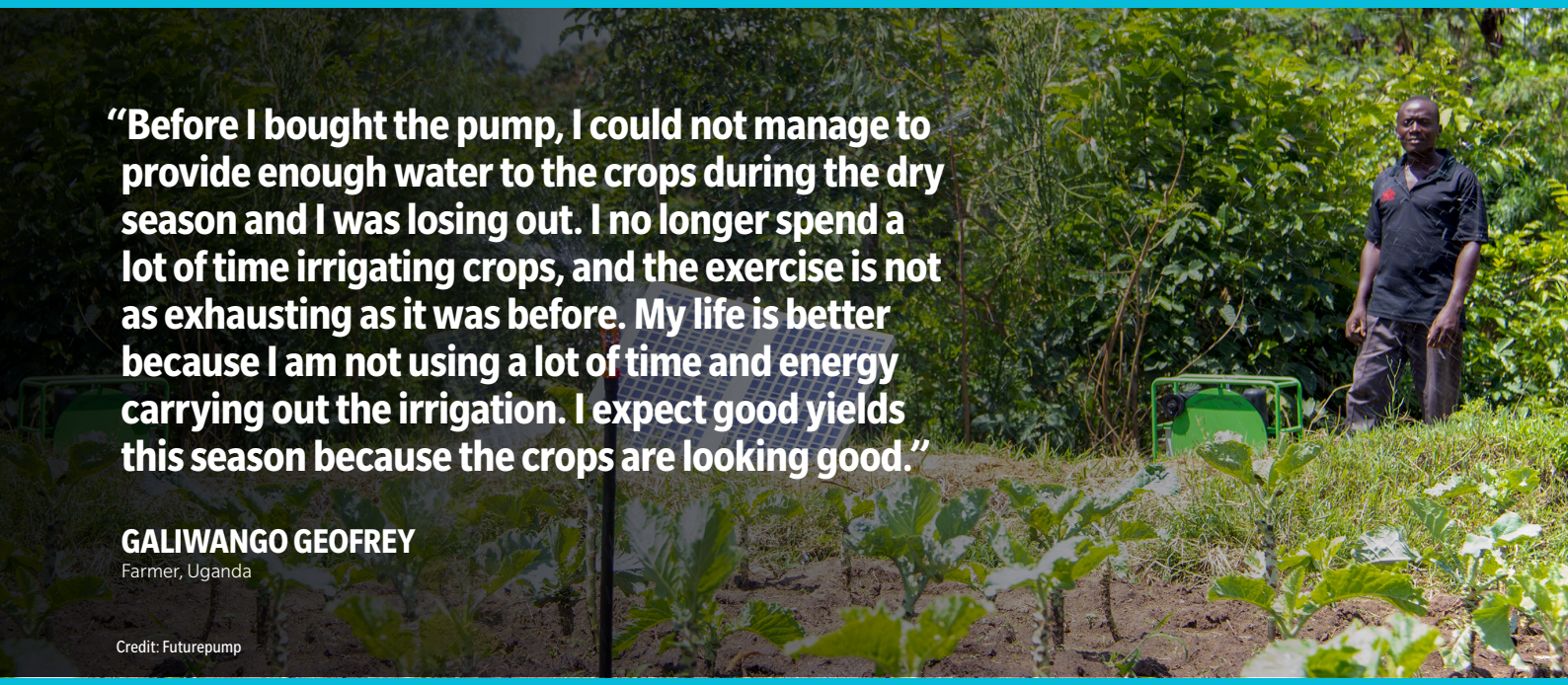
Reclassifying 2018 results highlights the rise of **mills/grinders.**[26] While these appliances were already considered to have high development impact potential, their growing perceived consumer demand is significant. This trend may be a reflection of the number of new companies entering the market or the increased visibility, diversity and availability of mills/grinders.

The noticeable consistency in the top five business/productive use appliances over the past five years suggests a sector focus on larger appliances for agricultural value chains and agricultural processing. This trend might also explain why **grain polishers/threshers/de-hullers**—a new category in the 2018 survey—rose into the top ten, along with **food drying units** and **milk chillers.** On the other hand, niche products like **icemakers** and **oil presses**, both used in agricultural value chains and processing, appear to run counter to this trend.

Smaller business appliances such as **mobile phone charging banks, hair clippers and hand power tools** rank low in perceived consumer demand and development impact potential. Meanwhile, **LED room lighting** continues its downward trajectory in both categories. Anecdotal evidence suggests the accessibility of high-quality lighting may be shifting perceptions of the technology to a basic business enabler rather than a productive use appliance in its own right.

26. Adding together the results for mills and grinders, which in 2018 were classified separately.

Consumer Insights: Solar Water Pumps



Solar water pumping systems offer a clean alternative to manual and diesel-driven pump sets, and are often used for agricultural operations in remote areas or where an alternative energy source is desired. Because considerable initial investment is required, solar pump users tend to be older, higher-income individuals with more education than solar home system (SHS), lantern or TV customers. Properly designed pumps can produce long-term cost savings and increased agricultural productivity, as well as provide access to clean water for communities in water insecure areas.[27]

27. Efficiency for Access and 60 Decibels (2019), Use and Benefits of Solar Water Pumps.

Table 2: Perceived Consumer Demand And Development Impact Potential Rankings Over Time For Business/Productive Use Appliances

Perceived Consumer Demand

	2020 SURVEY RESULTS	2018 SURVEY RESULTS (MODIFIED[18])	2016 SURVEY RESULTS (MODIFIED)	2015 SURVEY RESULTS (MODIFIED)
1	Solar Water Pumps	Solar Water Pumps	LED lighting appliances	LED lighting appliances
2	Agricultural Cold Storage/ Cold Chain Technologies	Refrigeration/Cold chain technologies (Agriculture cold chain)	Televisions	Mobile charging banks
3	Light Commercial/SME Refrigeration/Freezer Units	Refrigeration/Freezer units (Light commercial/SME)	Mobile/Smart phones	Televisions
4	Mills/Grinders	LED lighting appliances	Mobile phone charging banks	Refrigeration
5	LED Room Lighting Appliances	Mobile/Smart phones	Fans	Fans
6	Mobile Phone Charging Banks	Mills/grinders	Refrigeration (Light commercial/SME)	Laptops
7	Televisions	Milk chilling units	Solar water pumps	Solar Water Pumps
8	Computers (Desktops/Tablets/Laptops)	Televisions	Refrigeration (Agricultural cold chain)	Tablets
9	Milk Chilling Units	Mobile phone charging banks	Laptops	Clothes irons
10	Grain Polishers/Threshers/ De-Hullers	Hand power tools	Hand Power Tools	Grinders

Development Impact Potential

	2020 SURVEY RESULTS	2018 SURVEY RESULTS	2016 SURVEY RESULTS (MODIFIED)	2015 SURVEY RESULTS (MODIFIED)
1	Solar Water Pumps	Solar Water Pumps	LED lighting appliances	LED lighting appliances
2	Agricultural Cold Storage/ Cold Chain Technologies	Refrigeration/Cold chain technologies (agricultural cold chain)	Mobile/Smart phones/	Refrigeration
3	Mills/Grinders	Refrigeration/Freezer units (light commercial/SME)	Solar water pumps	Mobile charging banks
4	Light commercial/ SME refrigeration/Freezer units	Mills/Grinders	Refrigeration (agricultural cold chain)	Solar water pumps
5	LED room lighting appliances	LED room lighting appliances	Refrigeration (light commercial/SME)	Televisions
6	Computers (desktops/tablets/laptops)	Milk chilling units	Mobile phone charging banks	Laptops
7	Milk chilling units	Mills	Televisions	Fans
8	Grain polishers/Threshers/ De-hullers	Food drying units	Hand power tools	Rice mills
9	Food drying units	Hand power tools	Mills	Grinders
10	Sewing machines	Sewing machines	Sewing machines	Hand power tools

Credit: Ennos

Differences by Gender

We disaggregated the business/productive use development impact potential ranking by gender for the first time in the survey series. Interestingly, the majority of respondents (64%) reported that they would not change their rankings based on the end-user's gender, an even more striking figure than the household responses.

36% of respondents stated they would change their ranking based on the end user's gender. Similar to household appliances, the ranking results from this sub-group (Figure 5) reflect the assumption that women's commercial activities tend to follow the same pattern as their expected domestic roles. High ranking appliances for women are typically those that could serve as both household and productive use appliances, and would likely be used in home-based businesses. The appliances with little gender deviation are those which could also be used in home-based businesses, perhaps due to the traditional view of women as home keepers and men as wage earners.

Top 5 Development Impact Rankings of Business/Productive Use Appliances by Gender

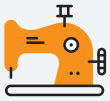
WOMEN

1. Sewing Machines
2. Light Commercial/SME Refrigeration/Freezer Units
3. Solar Water Pumps
4. Electric Cookers
5. LED Room Lighting

MEN

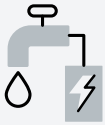
1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Mills/Grinders
4. Hand Power Tools
5. Light Commercial/SME Refrigeration/Freezer Units

Products that showed the largest deviation between in consumer perspectives for men and women include:

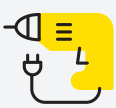


SEWING MACHINES:
Rank **first** for women and **19th** for men, despite anecdotal evidence of both men and women being employed as tailors throughout most of Africa's informal markets

ELECTRIC COOKERS:
Rank **fourth** for women and **15th** for men. Use of electric cookers may change gendered norms around cooking. Pilot results from Tanzania indicate that men participate more regularly in cooking when using an electric cooker.[28]



SOLAR WATER PUMPS:
Rank **third** for women and **first** for men. Despite high development impact potential for men and women, men own the overwhelming majority of SWPs. In survey of 400 SWP users in East Africa, only 16% of were women.



HAND POWER TOOLS:
Rank **20th** for women and **fourth** for men. Anecdotal evidence suggest when capacity building in coupled with energy access, the demand for such tools is not as gendered as anticipated.

28. CLASP, Electric Pressure Cooking: Accelerating Microgrid E-Cooking Through Business and Delivery Model Innovations.

Figure 5: Relative Rankings of the Development Impact Potential of Business/Productive Use Appliances by the Gender of the End User

Differences by Region

Overall, **perceived consumer demand** for productive use appliances was remarkably similar across regions. Still, a few notable regional preferences emerged:

- **Televisions** rank in top five most-demanded appliances in Central and West Africa only
- **Milk chilling units** are among the top five appliances in North Africa and India, but not in the rest of South Asia
- **Mills/grinders** rank in the top five only in the Asian subcontinent
- **Mobile phone charging units** are noticeably absent in the rankings in Asia, but are among the top five in Latin American and all African regions except Central Africa

Although **solar water pumps, agricultural cold storage/ cold chain technologies, light commercial/SME refrigeration/freezer units, LED room lighting appliances** and **millers/ grinders** are seen to have the highest **development impact potential** in most regions, product priorities do vary slightly (Figure 6):

- **Light commercial/SME refrigeration/freezer units** fell to fifth place only in North Africa
- **Millers/grinders** made the top five rankings in East and West Africa, South Asia and Southeast Asia
- **LED room lighting appliances** rank among the top five in every region, though their importance varies from second in North Africa to fifth in South Asia, East Africa and West Africa
- **Milk chilling units** appear only in the top five appliances for Central Africa, while egg incubators appear only top five appliances for Latin America
- **Computers** rank in top five appliances for Southern Africa and North Africa only

Figure 6: Relative Perceived Consumer Demand and Development Impact Potential for Productive Use Appliances Ranked by Region

Number of Respondents = 109
(%) shows percentage of survey respondents from that region.

WEST AFRICA (20%)

Perceived Consumer Demand

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. Mobile Phone Charging Banks
5. Televisions

Developmental Impact Potential

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. Mills/Grinders
5. LED Room Lighting Appliances (includes task and multi-point general lighting)

NORTH AFRICA (4%)

Perceived Consumer Demand

1. Agricultural Cold Storage/Cold Chain Technologies
2. Solar Water Pumps
3. Mobile Phone Charging Banks
4. LED Room Lighting Appliances (includes task and multi-point general lighting)
5. Milk Chilling Units

Developmental Impact Potential

1. Solar Water Pumps
2. LED Room Lighting Appliances (includes task and multi-point general lighting)
3. Agricultural Cold Storage/Cold Chain Technologies
4. Computers (Desktops/Tablets/Laptops)
5. Light Commercial/SME Refrigeration/Freezer Units

SOUTH ASIA (16%)

Perceived Consumer Demand

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. Mills/Grinders
5. LED Room Lighting Appliances (includes task and multi-point general lighting)

Developmental Impact Potential

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. Mills/Grinders
5. LED Room Lighting Appliances (includes task and multi-point general lighting)

SOUTHEAST ASIA (8%)

Perceived Consumer Demand

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. LED Room Lighting Appliances (includes task and multi-point general lighting)
5. Mills/Grinders

Developmental Impact Potential

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. LED Room Lighting Appliances (includes task and multi-point general lighting)
5. Mills/Grinders

LATIN AMERICA (3%)

Perceived Consumer Demand

1. Solar Water Pumps
2. Light Commercial/SME Refrigeration/Freezer Units
3. LED Room Lighting Appliances (includes task and multi-point general lighting)
4. Mobile Phone Charging Banks
5. Agricultural Cold Storage/Cold Chain Technologies

Developmental Impact Potential

1. Solar Water Pumps
2. LED Room Lighting Appliances (includes task and multi-point general lighting)
3. Agricultural Cold Storage/Cold Chain Technologies
4. Light Commercial/SME Refrigeration/Freezer Units
5. Egg Incubators

CENTRAL AFRICA (10%)

Perceived Consumer Demand

1. Solar Water Pumps
2. Light Commercial/SME Refrigeration/Freezer Units
3. Agricultural Cold Storage/Cold Chain Technologies
4. Televisions
5. LED Room Lighting Appliances (includes task and multi-point general lighting)

Developmental Impact Potential

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. LED Room Lighting Appliances (includes task and multi-point general lighting)
5. Milk Chilling Units

SOUTHERN AFRICA (7%)

Perceived Consumer Demand

1. Solar Water Pumps
2. LED Room Lighting Appliances (includes task and multi-point general lighting)
3. Agricultural Cold Storage/Cold Chain Technologies
4. Mobile Phone Charging Banks
5. Light Commercial/SME Refrigeration/Freezer Units

Developmental Impact Potential

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. LED Room Lighting Appliances (includes task and multi-point general lighting)
4. Light Commercial/SME Refrigeration/Freezer Units
5. Computers (Desktops/Tablets/Laptops)

EAST AFRICA (32%)

Perceived Consumer Demand

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. Mobile Phone Charging Banks
5. LED Room Lighting Appliances (includes task and multi-point general lighting)

Developmental Impact Potential

1. Solar Water Pumps
2. Agricultural Cold Storage/Cold Chain Technologies
3. Light Commercial/SME Refrigeration/Freezer Units
4. Mills/Grinders
5. LED Room Lighting Appliances (includes task and multi-point general lighting)

HEALTHCARE TECHNOLOGIES

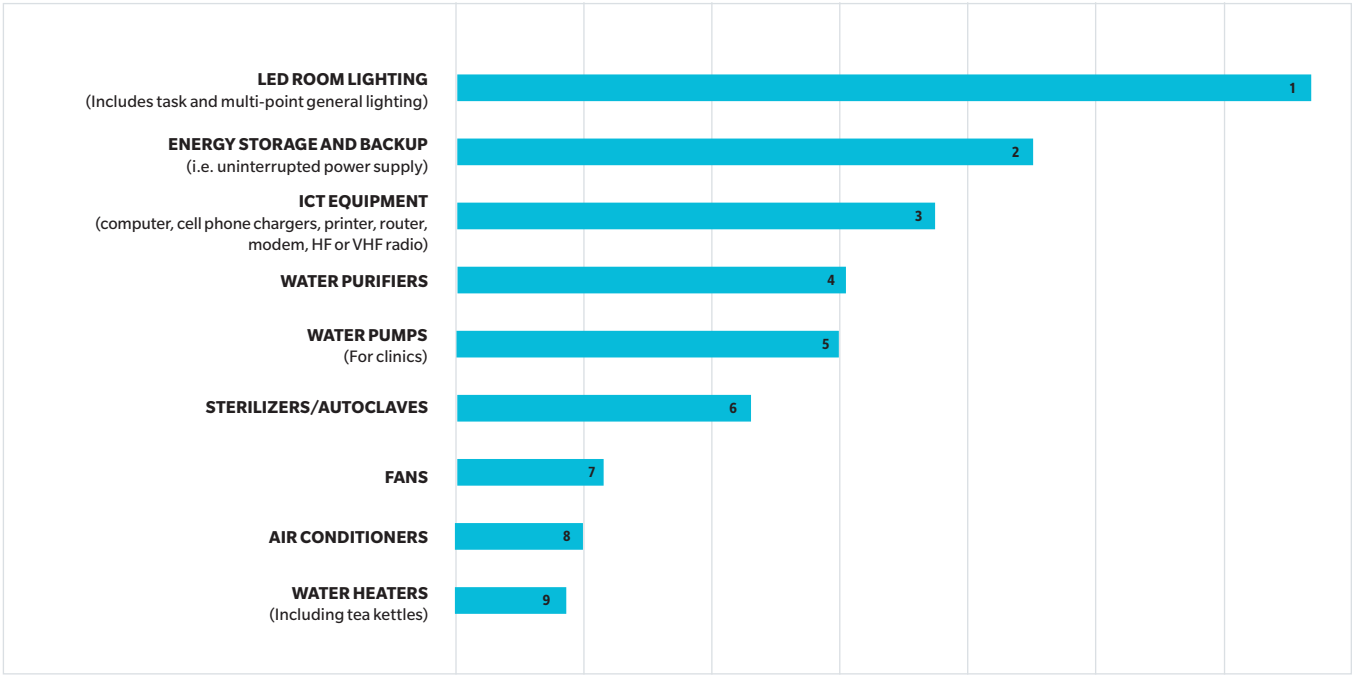
The 2020 edition of the survey asked respondents to rank the relative importance of 24 product categories in delivering healthcare services to rural and/or under-electrified communities. In order to provide a holistic perspective on clinic electrification needs, it included questions about clinic infrastructure as well as medical devices. The survey also asked respondents to rank health technologies according to their relative importance as part of the COVID-19 response and their importance to basic healthcare service delivery.

The 2020 survey uses input from seasoned sector professionals working actively on product development and supply to provide unique insights into the equipment needed for health service delivery in un- and under-electrified areas. This perspective is particularly important in the context of the COVID-19 pandemic, which has raised awareness among many sector stakeholders of the importance of electricity in health service provision. Perhaps as a result of this heightened awareness, the number of self-selecting respondents in the healthcare segment increased by 66% compared to the 2018 survey.

Clinic Infrastructure

Figure 7. Importance of Clinic Infrastructure Technologies for Health Service Delivery

35 Respondents



LED lighting is the highest-ranked **clinic infrastructure technology** by a significant margin. Access to lighting can dramatically improve the quality and safety of medical care, especially maternity care. The World Health Organization (WHO) estimates that 295,000 women died during childbirth in 2017, with 86% of these deaths taking place in sub-Saharan Africa and South Asia.[30] With many women still giving birth by kerosene lamp or candlelight, LED lighting can serve as a transformative medical intervention. Lighting also allows clinics to expand health service provision and reach more community members by operating after dark.

Energy storage and backup rank second, reflecting the fact that 59% of clinics in low- and middle-income countries lack a reliable supply of electricity; in sub-Saharan Africa, just 28% of clinics and hospitals have reliable energy.[31,32] Greater availability of energy storage technologies would therefore benefit an overwhelming majority of clinics in underserved areas.

ICT equipment, ranked third, allows health practitioners to communicate with laboratories and outside experts, improving their diagnostic and treatment capabilities. ICT equipment can also facilitate follow-up care and allow clinics to field inquiries from community members.

Water purifiers and **water pumps,** ranked fourth and fifth respectively, demonstrate the importance of a reliable water supply. Many clinical procedures require water, and potable water can ensure proper hydration for both patients and clinicians. It also facilitates basic hygienic practices such as handwashing and instrument sterilisation.

The technologies described above collectively ensure that clinics have continuous access to lighting, communications and water. Taken together, they also improve basic quality of life for clinical staff who often must live at or near the clinics. This can be an important factor in hiring and retaining personnel.[33]

30. World Health Organization (2019), Factsheet: Material Mortality.
31. Cronk, Ryan and Jamie Bartram (2018), "Environmental conditions in health care facilities in low- and middle-income countries: Coverage and inequalities", International Journal of Hygiene and Environmental Health.
32. Adair-Rohani et al (2013), "Limited electricity access in health facilities of Sub-Saharan Africa: a systematic review of data on electricity access, sources, and reliability", Global Health: Science and Practice.
33. Sustainable Energy for All and United Nations Foundation (2019), Lasting impact – Sustainable off-grid solar delivery models to power health and education.

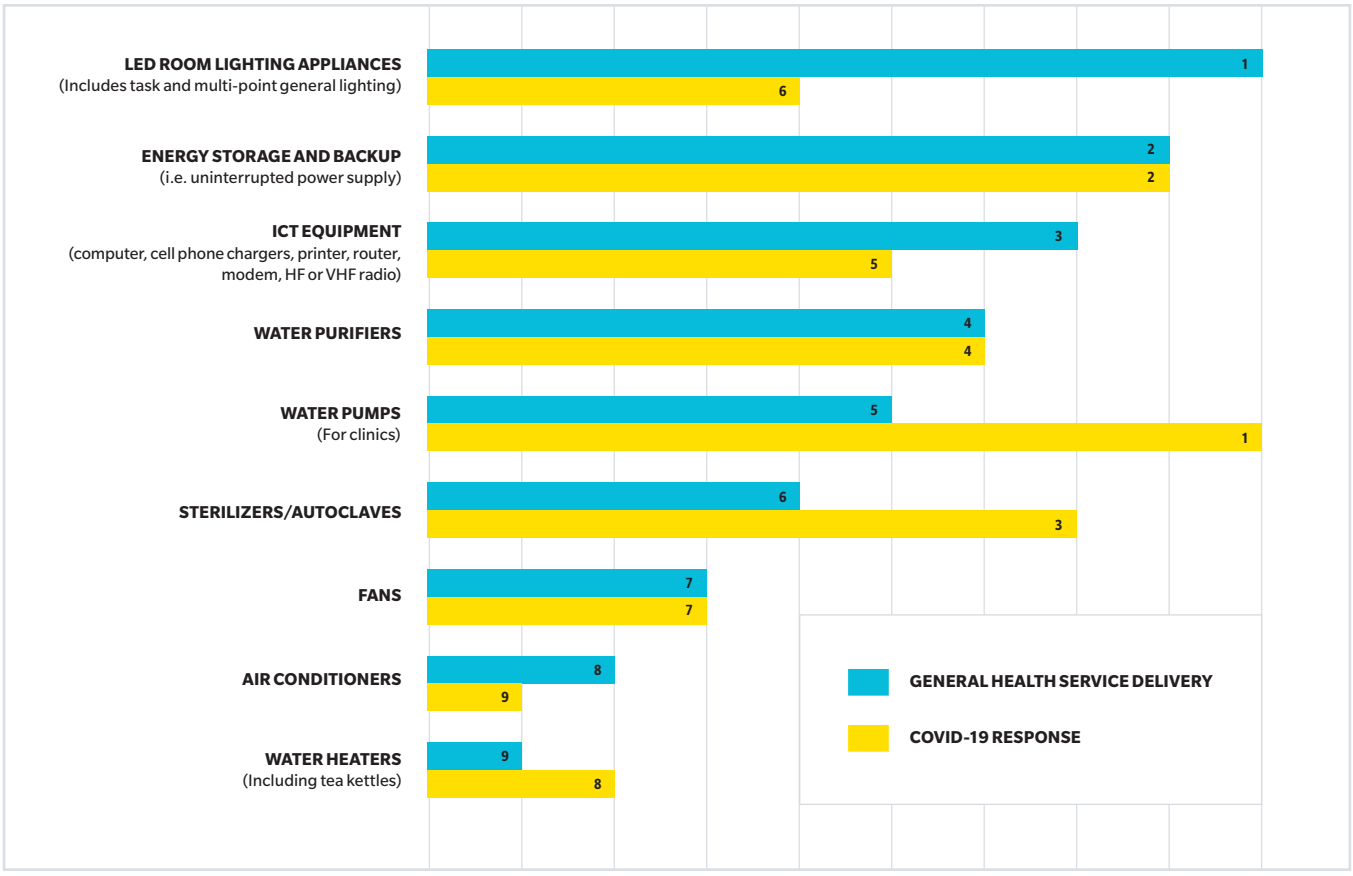
Clinic Infrastructure for Pandemic Response

The survey also asked respondents to rank clinic infrastructure specifically for the provision of COVID-19-related health services (Figure 8).

When ranking relative importance of relevant appliances to the COVID-19 pandemic response, respondents effectively inverted the rank order for **LED lighting** and **water pumps.** Sterilisers were also considered more important, and ICT equipment slightly less important. This could be due to the critical nature of handwashing and equipment sterilisation in responding to easily communicable viral infections such as COVID-19.

Figure 8. Comparison of Clinic Infrastructure for General Health Service Delivery Versus COVID-19 Response

35 Respondents

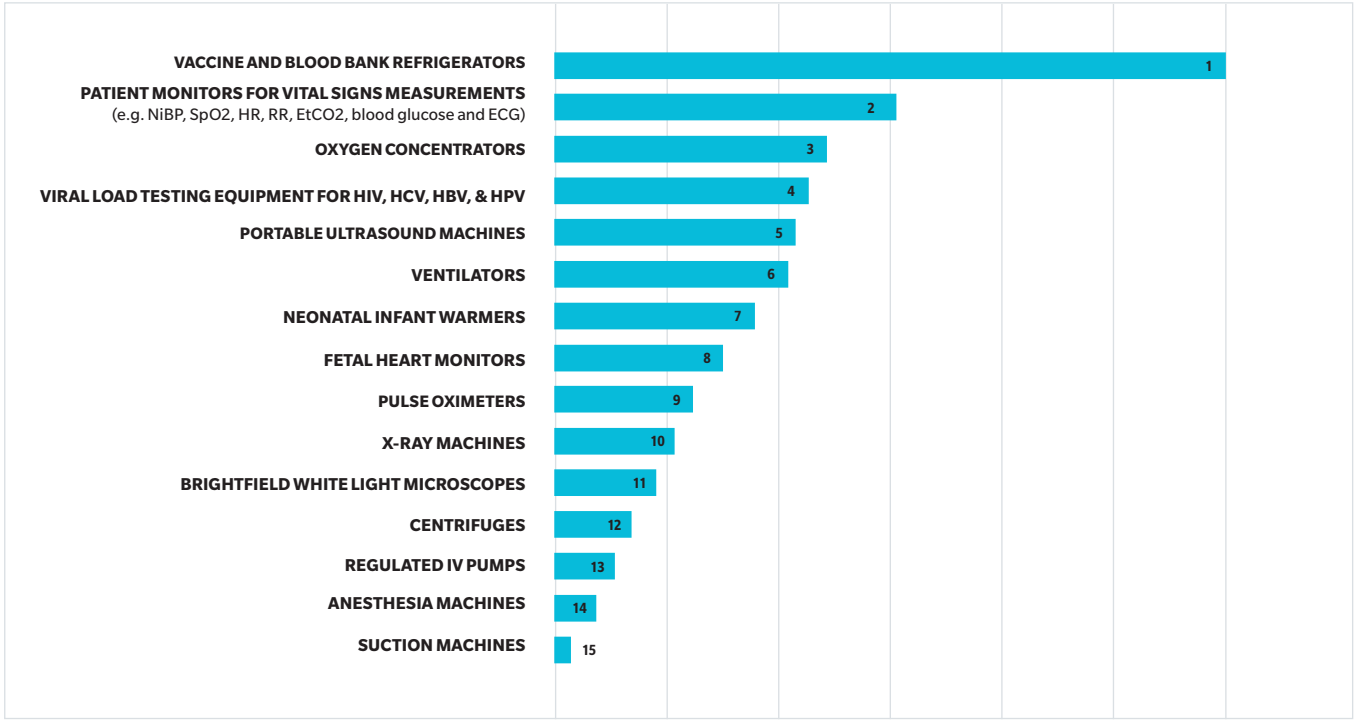


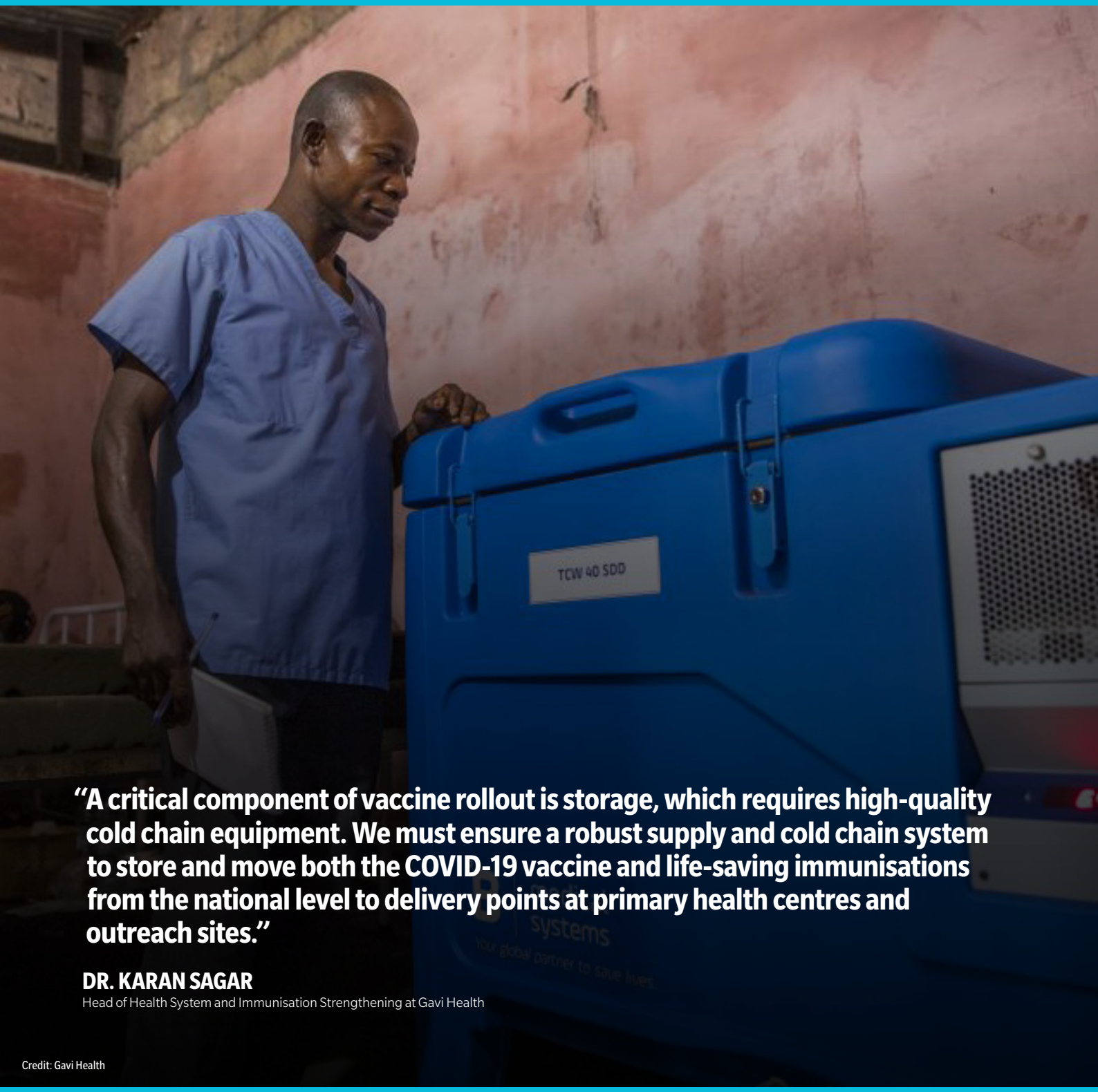
Medical Devices

The highest scoring **medical devices** align with critical services provided by primary health clinics: vaccination, diagnostic assessment and patient triage (Figure 9).

Figure 9. Importance of Medical Devices for Health Service Delivery

35 Respondents





"A critical component of vaccine rollout is storage, which requires high-quality cold chain equipment. We must ensure a robust supply and cold chain system to store and move both the COVID-19 vaccine and life-saving immunisations from the national level to delivery points at primary health centres and outreach sites."

DR. KARAN SAGAR
Head of Health System and Immunisation Strengthening at Gavi Health

Credit: Gavi Health

The lack of reliable medical cold chains affects the delivery of both the COVID-19 vaccine and routine life-saving immunisations. Prior to the pandemic, millions of children went unvaccinated against preventable diseases largely because healthcare systems lacked the cooling infrastructure necessary to keep vaccines viable all the way to last-mile patients. In order to deliver the COVID-19 vaccine to 60-70% of the world's population (4.7-5.5 billion people), new cold chain equipment will need to be rolled out on a massive scale.[34]

34. Sustainable Energy for All, Chilling Prospects.

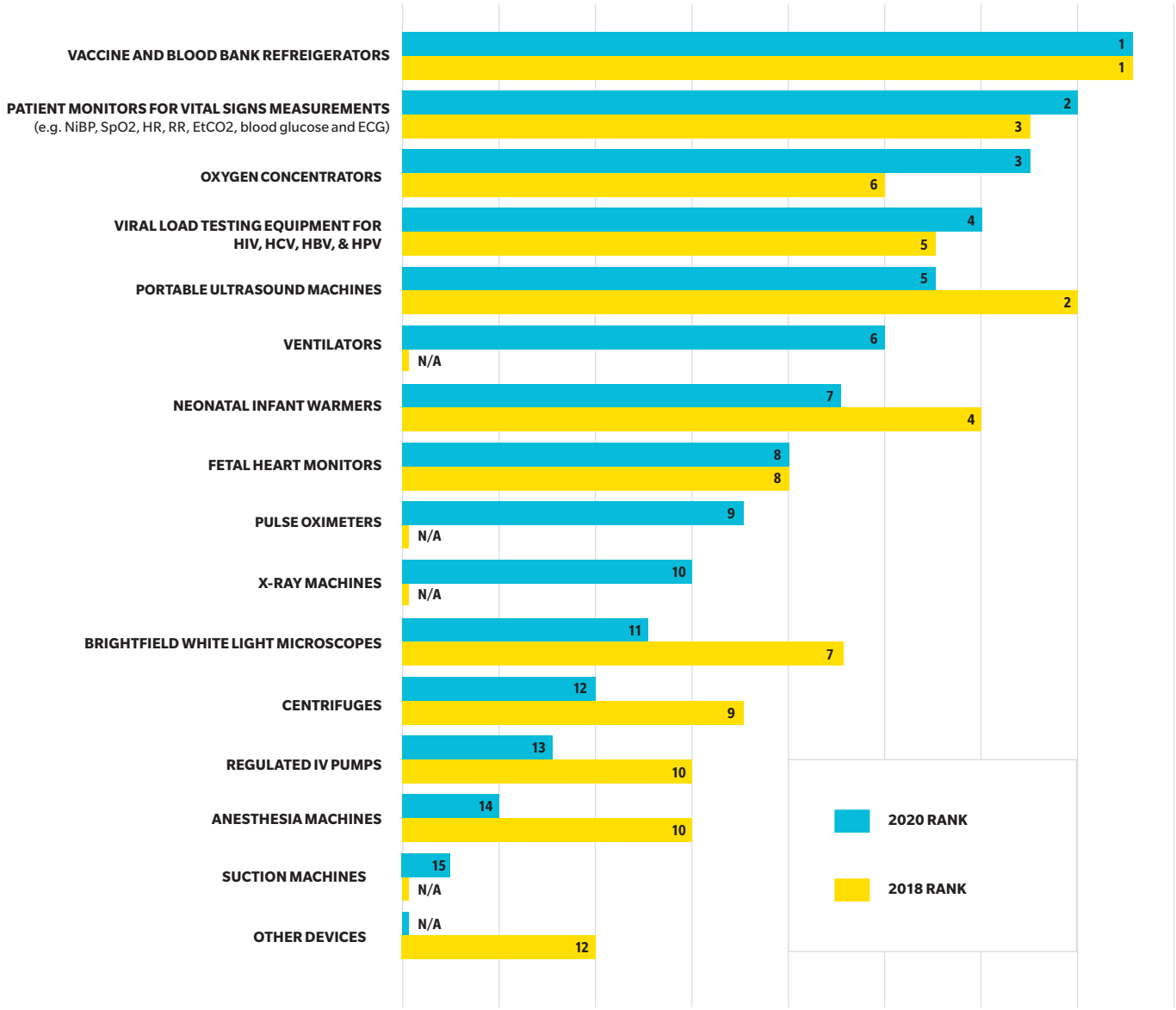
The 2020 survey included four new medical device categories: ventilators, pulse oximeters, x-ray machines and suction machines. Product rankings from 2018 and 2020 are therefore not directly comparable, but examining the results from both years highlights notable consistencies and changes (Figure 10).

Vaccine refrigerators scored highest in both surveys, underscoring the perception that vaccine cold chains are the foundation for healthcare provision in underserved areas.

Vital sign monitors also ranked near the top both years, indicating their importance as a basic tool for triage and clinical care.

Oxygen concentrators jumped from sixth to third in this year's rankings, while ventilators, not included in the 2018 survey, ranked sixth in 2020. Both results likely reflect the importance of these devices in the treatment of COVID-19 patients.

Figure 10. Comparison of 2018 and 2020 Medical Device Survey Responses



Data from routine market surveys ensures that sector actors have the information they need to help accelerate the uptake of efficient appliances. However, online surveys are limited by their structure, as well as by the number and characteristics of their respondent pool.

Still, more robust data and market intelligence are needed in order to grow and support the off-grid appliance sector. Efforts to collect company sales data should be expanded, with better representation of generic solar products and a more comprehensive methodology. There is also a need to further explore the gender dynamics of appliance purchases, uses and benefits. Finally, better representation of consumer voices is crucial, and more consumer-centric impact data collected through a unified methodology is needed. It could also prove useful to further explore regional differentiation in demand, especially given the disparity between reported regional sales[42] and the insights this survey gleaned from regional stakeholders.

Response rates to the healthcare section were higher in 2020 than in 2018. However, increased collaboration between the health and off-grid appliance sectors is needed, especially in light of the shortcomings exposed by the COVID-19 pandemic. More work is needed to quantify demand for healthcare appliances and understand the current market. We hope findings from this work can help bolster preparations for this and future pandemics/health crises.

This survey is just one component of the Efficiency for Access commitment to collect, verify and publish data on off-grid solar sales and market potential. Since publishing the 2018 Off-Grid Market Survey, the EforA has worked with GOGLA and Lighting Global to collect and publish semi-annual data on appliance sales from off-grid solar companies.[43] We have also published the **2019 State of the Off-Grid Appliance Market** report, along with numerous other reports on technologies, consumers and market insights over the past two years.[44]

42. GOGLA (2020), Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data H2 2019.
43. See sales and impact data reporting: https://www.gogla.org/source-type/sales-and-impact-data-reporting.
44. See Efficiency for Access publication library: https://efficiencyforaccess.org/publications

Other Efforts to Characterise Demand & Impact

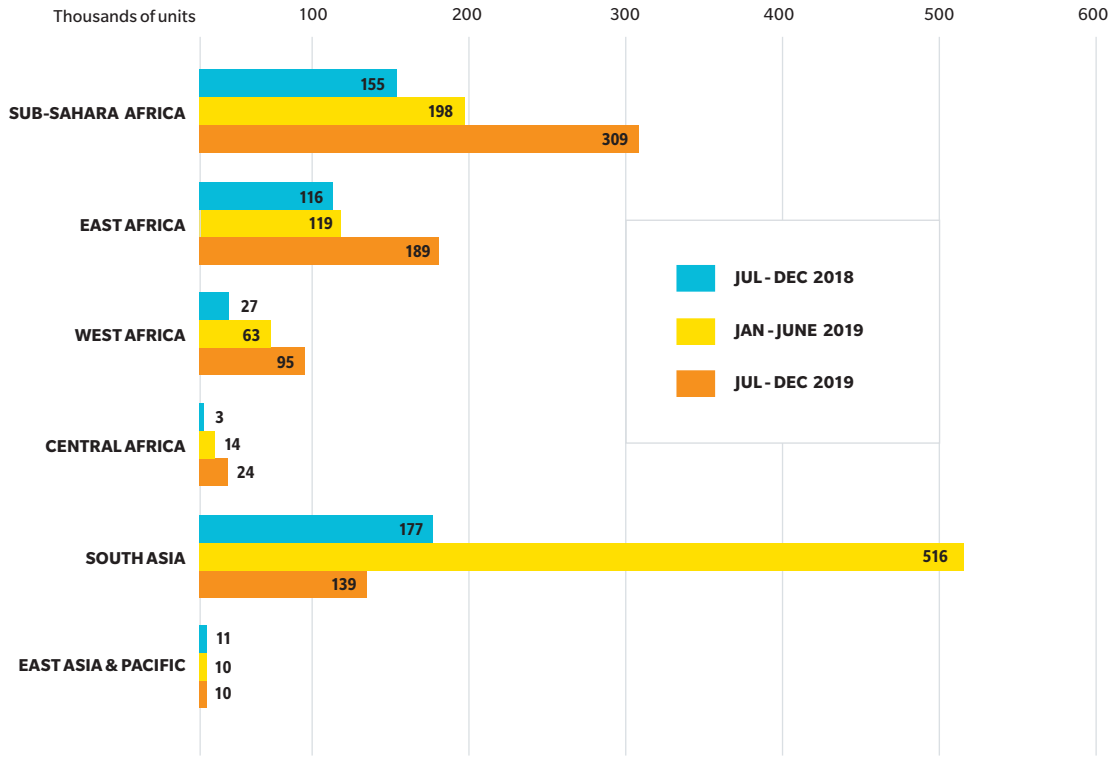
Access to reliable, robust market intelligence and consumer perspectives are critical for sector actors to accurately assess the market's needs and shift their activities accordingly. This survey represents just one effort to characterise perceived demand and impact, supplementing broader research efforts by the Efficiency for Access Coalition and other sector stakeholders. The reports highlighted in the following sections represent some of the most comprehensive information on market sales data, consumer perspectives and market projections currently available.

Market Sales Data

The **2018 Off-Grid Market Survey** was the first report to include off-grid appliance sales data, paving the way for the inclusion of appliance sales in the **Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data** in late 2018. This semi-annual report, produced by GOGLA, Efficiency for Access Coalition, Lighting Global and Berenschot, uses data collected from GOGLA and Lighting Global affiliates to provide crucial information on the sales and market trends of off-grid solar lighting products, SWPs, fans, refrigerators and TVs.

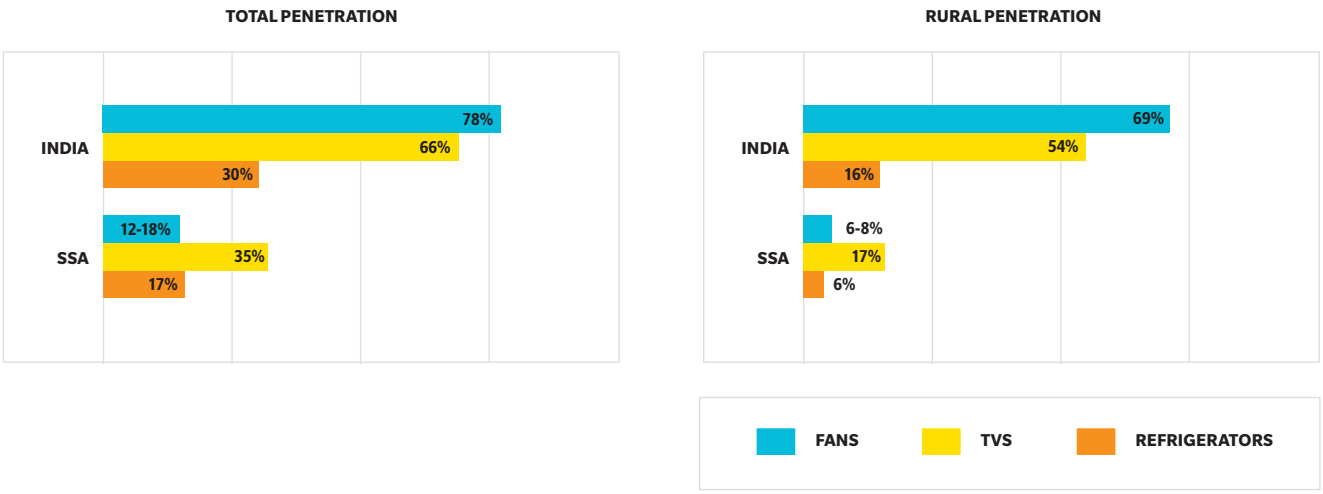
According to the **2019 July-December Global Off-Grid Solar Market Report,** 1.2 million appliances were sold in 2019 (7,000 refrigeration units, 30,000 SWPs, 471,000 TVs and 681,000 fans). Sales vary greatly by region (Figure 11), with 308,000 appliances sold in East Africa in 2019 and only 158,000 sold in West Africa during the same period.

Figure 11. GOGLA Affiliates' Total Regional Sales of Off-Grid TVs, Fans, Solar Water Pumps and Refrigeration During the Past Three Reporting Periods



In parallel, the **2019 State of the Off-Grid Appliance Market Report** analyses the market potential for off-grid appropriate TVs, fans and refrigerators. In addition to sizing the addressable market for these appliances, it provides comparative data on both on- and off-grid appliance ownership in sub-Saharan Africa (SSA) and India (Figure 12). For example, in SSA, only 17% of households own a refrigerator. For rural households that number is even lower, at just 4%.

Figure 12. Appliance Ownership in SSA and India (% of Households Owning an Appliance)



Consumer Perspectives

Consumer voices are a vital component of any effort to develop comprehensive market intelligence, and are crucial for donors looking to effectively allocate investment resources in product development. Consumer feedback and field testing also help ensure that products and business models are appropriately designed and able to be serviced. However, publicly available data on consumer perspectives remains a need throughout the sector.

Since the release of the 2018 Off-Grid Market Survey, Efficiency for Access published different consumer perspectives that highlight how appliance ownership impacts quality of life (Table 3).

Table 3. Impact of Appliance Ownership on Quality of Life

	APPLIANCE		
	TELEVISIONS	SOLAR WATER PUMPS	REFRIGERATORS
% CUSTOMERS THAT SAID OWNERSHIP IMPROVED QUALITY OF LIFE	93%	81%	97%
NET PROMOTER SCORE*	38	48	45
% CUSTOMERS THAT BELIEVE THEIR APPLIANCE IS "VERY GOOD" OR "GOOD" VALUE FOR MONEY	81%	82%	91%
% CUSTOMERS WHO EXPERIENCE CHALLENGES	34%	50%	30%
SAMPLE SIZE	2,370 customers	375 customers	114 customers
REPORT	Use and Impact of Solar TVs	Use and Benefits of Solar Water Pumps	Data collected from Global LEAP Results-Based Financing customers with 60 Decibels; unpublished due to low sample size**

*Net Promoter Score is a proxy for gauging customer satisfaction, stickiness and loyalty. This indicator is important for understanding customer experience and gathering feedback. It is measured through asking customers to rate their likelihood to recommend the product/service to a friend. Anything above 50 is considered very good.
**An updated with a larger sample size will be published later this year.

Consumer feedback is not always positive. Critical end-user feedback provides an important opportunity for off-grid companies to improve products and business models, ultimately improving customer outcomes as well as revenues. A forthcoming Efficiency for Access Coalition and 60 Decibels report analyses data from solar water pump, TV and refrigerator customers, most of whom had purchased their appliance within the last 12-24 months. 14% of customers had stopped using their appliance. Of these 14%, 5% no longer even possessed it.

Understanding current customer repayment issues can help market players develop more sustainable financing plans, which in turn helps customers avoid excess debt. 60 Decibels surveyed 35,000 off-grid customers and found that 65% of refrigerator customers reported taking out another loan to make payments on their fridge, and 55% said they sometimes cut back on consumption in other areas to make payments.[35]

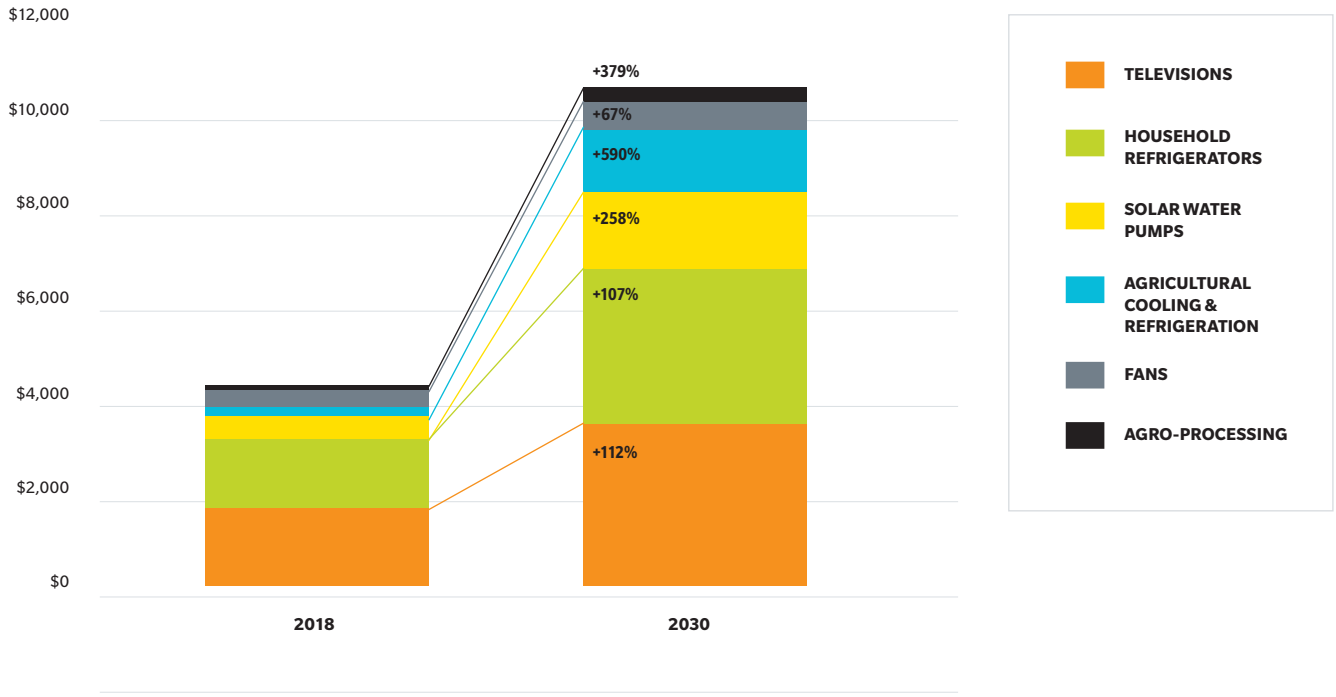
Field testing and consumer feedback can also identify additional appliance use cases and opportunities for design improvements. Efficiency for Access surveyed 375 solar water pump customers and 22% of stated they did not use their pump for irrigation or farming, but for domestic or institutional use, such as in schools or construction sites.[36] Recognising opportunities for additional use cases can help market actors develop appliances with greater functionality, thereby increasing their overall impact.

35. 60 Decibels (2020), Why off-grid energy matters.
36. Efficiency for Access (2019), Use and benefits of solar water pumps.

Market Potential

The off-grid appliance market is poised to grow rapidly over the next decade. The 2019 State of the Off-Grid Appliance Market Report estimated the cumulative market opportunity for televisions, refrigerators and fans at USD 12.6 billion in 2018. If current trends continue, will grow to USD 25.3 billion by 2030. Figure 13 shows the predicted growth of the obtainable market in sub-Saharan Africa alone, where consumer finance and off-grid appliance distributors are less accessible than elsewhere.

Figure 13. Total Obtainable African Market for Household Appliances and Productive Use Applications



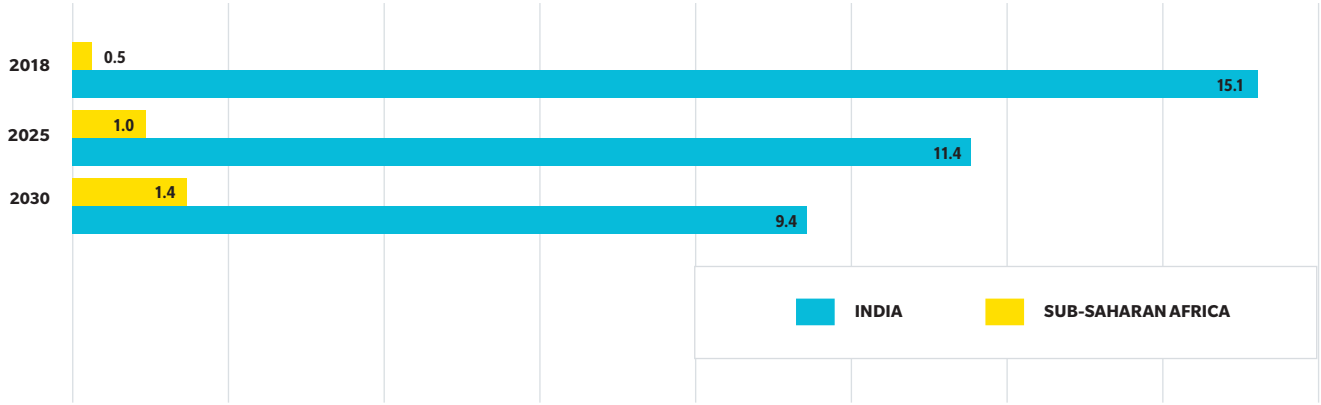
Lighting Global analysed the market for small scale solar appliances of 1kW or less in 2019. They estimate that the addressable market for irrigation pumps, cooling and refrigeration, and agro-processing appliances in emerging markets is USD 11 billion.[37] However, when access to financing and consumer accessibility are considered, the market potential falls to USD 700 million.[38]

In 2019, Efficiency for Access examined the potential for small, 75–370W pumps in SSA, and large, 2–4kW pumps in India. Findings reveal the addressable market in SSA may triple to USD 1.6 billion within the next decade, including as many as 2.8 million households by 2030.[39] In contrast, the Indian market is expected to contract to USD 9.4 billion due to the likely reduction or removal of Saubhagya, the state-run solar water pump subsidy programme. Nevertheless, overall market potential is still expected to reach USD 11 billion in 2025 (Figure 14).[40]

37. Lighting Global (2019), The Market Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Sub-Saharan Africa.
38. i.d.
39. Efficiency for Access (2019), Solar Water Pump Outlook 2019: Global Trends and Market Opportunities.
40. i.d.

Figure 14. Market Potential for Solar Water Pumps in SSA Compared to that of India

Billions in USD



Although the off-grid appliance market is projected to grow rapidly over the next decade, these estimates cannot be realised without addressing existing challenges of consumer affordability and distribution. Even if the market achieves the projections described in the aforementioned reports, many households will still lack access to transformative appliances. Increasing access to impactful, efficient off-grid appliances requires accurate market sales information and robust consumer data, so that market players can invest in business models and appliance designs that best serve their customers.

Credit: Bimala Colavito

Methodology

The 2020 Off-Grid Appliance Market Survey synthesises data from 133 energy access practitioners. The 2020 survey featured a more sophisticated survey tool than previous editions, further refining appliance categories to provide more nuanced results and deeper insight into consumer needs and priorities. Respondents were also asked about the importance of healthcare-related technologies specifically in the context of the COVID-19 crisis; these real-time insights could help identify an effective response for the off-grid sector, as well as help it prepare for future crises. It should be noted, however, that data in the healthcare technologies segment do not reflect the views of healthcare practitioners; we reached out to several to complete the survey, but did not receive any response.

Credit: Sunny Money

Survey Design

The survey was open from April 13 to May 1, 2020. We divided 56 product categories into three segments, with some categories repeated across two or more segments and some disaggregated into specific applications relevant to two or more segments (see Annex: "Survey Questionnaire").

Appliance Categories

Appliance categories were chosen based on the highest-performing categories in the previous three surveys, as well as products suggested by previous survey respondents. Several market and subject matter experts – including Sustainable Energy for All (SEforALL), the Clinton Health Access Initiative (CHAI), and Modern Energy Cooking Services (MECS) – also provided input on products and framing.

The list of categories for each question was randomised to control for presentation bias. Respondents were prompted to select which of the segments they wanted to provide feedback

Dissemination

As with previous editions, the 2020 survey did not poll consumers directly. Instead, it was distributed to relevant industry professionals well-informed about the off-grid solar energy market. Their insights help shape LEIA and Efficiency for Access work alongside consumer-facing research, including our collaborative work with 60 Decibels'.[41]

We disseminated the survey digitally to staff at the following organisations: CHAI, the Global Distributors Collective (GDC), the Climate Literacy and Energy Awareness Network (CLEAN), Sun-Connect News, MECS, ENERGIA, SEforALL, Energy4Impact (E4I), the Africa Clean Energy Technical Assistance Facility (ACE TAF), the African Minigrid Developers Association (AMDA), the Global Off-Grid Lighting Association (GOGLA), Power for All, Global LEAP, the International Finance Corporation's Lighting Global, and the Clean Energy Access Network (CLEAN). We sincerely thank these partners, as well as their members and stakeholders, for their participation.

They survey was also distributed widely in the sector through social media, direct email and newsletter channels.

41. See Why Off-Grid Energy Matters, The Use and Impacts of Solar TVs and The Use and Impacts of Solar Water Pumps

Quality Control

All survey responses went through a validation process for data quality control, ensuring that only one survey was completed per user. However, we did not restrict the number of responses each organisation could submit, and on three occasions multiple respondents from the same organisation completed the survey. These responses were kept in the analysis; they all came from larger institutions in which the respondents held different roles, and therefore had different perspectives to offer.

Ranking Calculations & Data Analysis

For each question, we assigned a value to products based on their rankings: a '1' ranking received a value of five, a '2' ranking earned a value of four, and so on. Products below the top five ranking did not receive a value. We summed the values by product to determine their rank.

We also subset survey data on perceived impact by end user gender, and on perceived demand and impact by geographic region. Analysis of perceived impact by gender was based only on respondents who stated their rankings would change based on the end user's gender. Regional rankings were calculated based on the region(s) in which respondents focused their work.

Some questions allowed respondents to select more than one option. Consequently, the raw counts of each answer do not necessarily reflect the total number of respondents; instead, they reflect the number of instances that option was selected.

All rankings and associated insights presented in this report are based on the collective perceptions of the respondent pool and may not always represent industry-wide characteristics.

Sample Snapshot

Key Characteristics of Respondents

The 2020 survey received 133 complete submissions from participants around the world representing a wide range of professional affiliations (Figure 15), areas of expertise (Figure 16) and geographic regions (Figure 17). The majority of respondents have professional expertise in business/productive use appliances and focus their work in the East Africa region. An overwhelming majority of the sample identified as male (80%).

Figure 15. Relative Frequency of Respondents' Professional Affiliation

133 Respondents

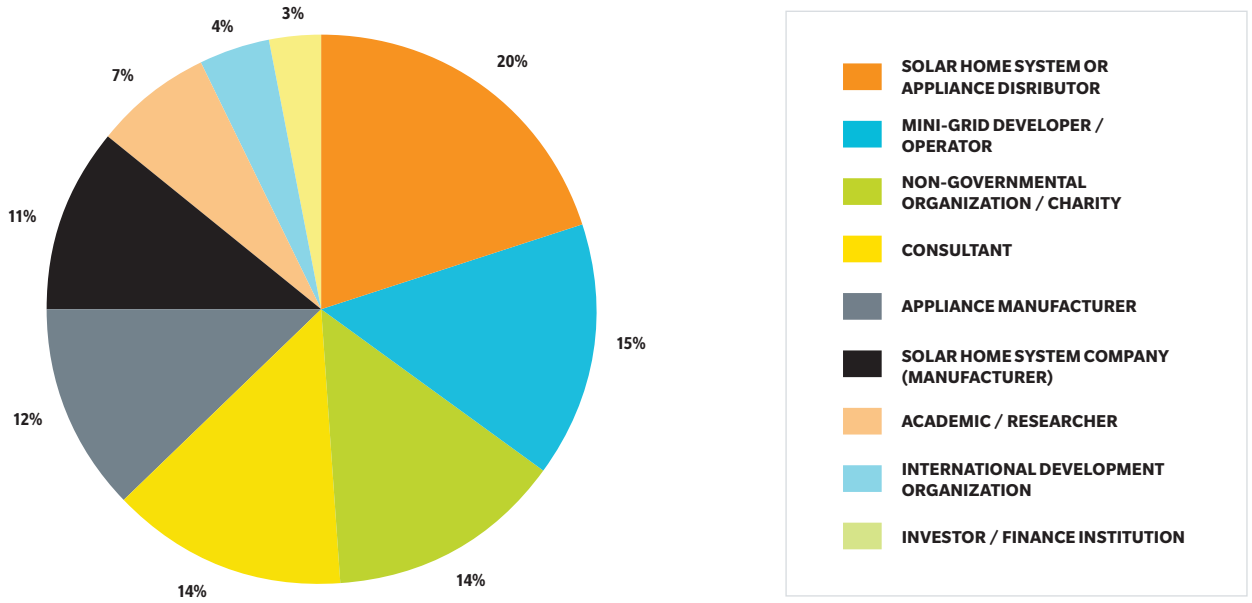


Figure 16. Relative Frequency of Respondents' Professional Expertise Selections

133 Respondents, 228 Selections

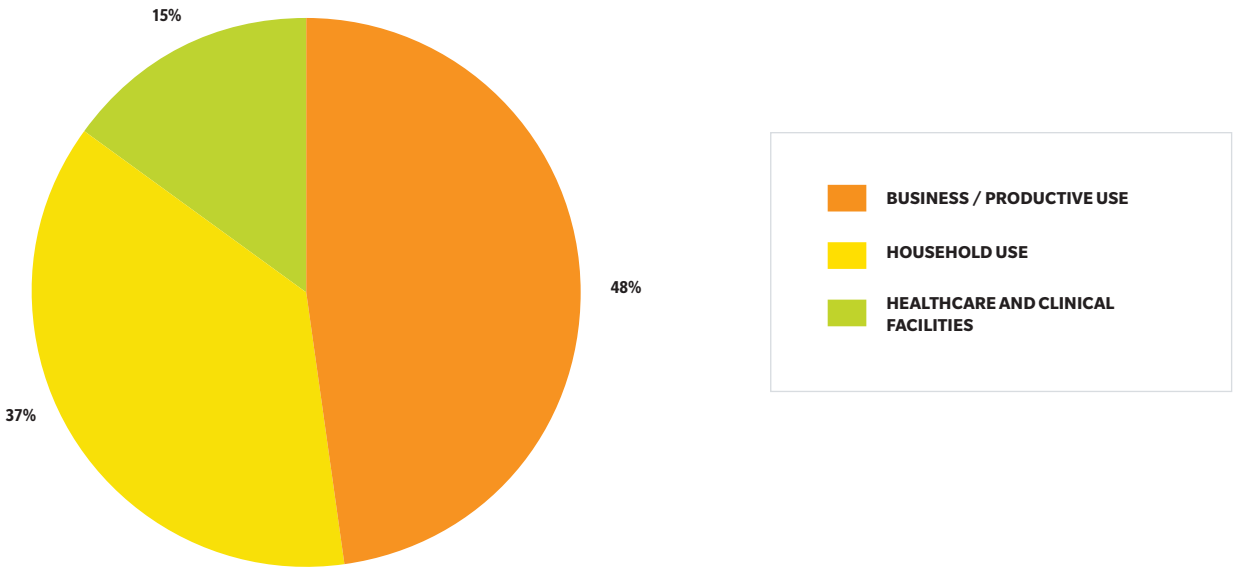
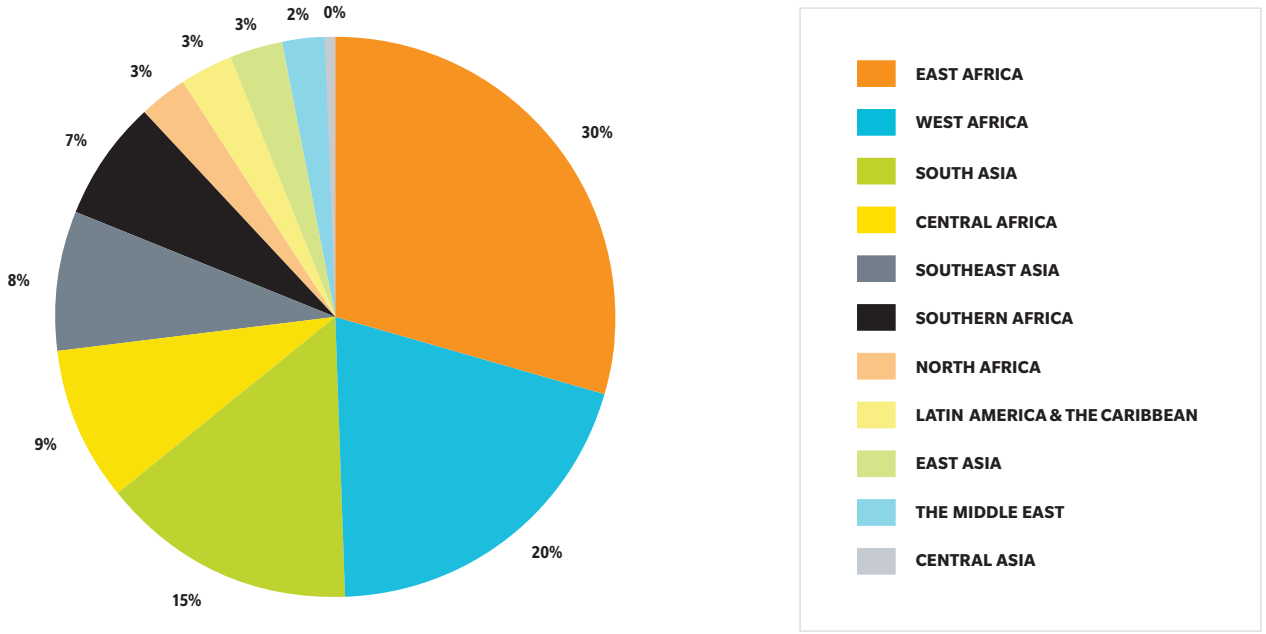


Figure 17. Relative Frequency of Respondents' Geographic Region Selections

133 Respondents, 228 Selections



Summary of Feedback

Respondents were given the opportunity to indicate which other appliances in the off-grid household, business/productive use or healthcare appliance category they would like to see included in future editions of the Off-Grid Appliance Market Survey.

Household appliances proposed for future consideration were: speakers, water purifiers, dryers, dishwashers, blenders and solar fencing.

Proposed business and productive use equipment included additional agricultural machinery (e.g. grinding machines for specific crops like maize and groundnuts), fishing lights, carpentry machinery, looms and textile machinery, water purifiers, and recycling or desalination tools.

AC inverters and internet equipment appliances were also suggested.

Credit: Dan Odero

Survey Questionnaire

Based on their group selection(s), respondents were asked to answer two key questions on consumer demand and socioeconomic development for the household and productive use segments. For the healthcare segment, respondents were asked three two-part questions on demand, as defined by relative importance for delivering healthcare, healthcare infrastructure, and healthcare during the COVID-19 crisis.

Respondents who selected the household or productive use segments were also asked to indicate whether the ranking they gave for the socioeconomic development and poverty reduction question would change based on the gender of the end-user. Those who responded positively were then prompted to re-do their rankings for men and women.

The questions posed in each segment are provided verbatim below:

Household Segment

Demand

Please rank your previous five choices for the off-grid household products that – in your estimation –will see the **most overall off-grid consumer demand** in the next three years. Please rank your top five choices, from 1 being the highest consumer demand, to 5 being the 5th highest consumer demand.

Impact

Please rank your top 5 selections of household appliance product categories, in terms of their **potential positive impact on socioeconomic development and poverty reduction** over the next three to five years. 1 is the highest impact and 5 is the lowest impact.

Gender

The previous question asked you to rank household-appropriate product categories based on their impact on socioeconomic development and poverty reduction. **Would your ranking change based on the gender of the end-user?**

- Please rank your top 5 selections for household appliance product categories in terms of their potential positive impact on socioeconomic development and poverty reduction from the perspective of **women.** 1 is the most impact, 5 is the least impact.
- Please rank your top 5 household appliance product selections in terms of their potential positive impact on socioeconomic development and poverty reduction from the perspective of **men.** 1 is the most impact, 5 is the least impact.

The list of appliances presented in each question was randomised to avoid bias based on order of presentation.

LED ROOM LIGHTING (Includes task and multi-point general lighting)	**RICE COOKERS**
TELEVISIONS	**CLOTHES IRONS**
FANS	**CLOTHES WASHERS**
REFRIGERATION	**MODEMS, WEB ROUTERS, INTERNET / CONNECTIVITY EQUIPTMENT**
FREEZER UNITS (HOUSEHOLD)	**MOBILE / SMART PHONES**
RADIOS	**AIR CONDITIONERS**
SEWING MACHINES	**AIR COOLERS / EVAPORATIVE COOLERS**
COMPUTERS (Desktops/Tablets/Laptops)	**ELECTRIC PRESSURE COOKERS**
HAIR CLIPPERS	**SOLAR OR ELECTRIC WATER PUMPS**
HAND POWER TOOLS	**MICRO MILLS / GRIDERS**

Business/Productive Use Segment:

Demand

Of the following appliance product categories that might be appropriate for business uses and productivity, please select the top five (5) product categories that – in your estimation – will see the **most overall off-grid consumer demand** in the next three to five years. Please rank your top five choices, from 1 being the highest consumer demand, to 5 being the 5th highest consumer demand.

Impact

Of the following business uses and productivity appliance product categories, please select the top five (5) product categories in terms of their **potential positive impact on socioeconomic development and poverty reduction** over the next three to five years. Please rank your top five choices, from 1 being the highest consumer impact, to 5 being the 5th highest consumer impact.

Gender

The previous question asked you to rank productive use-appropriate product categories based on their impact on socioeconomic development and poverty reduction. **Would your ranking change based on the gender of the end-user?**

- Please rank the same productive use appliance product categories in terms of their potential positive impact on socioeconomic development and poverty reduction from the perspective of **women.**
- Please rank the same productive use appliance product categories in terms of their potential positive impact on socioeconomic development and poverty reduction from the perspective of **men.**

The list of appliances presented in each question was randomised to avoid bias based on order of presentation.

LED ROOM LIGHTING (Includes task and multi-point general lighting)	**HAND POWER TOOLS**
TELEVISIONS	**AGRICULTURAL COLD STORAGE/COLD CHAIN**
SEWING MACHINES	**LIGHT COMMERCIAL/SME REFRIGERATION/FREEZER UNITS**
SOLAR WATER PUMPS	**ICE MAKERS**
COMPUTERS (Desktops/Tablets/Laptops)	**MILK CHILLING UNITS**
HAIR CLIPPERS	**FOOD DRYING UNITS**
MOBILE PHONE CHARGING BANKS	**ELECTRIC COOKERS**
MILLS/GRINDERS	**EGG INCUBATORS**
GRAIN POLISHERS/THRESHERS/DE-HULLERS	**OIL PRESSES**
SOLDERING IRONS/WELDING TOOLS	**JUICERS/BLENDERS**

Healthcare Segment:

Infrastructure

Of the following appliance product categories relevant to health care delivery, specifically in primary care facilities in rural/remote/off-grid areas, please select the **top five (5) infrastructure-related product categories in terms of demand** (i.e. the relative importance of each in delivering basic healthcare services to rural and/or under-electrified populations). Please rank your top five choices, from 1 being the highest need, to 5 being the 5th highest need.

The list of appliances presented in each question was randomised to avoid bias based on order of presentation.

LED ROOM LIGHTING (Includes task and multi-point general lighting)	**WATER HEATER** (including tea kettles)
ICT EQUIPMENT (computer, cell phone chargers, printer, router, modem, HF or VHF radio)	**WATER PURIFIER**
FAN	**WATER PUMP** (for clinics)
AIR CONDITIONER	**STERILISER/AUTOCLAVE** (e.g. uninterrupted power supply)

Healthcare Delivery

Of the following appliance product categories relevant to health care delivery in resource-constrained environments, specifically in primary care facilities in rural/remote/off-grid areas, please select the **top five (5) medical service-related product categories in terms of demand** (i.e. the relative importance of each in delivering basic healthcare services to rural and/or under-electrified populations).

Please rank your top five (5) medical service-related product categories in terms of demand (i.e. the relative importance of each in delivering basic healthcare services to rural and/or under-electrified populations). 1 is the highest demand, 5 is the lowest demand.

The list of appliances presented in each question was randomised to avoid bias based on order of presentation.

PORTABLE ULTRASOUND MACHINE	**X-RAY MACHINE**
OXYGEN CONCENTRATOR	**VIRAL LOAD TESTING FOR HIV, HCV, HBV, AND HPV TECHNOLOGIES**
FETAL HEART MONITOR	**NEONATAL INFANT WARMER**
PULSE OXIMETER	**ANAESTHESIA MACHINE**
PATIENT MONITOR FOR VITAL SIGNS (e.g. NiBP, SpO2, HR, RR, EtCO2, blood glucose and ECG)	**VENTILATOR**
BRIGHTFIELD WHITE LIGHT MICROSCOPE	**VACCINE AND BLOOD BANK REFRIGERATORS**
REGULATED IV PUMP	**SUCTION MACHINE**
CENTRIFUGE	**OTHER DEVICES** (please specify)

COVID-19

Of the following appliance product categories relevant to health care delivery during the COVID-19 pandemic in resource-constrained environments, specifically in primary care facilities in rural/remote/off-grid areas, please select the **top five (5) medical service-related product categories in terms of demand** (i.e. the relative importance of each in delivering pandemic-related healthcare services to rural and/or under-electrified populations).

Please rank your top five (5) medical service-related product categories in terms of demand (i.e. the relative importance of each in delivering pandemic-related healthcare services to rural and/or under-electrified populations). 1 is the highest demand, 5 is the lowest demand.

The list of appliances presented in each question was randomised to avoid bias based on order of presentation.

LED ROOM LIGHTING (Includes task and multi-point general lighting)	**WATER PURIFIER**
ICT EQUIPMENT (computer, cell phone chargers, printer, router, modem, HF or VHF radio)	**WATER PUMP** (for clinics)
FAN	**STERILISER/AUTOCLAVE** (e.g. uninterrupted power supply)
AIR CONDITIONER	**ENERGY STORAGE AND BACKUP** (e.g. uninterrupted power supply)
WATER HEATER (including tea kettles)	

Credit: Spark Light

EFFICIENCY FOR ACCESS

Credit: Arne Jacobson, Schatz Energy Research Center

CONTACT US

efficiencyforaccess.org
info@efficiencyforaccess.org
@EforA_Coalition

UKaid from the British people

clasp

SUSTAINABLE ENERGY FOR ALL