

# **OFF-GRID APPLIANCE MARKET SURVEY:**

**Perceived Demand and Impact Potential of Household,  
Productive Use and Healthcare Technologies**

**Third Edition**



**SEPTEMBER 2018**

EFFICIENCY FOR ACCESS COALITION



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**The off-grid solar market continues to grow rapidly. A key driver of that growth is the increasing uptake of solar home systems large enough to power household appliances, and an increasing awareness of the transformative potential for distributed renewable energy systems to power productive use appliances.**



Efficiency for Access was organized in 2015 as a year-long call to action and collaborative effort led by the Global Lighting and Energy Access Partnership (Global LEAP) and Sustainable Energy for All, with the aim of harnessing the power of energy efficiency to accelerate universal access to energy. Now UK aid, Power Africa, the International Finance Corporation, the World Bank Group, Rockefeller Foundation, Shell Foundation, Sida, EnDev, Good Energies Foundation, and more have joined together under a scaled-up Efficiency for Access Coalition to promote energy efficiency as a potent catalyst in global clean energy access efforts.

The Coalition recognizes the latent demand for modern energy services, and is seizing this opportunity to scale up markets and reduce prices for new super-efficient products by supporting technological innovation, and improving sector coordination. In this way, the Coalition supports the United Nations' Sustainable Development Goal 7, to ensure access to affordable, reliable, sustainable, and modern energy for all.

There are positive signals from energy access professionals, as well as development finance institutions and other funders engaged in the sector – including the Efficiency for Access Coalition's donor roundtable – towards a more holistic approach to electrification. There is also growing interest in enabling and scaling higher levels of energy access that go beyond household electrification to powering appliances for productive use, as well as for institutions such as schools and health clinics. However, very little market data exists to inform potential investment decisions of Efficiency for Access Coalition donors, as well as the business and design decisions of market actors looking to expand to new product areas. Our appliance market survey is one key input to informing this prioritization.

In 2014, and again in late 2016, in partnership with the UK's Department for International Development, the United Nations Foundation, Power Africa, and many others, CLASP – via the Global Lighting and Energy Access Partnership (Global LEAP) – conducted a survey of energy access professionals to assess the expected demand for and impact of off- and weak-grid<sup>1</sup> appliances. In 2018, this survey was conducted under the broader framework of Efficiency for Access.

Unlike previous years, this year's survey was branched at the outset, and respondents were asked to indicate their interest in answering questions across household, business/productive use, and healthcare appliances. This increased response rates across the board, and allowed for a deeper dive into differences in ranking across household versus income-generating activities. The healthcare segment was also disaggregated into two sections – infrastructure and medical appliances – to allow for further detailing of perceived demand.

This year, the third iteration of the biannual Off-Grid Appliance Market Survey received significant attention from the energy access sector, with 135 full responses from industry, policy, and development stakeholders all over the world. The respondent pool skewed primarily towards a lens of energy service providers (59% of respondents) operating across sub-Saharan Africa (52% of respondents).

1. Off-grid" refers to populations that live far from the traditional grid; "weak-grid" refers to populations that have unreliable grid connectivity and suffer frequent and sometimes lengthy outages.

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**As with past surveys, the authors hope these results can serve as a key piece of market intelligence to enhance the global understanding of the off-grid appliance market and provide a framework for stakeholders to identify business opportunities and high-impact policy and programmatic interventions. The 2016 survey results, helped develop the business case, technologies of focus, and near-term research interests of the Low Energy Inclusive Appliances (LEIA) programme, which was launched in late 2017 alongside the newly scaled-up Efficiency for Access Coalition. This year's results will help to revisit some of these choices, and inform Research & Development investments as well as other activities.**

The Efficiency for Access Coalition is jointly coordinated by CLASP, an international appliance energy efficiency and market development specialist not-for-profit organization, and the UK's Energy Saving Trust, which specializes in energy efficiency product verification, data and insight, advice and research.

This survey was developed by CLASP and the United Nations Foundation, and benefited from expert review by the Energy Saving Trust (EST), the Clinton Health Access Initiative (CHAI), and the International Finance Corporation (IFC); CLASP conducted the analysis.

This material has been funded by UK aid from the UK government. However, the views expressed do not necessarily reflect the UK government's official policies.



**This latest edition of the Off-Grid Appliance Market Survey Report brings new and more nuanced insights to stakeholder perceptions of the evolving off-grid appliance market.**

**Taken together, the series of surveys indicates that perceptions of demand for off-grid appropriate appliances have shifted over time.**

**Such up-to-date market intelligence will allow stakeholders to accurately assess and shift their own activities across business planning, design considerations, investment decisions, and marketing opportunities.**



**Some household appliances remain top of mind for industry leaders and consumers:**

Since 2014, LED room lighting has been the highest ranked household appliance in terms of perceived consumer demand and impact potential. This underlines the fact that while much progress has been made in the distributed energy sector, basic energy access needs remain out of reach for many households and communities across the globe. Televisions and mobile/smart phones remain in the top three rankings as well, showcasing the importance of communication and staying informed in our increasingly connected world.



**Consumer demand for, and potential impact of, specific appliances varies widely by region:**

Especially when it comes to fans, which were ranked first in terms of demand in South Asia alone. Similarly, air conditioning units only made it into the top five rankings in South Asia. Such regional differences suggest that, while consumer demand for off-grid appliances remains broadly similar across regions, regional preferences are important and should be considered by industry, policymakers, and other stakeholders.



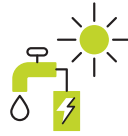
**Refrigerator demand continues to grow and has the potential to drive significant economic growth:**

There is an increasing demand for – and a growing commercial opportunity around – refrigeration technologies at all scales. Consistent top three rankings for household refrigerators, refrigerators/freezer units for commercial use, agricultural cold chain technologies, milk chilling units and vaccine refrigeration across all regions underscores the transformative potential of this near-to-market technology. More work is needed to unlock its affordability and off-grid appropriateness to reach true scale.



**There is a critical difference between theoretical needs versus market realities:**

Many of the appliances ranked highly in terms of perceived demand or impact, such as refrigerators and milk chilling units, had little to no reported sales. This discrepancy underscores the continued lack of commercial availability – and viability – of many appliances in off-grid markets, and is a signal for investors to continue R&D support and enterprise financing to help overcome these barriers.



**Demand for larger “productive use” or “income generating” appliances is rising:**

Solar water pumps emerge as the top near-to-market appliance of note, for the first time ever being ranked above refrigeration and LED lighting appliances in terms of potential impact. Off-grid customers are also showing interest in a wider range of appliances, as evidenced by high rankings for many of the newly introduced categories, including electric cookstoves and internet/connectivity equipment.



**Highly varied, and at times divergent, responses regarding demand for healthcare appliances underscore a need for further research:**

While there is overwhelming consensus around the continued and largely unaddressed need for basic lighting in healthcare settings, unclear patterns of rankings for specific medical equipment underscore the need for additional resources to scope out region- and clinic-dependent nuances. Refrigerators and patient monitors in particular are among high impact medical appliances, and likely to be required even in the smallest primary health facilities in rural areas.



**Demands and priorities shift based on gender perspectives for certain household appliances:**

While the demand for LED room lighting, mobile phone charging banks, and refrigeration/freezer units show little deviation between male and female perspectives, other household appliances that support labor-intensive activities, such as hand power tools, clothes washers, sewing machines, and electric cookstoves demonstrate significant difference between gender perspectives.

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## A Note On Definitions

For the purposes of this survey and other Efficiency for Access & affiliated activities:



### APPLIANCES

“Appliances” are defined as energy consuming products that can operate in an off-grid energy system, such as low-voltage DC solar home systems or AC/DC mini-grids.



### PRODUCTIVE USE OF ENERGY

“Productive use of energy” is defined<sup>2</sup> as involving the application of energy derived mainly from renewable resources to create goods and/or services either directly or indirectly for the production of income or value.



### INFRASTRUCTURE & MEDICAL EQUIPMENT

Among healthcare appliances, “infrastructure” categories are defined as appliances or product groups needed for the operational environment (i.e. the clinic/building) and “medical equipment” categories are defined as appliances and supplies relevant for specific medical interventions and practices.

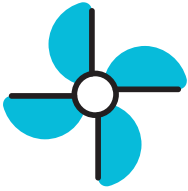
2. Cabraal, R.A. et al. (2005). “Productive Uses of Energy for Rural Development”, <https://www.annualreviews.org/doi/abs/10.1146/annurev.energy.30.050504.144228>





The survey results help pinpoint current perceptions of demand and impact across different use segments, as well as across time and regions. Through these results, we are also able to observe consistencies, trends, and breakthrough changes as they arise in the off-grid appliance markets.





# HOUSEHOLD USE APPLIANCES

The following section describes respondent rankings for the anticipated off-grid consumer demand and potential impact on socioeconomic development and poverty reduction of 18 products included in the household appliance segment.

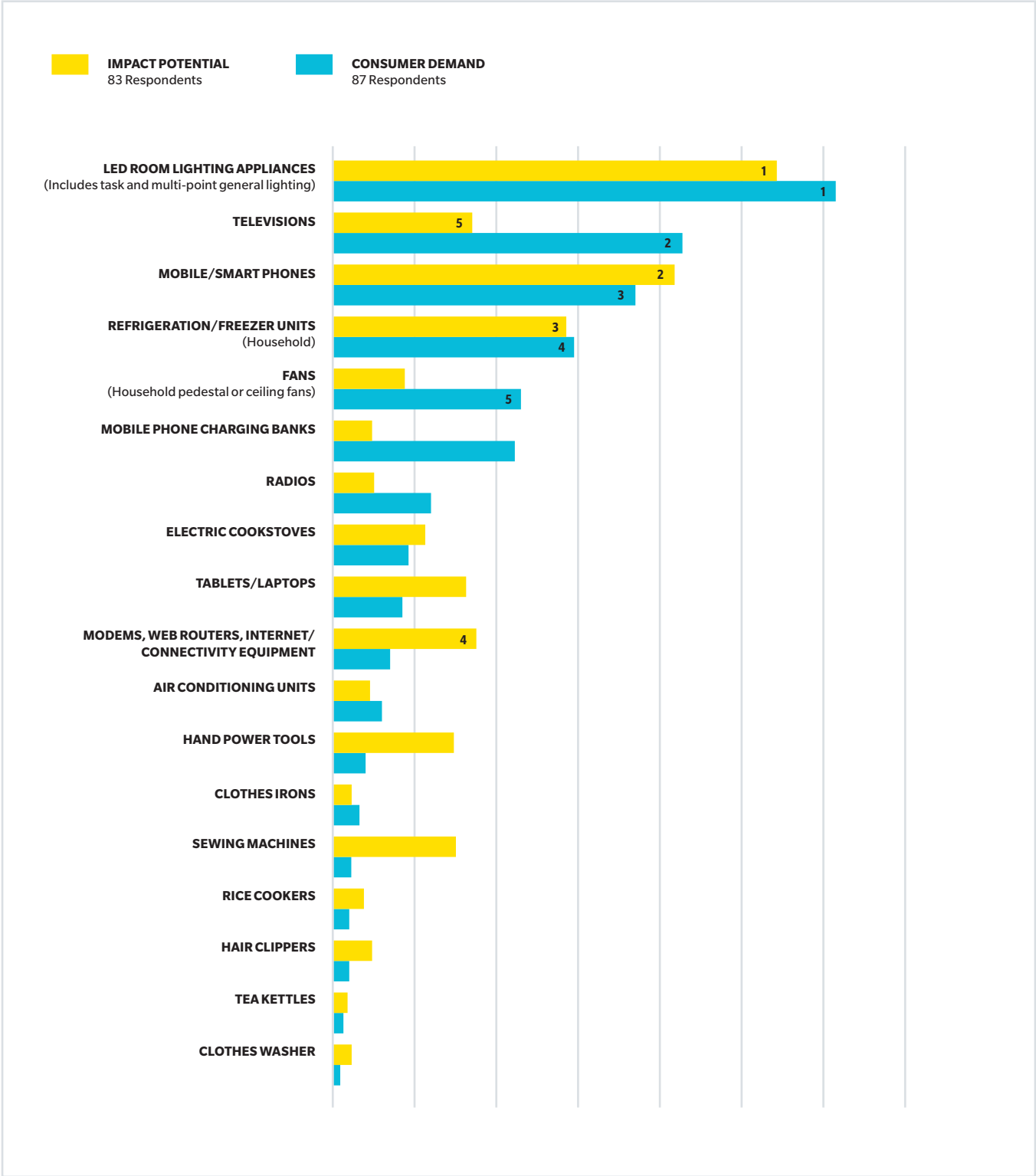
We acknowledge that new appliance categories were added in the 2018 survey based on previous surveys respondents' feedback; subject matter expert feedback; Efficiency for Access Coalition interests; and changing market signals. For the household use appliances segment, the new categories are: clothes washers; modems, web routers, Internet/connectivity equipment; air conditioning units; and electric cookstoves. Tablets and laptops were also presented as a joint category this time, instead of separately.



Credit: Fenix International Inc.

# Demand and impact perceptions of household appliances in 2018

Figure 1: Comparative rankings of perceived consumer demand versus impact potential of household appliances



Comparing the demand and impact rankings (Figure 1), **LED room lighting** remains the highest ranked household appliance in terms of both anticipated consumer demand and potential impact. This is unsurprising, as it represents the first rung in the energy access ladder and unlocks all other socioeconomic development opportunities.

**Televisions** ranked second highest in terms of consumer demand, but ranked fifth in terms of the potential impact. While TVs are among the main inspirational products in high demand by off-grid consumers across the globe, their impact beyond entertainment is less discussed, and the socioeconomic benefits of using TVs, including women's and children's education, have not yet been fully explored and documented. This could be one of the reasons why TVs are generally viewed as a "lower impact" product, as exemplified by the survey results.

**Refrigerators and freezers for household use** ranked fourth in consumer demand after LEDs, TVs, and mobile phones, indicating that this is an emerging household appliance that consumers are likely to seek after their basic energy service needs are met.

**Fans** were ranked as the fifth highest in terms of consumer demand, but dropped to tenth in terms of potential impact. This strengthens the hypothesis that the potential impact of fans around health and wellbeing, especially in certain climatic and living conditions, are still not well understood.

Respondents ranked **modems, web routers, internet/connectivity equipment**, a new appliance category in the 2018 survey, fourth in terms of potential impact, before TVs and tablets/laptops. However, in terms of consumer demand, it was ranked in tenth place, with tablets/laptops placing ninth. As these products are very closely linked in terms of operability, the corresponding rankings underline the importance of internet access overall, alongside energy access to power appliances.

**Electric cookstoves**, also introduced in 2018 as one of the horizon technologies of interest under the LEIA programme, ranked relatively high in both demand (eighth) and impact (tenth). Even though electric cooking technology is not viable due to its relatively high load requirement, currently achievable only via a large-scale micro-grid, the rankings underline its importance.

**Air conditioning units (ACs)**, a new product category added to the 2018 survey based on feedback from the previous survey's respondents, ranked eleventh in terms of consumer demand and fourteenth in terms of impacts. Even though ACs were not highly ranked for demand, the data show that consumers may overall have a higher demand for ACs than other appliances that are typically used for more labor intensive activities, such as drilling/hammering, ironing, sewing, and clothes washing.



# Perceptions of the demand and impact potential of household appliances through time

One of the most interesting aspects of conducting these surveys on a semi-annual basis is the emerging picture of relative importance placed on specific appliances over time. Some of the differences observed over time could be due to changing industry signals, such as falling solar photovoltaic (PV) prices and the rise of vertically integrated distributed energy service companies (DESCOs) with an “energy as a service” business model. Another factor is customer signals, in terms of their increasing aspirations and ability to pay.

Table 1 showcases such observed changes across the three iterations of this survey. The comparison analysis that follows is not intended to provide a like-for-like comparison with survey results from previous years, but rather a sense of how off-

grid market trends might be evolving over time. Since in the 2018 survey, household and productive use appliances were separated into two segments, with some overlapping and some distinct appliances, a direct comparison is not always possible.

Since 2014, LED lighting appliances have consistently been the highest ranked household appliances in terms of anticipated consumer demand and impact potential, and the top three appliances in this year’s survey – LED lighting, televisions, and mobile/smart phones – are the same as in 2016. Refrigerator/freezer units and fans moved up to third and fourth place respectively in 2018, compared to mobile charging banks (fourth) and refrigeration (fifth) in 2016.

**Table 1: Consumer demand and impact rankings through time for household appliances**

	2014 SURVEY RESULTS (MODIFIED*)	2016 SURVEY RESULTS (MODIFIED*)	2018 SURVEY RESULTS
<b>ANTICIPATED CONSUMER DEMAND</b>	1 LED lighting appliances	LED lighting appliances	LED lighting appliances
	2 Mobile charging banks	Televisions	Televisions
	3 Televisions	Mobile/Smart phones	Mobile/Smart phones
	4 Radios	Mobile phone charging banks	Refrigeration/Freezer units
	5 Refrigeration	Refrigeration	Fans
	6 Fans	Fans	Mobile phone charging banks
	7 Laptops	Radios	Radios
	8 Tablets	Laptops	Electric cookstoves
	9 Rice cookers	Hand power tools	Tablets/Laptops
	10 Clothes irons	Small speaker systems	Modems, web routers, internet/ connectivity equipment
	2014 SURVEY RESULTS (MODIFIED*)	2016 SURVEY RESULTS (MODIFIED*)	2018 SURVEY RESULTS
<b>DEVELOPMENT IMPACT POTENTIAL</b>	1 LED lighting appliances	LED lighting appliances	LED lighting appliances
	2 Refrigeration	Mobile/Smart phones	Mobile/Smart phones
	3 Mobile charging banks	Mobile phone charging banks	Refrigeration/Freezer units
	4 Televisions	Televisions	Modems, web routers, internet/ connectivity equipment
	5 Laptops	Refrigeration	Televisions
	6 Radios	Hand power tools	Tablets/Laptops
	7 Fans	Sewing machines	Sewing machines
	8 Rice Cookers	Radio	Hand power tools
	9 Grinders	Laptops	Electric cookstoves
	10 Hand power tools	Fans	Fans

\*Demand and impact rankings in the 2014 and 2016 surveys were adjusted to ignore products that were moved to the productive use segment in 2018.

Mobile phone charging banks dropped from fourth place in 2016 to sixth in 2018, while refrigerators moved from fifth place in 2016 to fourth in 2018, and fans moved up from sixth in 2016 to fifth in 2018.

New categories of appliances, such as electric cookstoves and internet/connectivity equipment, ranked among the top ten in terms of household consumer demand in 2018, justifying their inclusion in this survey iteration. Internet/connectivity equipment made a particularly strong entry, being ranked fourth in terms of potential socioeconomic impacts, after LED lighting, mobile/smart phones, and refrigeration/freezer units.

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**In terms of potential impacts, the rankings of household appliances across 2014, 2016, and 2018 were less consistent – except for LED lighting appliances remaining top of the list.**

However, adjusting rankings to ignore products that were moved to the productive use segment in 2018 (the “Modified” 2016 Survey Results column in Table 1) means the 2016 rankings for the top ten appliances become more similar to the results observed in 2018.

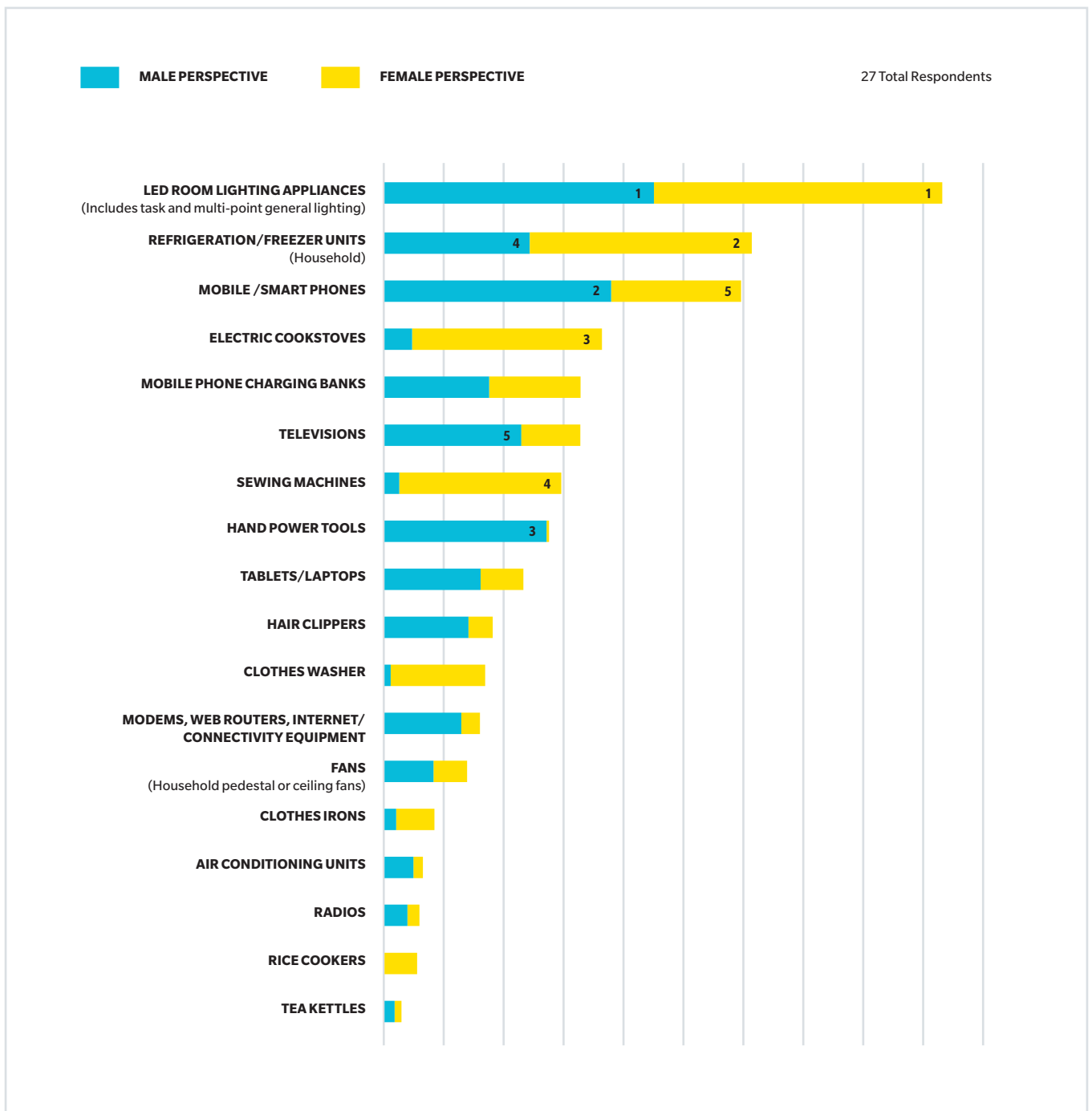


# Gender differentials for household use appliances

The household impact potential question was also disaggregated by gender for the first time in this survey series. Following the original question about relative impact for socioeconomic development and poverty reduction, respondents were asked to indicate whether their ranking would have changed based on the gender of the end-user (89 respondents answered this question).

The majority of respondents reported that they would not change their ranking of household products for male versus female end-users when prompted to do so. Those who indicated they would (37% of respondents) were then asked to re-rank their choices from both genders' perspectives (Figure 2).

**Figure 2: Relative rankings of the potential impact of household appliances by the gender of the consumer**



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The results indicate that LED room lighting, mobile phone charging banks, and refrigeration/freezer units showed little deviation between female and male user perspectives. Besides these three appliances, the top household use appliances that were considered to have the highest potential impact are:



**FROM A FEMALE PERSPECTIVE:**

- Electric cookers
- Sewing machines
- Clothes washers
- Mobile/smart phones
- Televisions



**FROM A MALE PERSPECTIVE:**

- Mobile/smart phones
- Hand power tools
- Televisions
- Tablets/laptops,
- Hair clippers

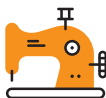
**Products that showed the largest deviation between female and male consumer perspectives include:**



**HAND POWER TOOLS:** ranked **third** highest impact from a male perspective and **18th** from a female perspective



**CLOTHES WASHERS:** ranked **17th** from a male perspective and **sixth** from a female perspective



**SEWING MACHINES:** ranked **14th** from a male perspective and **fourth** from a female perspective



**ELECTRIC COOKSTOVES:** ranked **12th** from a male perspective and **third** from a female perspective.

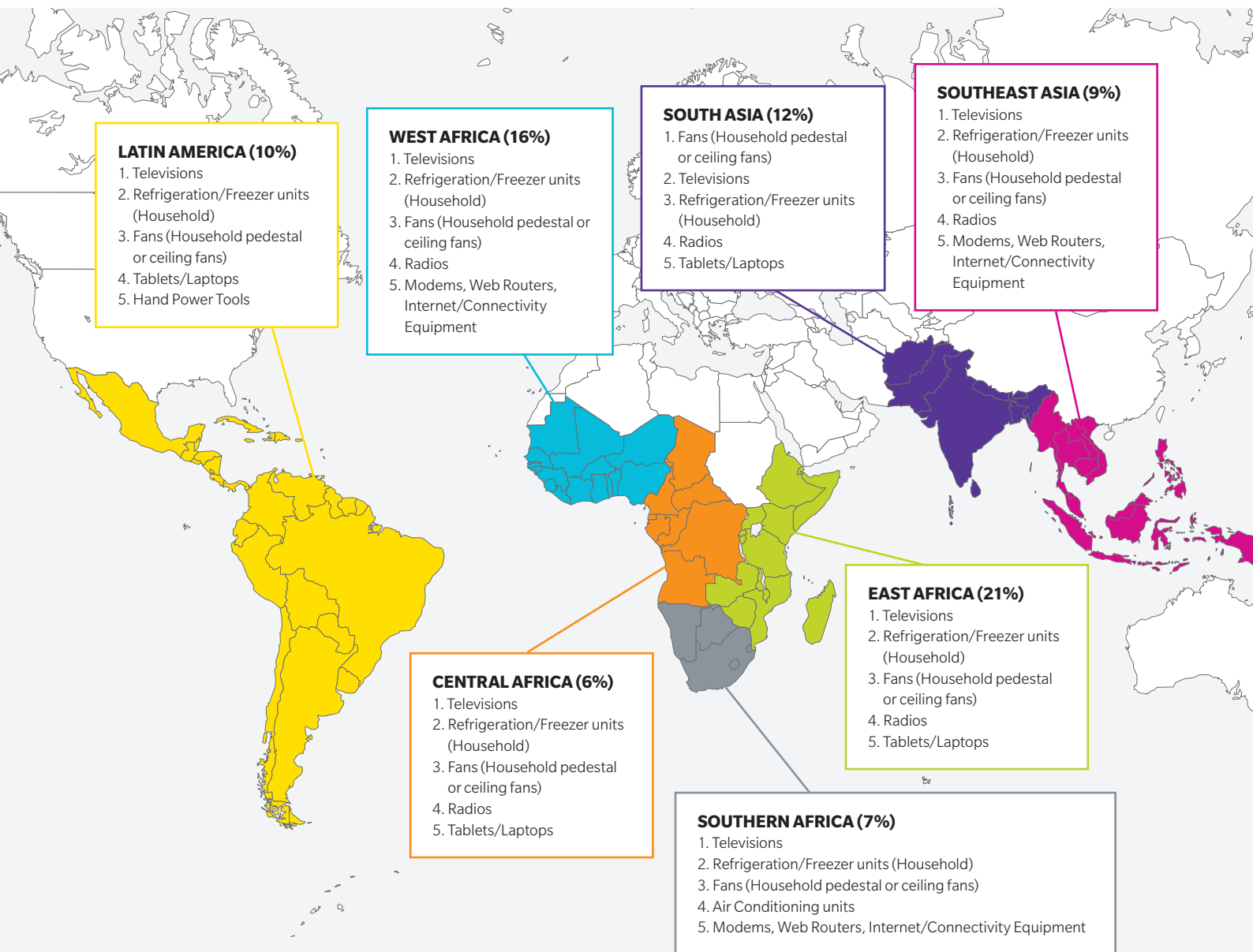


# Differences in household use appliance rankings by region

We examined product rankings by region, looking for variations in product priorities across off-grid markets (Figure 3). Respondents consistently ranked LED room lighting appliances, televisions, mobile/smart phones, refrigeration/freezer units for household use, and household pedestal or ceiling fans highly in terms of demand.

As LEDs, smart phones, and charging banks are among the products that tend to already factor in most DESCO product offerings, similar to our analysis of the 2016 survey, we removed these products from this part of the analysis to demonstrate each region’s demand for “advanced” household services compared to more basic and widely available products.

**Figure 3: Relative demand for household appliances ranked by region**



Number of Respondents = 87

(%) shows percentage of survey respondents from that region.

The top 5 regional breakdowns showcased in this map are East, West, Southern, and Central Africa; South and Southeast Asia; and Latin America. Additional geographies respondents could select from also included “other,” North Africa, Middle East, North America, East Asia, and Europe, which were omitted from this analysis.

LEDs, smart phones, and charging banks were removed from the rankings to demonstrate each region’s demand for more “advanced” household services compared to more basic and widely available products, consistent with the analysis in the 2016 survey.

Overall, rankings were similar across regions, but respondents expressed some distinctive regional characteristics. For example:

- While **televisions, refrigerators,** and **fans** ranked in the top three across the board, and generally in that order, fans rose to first place in South Asia. Given the relatively hot and humid ambient temperatures in this region, this increase in ranking is understandable, and follows the results of the 2016 survey where this top ranking was also observed for Bangladesh<sup>3</sup>.
- Along the same vein, **air conditioning units** only made it into the top five rankings in South Asia.
- Another exception was **hand power tools**, which only made the top five ranking in Latin America.
- **Radios** were considered to have high demand in most regions except Southern Africa and Latin America. As these two regions constitute a relatively small segment of the respondent pool, the ranking deviations for hand power tools and radios are likely not due to specific regional preferences, but a result of survey limitations.
- Either **tablets/laptops** or **internet/connectivity equipment** was included in the top five rankings across all regions, once again highlighting the importance of this group of products in terms of socioeconomic development.

While these results are not directly comparable to the 2016 survey findings, since some appliances like **solar water pumps** were moved to the productive use appliances segment in 2018, refrigeration, fans, and televisions show a distinct trend in remaining as the top ranked appliances for demand across the two years. The only appliance that remained in the household uses segment but dropped from top-five regional rankings was **rice cookers**, which ranked as fifth highest demand in Bangladesh in 2016, but did not make it into the rankings for any regions in 2018.

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**These regional perspectives from energy access professionals and DESCOs suggest that, while consumer demand for off-grid appliances remains broadly similar across regions, regional preferences are important and should be considered by industry stakeholders as well as policymakers.**

3. In 2016, Bangladesh was offered as a separate region/country option. It was rolled into the "South Asia" region in the 2018 survey.



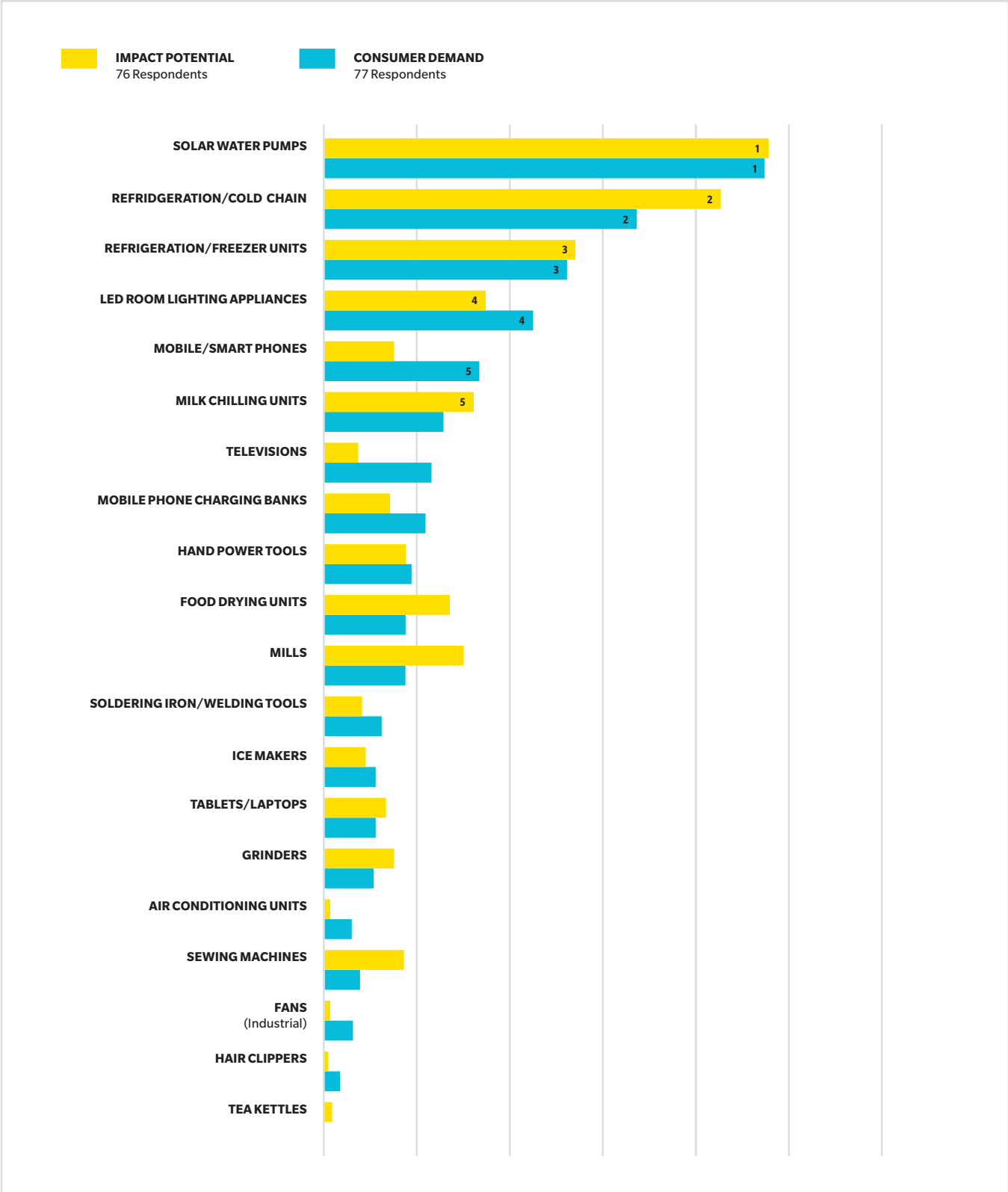
## BUSINESS/ PRODUCTIVE USE APPLIANCES

The following section describes respondent rankings for the anticipated off-grid consumer demand and potential impact of the 20 products in the business/productive use appliance category. For the business/productive use segment, the new categories added in 2018 are: food drying units, air conditioning units, milk chilling units, and ice makers. As with the household uses segment, tablets/laptops were presented as one category, and welding tools were added to the soldering irons option from the previous survey. Refrigeration was disaggregated to differentiate use cases, i.e. refrigeration units for light commercial versus agricultural cold chain use.



# Demand and impact perceptions of productive use appliances in 2018

Figure 4: Comparative rankings of consumer demand versus impact potential of business/productive use appliances



- Comparing demand versus impact rankings (Figure 4), **solar water pumps** were ranked the highest in terms of both anticipated consumer demand and potential impact.
- **Refrigeration for agricultural cold chain** and **refrigeration/freezer units for light commercial/SME use** were ranked second and third respectively, again in terms of both demand and impact.
- **LED room lighting, phones,** and **televisions** were ranked consistently lower compared to household demand or impact rankings, but were still among the top ten products.
- Of the newly added categories, **milk chilling units** and **food drying units** made it into the top ten ranking in terms of consumer demand, ranking sixth and tenth respectively. Milk chilling units received an even higher ranking (fifth) in terms of impact.
- **Air conditioning units** was another new product category added to the 2018 survey, and ranked sixteenth in terms of consumer demand and impact. Along the same vein, fans for industrial use were also ranked very low in terms of both demand and impact (seventeenth in both cases).
- The appliance that showed a significant difference between demand and impact rankings was **solar sewing machines**, which were ranked seventeenth in terms of demand, but received a much higher impact ranking (ninth).



# Perceptions of demand and impact potential of business/productive use appliances through time

Table 2 showcases the perceived consumer demand and impact potential rankings for business/productive use appliances across the three surveys. We modified the first two survey ranking results to remove products that were categorized only as household appliances in the 2018 survey. While the rankings are not always directly comparable across time, the adjustments made to 2014 and 2016 rankings enable an easier observation of potential consumer demand and impact trends across all surveys.

**Table 2: Consumer demand and impact rankings through time for business/productive use appliances**

	2014 SURVEY RESULTS (MODIFIED*)	2016 SURVEY RESULTS (MODIFIED*)	2018 SURVEY RESULTS
<b>ANTICIPATED CONSUMER DEMAND</b>	1	LED lighting appliances	LED lighting appliances
	2	Mobile charging banks	Televisions
	3	Televisions	Mobile/Smart phones
	4	Refrigeration	Mobile phone charging banks
	5	Fans	Fans
	6	Laptops	Refrigeration (Light commercial/SME)
	7	Solar Water Pumps	Solar water pumps
	8	Tablets	Refrigeration (Agricultural cold chain)
	9	Clothes irons	Laptops
	10	Grinders	Hand Power Tools
<b>DEVELOPMENT IMPACT POTENTIAL</b>	1	LED lighting appliances	LED lighting appliances
	2	Refrigeration	Mobile/Smart phones
	3	Mobile phone charging banks	Solar Water Pumps
	4	Solar water pumps	Refrigeration (Agricultural cold chain)
	5	Televisions	Refrigeration (Light commercial/SME)
	6	Laptops	Mobile Phone Charging Banks
	7	Fans	Televisions
	8	Rice mills	Hand power tools
	9	Grinders	Mills
	10	Hand power tools	Sewing Machines

\*To enable better comparison with the 2018 rankings, 2014 and 2016 rankings were adjusted to ignore products that were categorized as household appliances in the 2018 survey.



Credit: SELCO Foundation

The results reveal significant changes across time. In 2018, **solar water pumps** ranked the highest in terms of both consumer demand and potential impact – for the first time ever being ranked above refrigeration and LED lighting appliances. **Refrigeration equipment**, for both agricultural cold chain and light commercial/SME applications, were ranked second and third in both consumer demand and potential impacts. **Milk chilling units**, a new category, ranked fifth in terms of potential impact, strengthening the consistent focus on refrigeration products across the board.

The rankings for smaller business appliances – particularly **LED lighting appliances, mobile/smart phones**, and **mobile phone charging banks** – dropped lower compared to the 2014 and 2016 findings. The biggest change was seen with mobile/smart phones, which dropped from being ranked second in 2016 to tenth in 2018 in terms of potential impact.

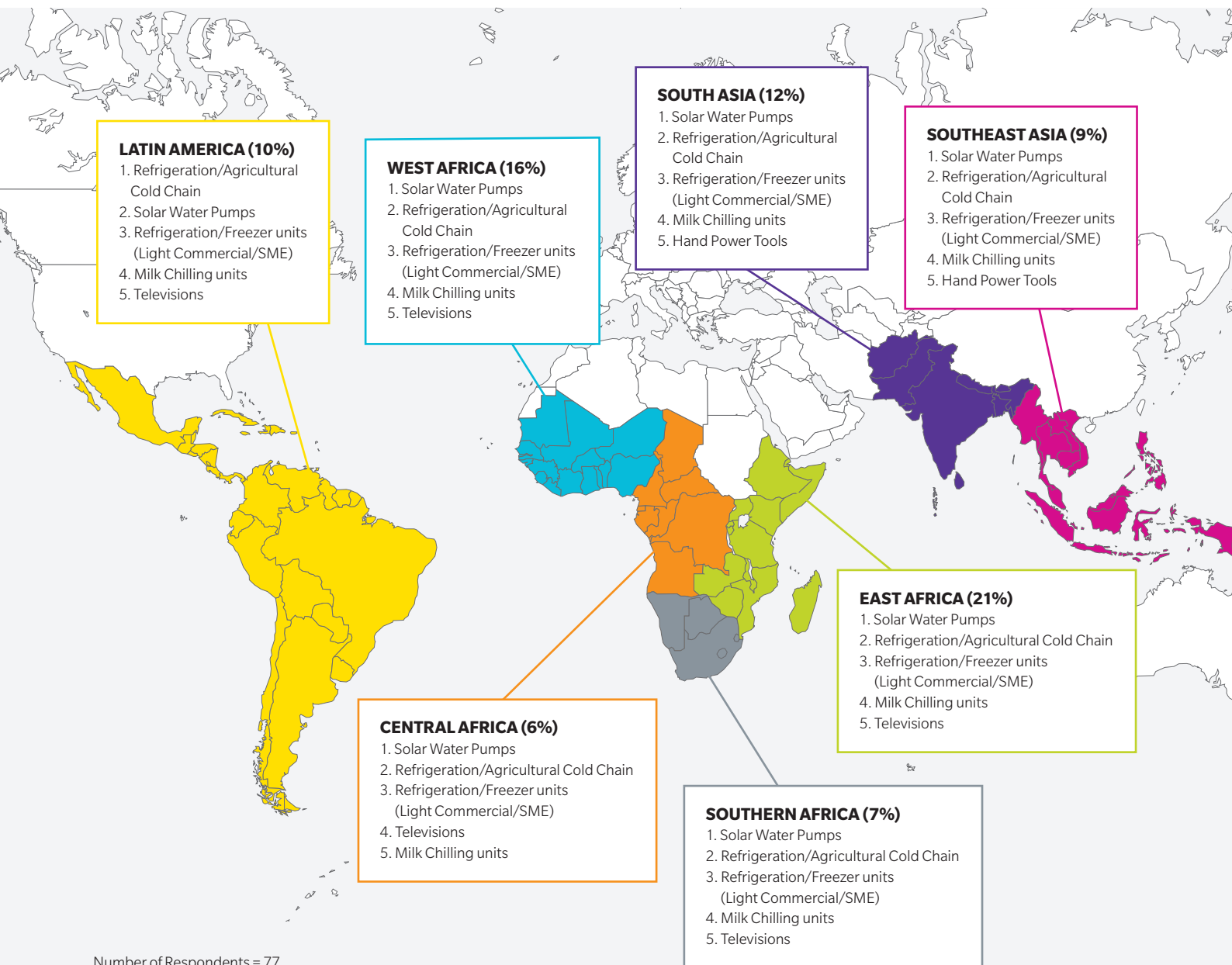
The drastic change observed in the top three product ranking could suggest that the off-grid sector may be shifting its focus collectively towards larger business/productive use appliances. Another reason could be the increasingly saturated market for phone charging and lighting as a business. Especially as solar lamps now routinely come with a phone charger port, this could mean that the phone charging business is no longer viable in many markets.

In terms of agricultural processing appliances, **food drying units**, a new product added to the 2018 survey, was ranked among the top ten business/productive use appliances in terms of both consumer demand and potential impact. **Mills** were not ranked among the top ten in terms of consumer demand consistently across 2014, 2016, and 2018. However, they were ranked among the top ten products in terms of potential impact. A potential explanation for this is that there are only a few solar milling products currently available on the commercial market. Anecdotally, fuel mills are most widely used in off-grid areas with positive economic impact, but solar mills are not readily available. Consumers may therefore not be aware of the alternative, or the cost may still be prohibitively high for most clients or applications, which continues to inhibit demand for this product.

# Differences in business/productive use appliance rankings by region

We examined product rankings by region similar to the household appliances, looking for variations in product priorities across off-grid markets (Figure 5). Respondents consistently ranked solar water pumps, refrigeration for agricultural cold chain, refrigeration/freezer units for light commercial/SME applications, LED room lighting appliances, and mobile/smart phones highly in terms of demand and impact.

**Figure 5: Relative demand for business/productive use appliances ranked by region**



Number of Respondents = 77

(%) shows percentage of survey respondents from that region.

The top 5 regional breakdowns showcased in this map are East, West, Southern, and Central Africa; South and Southeast Asia; and Latin America. Additional geographies respondents could select from also included "other," North Africa, Middle East, North America, East Asia, and Europe, which were omitted from this analysis.

LEDs, smart phones, and charging banks were removed from the rankings to demonstrate each region's demand for more "advanced" household services compared to more basic and widely available products, consistent with the analysis in the 2016 survey.



Overall, rankings were similar across regions, with relatively few distinctive regional characteristics. These include the following:

- **Hand power tools** made it into the top five rankings in terms of demand for West Africa, South Asia, and Southeast Asia. However, they were not included in the top five impact rankings in any region.
- **Milk chilling units** ranked highly in six out of the seven regions in terms of demand, with the one exception being West Africa. Similarly, in terms of impact, this category was included in the top five rankings across all regions.
- **Televisions** were among the top five products in terms of demand for five regions out of seven (East Africa, West Africa, Central Africa, Southern Africa and Latin America). This underlines the importance of not limiting our definition of “productive use”. Televisions are a significant source of added income for small entrepreneurs such as restaurant and café owners. They can also serve as a pathway to income generation, such as opening a video hall. In terms of impact, however, televisions were not included in any region’s top five categories.
- Even though they were not included in the top five rankings in terms of demand in any region, **mills** (in the case of East Africa, West Africa, and Southeast Asia) and **food drying units** (in the case of South Asia) did make it into the impact rankings. Demand might be relatively low because the need is currently being met by fuel mills and traditional sun drying or fuel-based drying. It is also possible that cleaner alternatives are not yet well known due to their scarcity in the market.

While these results are not directly comparable to the 2016 survey findings, the results are still consistent. In 2016, solar water pumps, agricultural cold chain, and light commercial/SME refrigeration were also among the top five ranked appliances consistently across the majority of regions polled.



Credit: AgSol



# HEALTHCARE APPLIANCES

The following section describes respondent rankings for perceived demand<sup>4</sup> of the 19 products in the healthcare appliance category. To glean a more detailed perspective of appliances relevant to healthcare, in the 2018 survey, this category consisted of a two-part question, where respondents ranked healthcare infrastructure appliances (8) and medical devices (11) separately<sup>5</sup>.

4. For the healthcare segment, “perceived demand” was defined in the questionnaire as “the relative importance of each in delivering healthcare services to rural and/or under-electrified population”.

5. Categories based on World Bank and WHO (2015) “Access to Modern Energy Services for Health Facilities in Resource-Constrained Settings”, [http://apps.who.int/iris/bitstream/handle/10665/156847/9789241507646\\_eng.pdf;jsessionid=A8AFEE2707C867BE9281486C0CDCD208?sequence=1](http://apps.who.int/iris/bitstream/handle/10665/156847/9789241507646_eng.pdf;jsessionid=A8AFEE2707C867BE9281486C0CDCD208?sequence=1)



Credit: We Care Solar

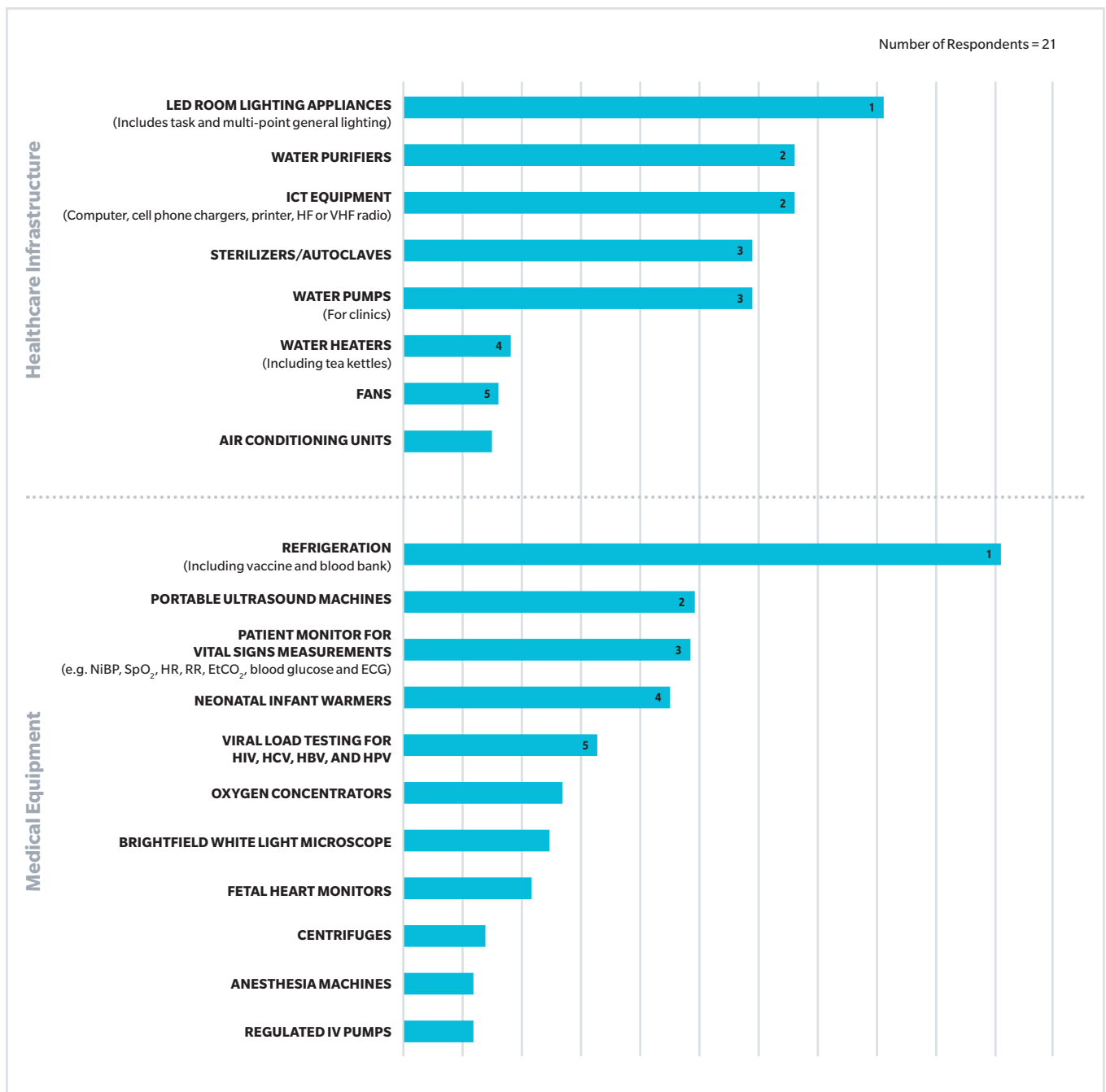
The healthcare segment received a higher response rate in 2018 (16% versus 6% in 2016). In 2018, respondents were asked to express their own interest and expertise in answering questions across the survey segments, rather than being pre-selected based on their affiliation. This approach worked well given that none of the respondents of the 2018 survey actually identified themselves as a healthcare or healthcare equipment provider<sup>6</sup>.

As indicated in Figure 6, the top three healthcare and clinical appliances ranked by perceived demand are **LED room lighting appliances**, **water purifiers**, and **ICT equipment** for

infrastructure; and **refrigeration**, **portable ultrasound machines**, and **patient monitor for vital signs measurements** for medical equipment. Refrigeration was included under medical equipment instead of infrastructure, to specify vaccine storage.

**Water purifiers** and **water pumps for clinics** ranked second and fourth respectively in the 2018 survey, showcasing a significant potential demand for these product types in healthcare infrastructure settings.

**Figure 6: Rankings of the perceived demand of healthcare appliances for infrastructure and medical equipment**



6. Please see the Methodology and Respondent Characteristics sections for further details.

## Perceptions of demand for healthcare appliances through time

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Due to the discrepancies in response rates and categories included, as well as the two-part nature of this question in 2018, it is difficult to justify making direct comparisons to the 2016 findings for this segment. Future iterations of the survey will provide more granular comparisons.

Keeping this in mind, many of the results remained consistent across the board: **refrigeration** (including vaccine and blood bank refrigeration) and **LED room lighting appliances** were ranked as top two in terms of perceived demand by respondents in 2016, which mirrors the highest rankings in 2018. **Similarly, ICT equipment, neonatal infant warmers, and patient monitor for vital signs measurements** were ranked highly across the two surveys.

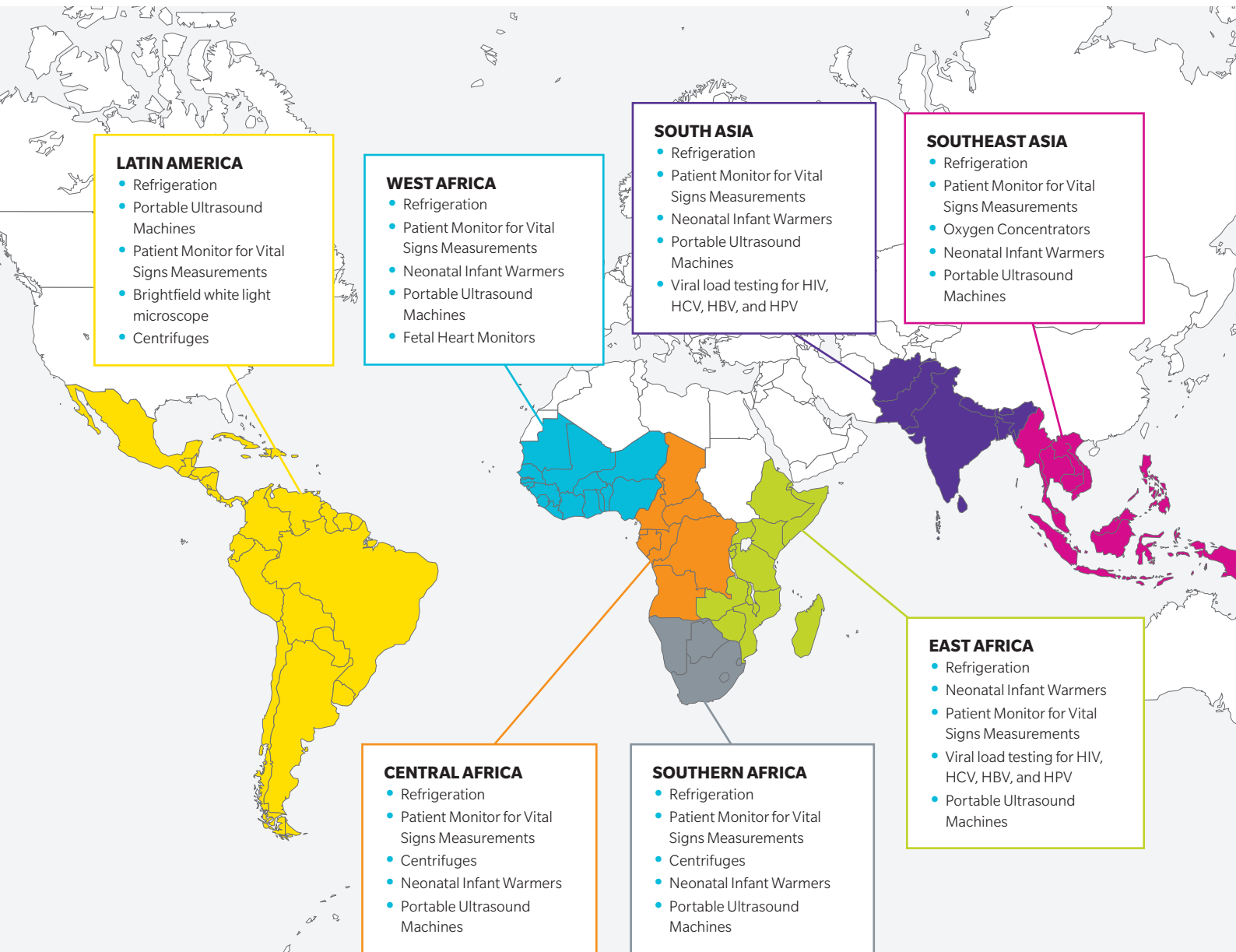


Credit: UN Foundation / Powering Health Care

# Differences in healthcare appliance rankings by region

The 2018 survey results provide an opportunity to look at regional differences in terms of the ranking of healthcare appliances for the first time.

**Figure 7: Relative demand for medical equipment ranked by region**



Number of Respondents = 21

(%) shows percentage of survey respondents from that region

Refrigeration includes vaccine and blood bank refrigerators

Patient Monitor for Vital Signs Measurements examples include NiBP, SpO<sub>2</sub>, HR, RR, EtCO<sub>2</sub>, blood glucose, and ECG

The top 5 regional breakdowns showcased in this map are East, West, Southern, and Central Africa; South and Southeast Asia; and Latin America. Additional geographies respondents could select from also included "other," North Africa, Middle East, North America, East Asia, and Europe, which were omitted from this analysis.

In terms of infrastructure-related appliances:

- **LED room lighting appliances** were ranked first across all regions. This overwhelming consensus highlights the continued gap for even the most basic lighting services in healthcare settings across the developing world. Lighting drastically improves the quality of care compared to alternative options, such as battery torches, candles, and kerosene lamps. Lighting also drives the improved provision of health services by allowing clinics to extend operating hours beyond daylight and by increasing security and comfort for both patients and staff.
- **ICT equipment** also received high rankings across all regions surveyed, showing the importance of communication and record keeping among medical professionals to better patient outcomes and facility management. With ICT equipment, health care workers can make data-based decisions more easily, maintain immunizations and patient records for community members, and monitor and maintain supplies.
- **Water pumps for clinics** and **sterilizers/autoclaves** were included in the top five rankings across all regions. **Water purifiers** were also included in the top rankings for three of the seven regions (East Africa, West Africa, and Central Africa). When taken together, these findings underline the importance – and continued lack – of sterilizing equipment and access to (running) water in healthcare settings. The lack of equipment for water, sanitation and hygiene (WASH), which are critical inputs for quality health care, emphasizes the need for increased investment in WASH appliances and infrastructure.
- **Fans** were only ranked among the top five products in Southeast Asia and Central Africa, which is consistent with health facilities' desire to provide comfortable environments in the relatively hot and humid climates of these regions.

In terms of medical equipment (Figure 7):

- **Refrigeration** (including vaccine and blood bank refrigerators) was ranked first across all regions, which highlights the continued gap for this vital need in healthcare settings, despite diverse initiatives to provide clinics in developing countries with vaccine refrigeration options. It also showcases the difficulty in managing the relatively high load requirement of a larger appliance like a refrigerator – particularly in many clinics in resource-constrained settings with low energy access rates.
- **Patient monitor for vital signs measurements** (e.g. NiBP, SpO<sub>2</sub>, HR, RR, EtCO<sub>2</sub>, blood glucose and ECG) equipment was ranked highly across all regions. The demand for patient monitoring tools demonstrates the latent desire, but lack of resource capacity for, diagnostic testing in resource-constrained health facilities.
- **Portable ultrasound machines** were included among the top five demanded pieces of medical equipment across all regions. Along the same vein, **neonatal infant warmers** were included in the top five rankings across all regions but one (Latin America), and **fetal heart monitors** were included in the rankings for West Africa. Collectively, these results underline not only the importance of maternal and neonatal healthcare, but the continued lack of basic equipment as a barrier to delivering maternal child health services in many regions.
- **Viral load testing for HIV, HCV, HBV, and HPV** was included in the top five rankings for East Africa and South Asia. **Centrifuges** made it into the top five rankings for Central Africa, Southern Africa, and Latin America. **Oxygen concentrators** and **Brightfield white light microscopes** were included in the top five rankings for one region each only – Southeast Asia and Latin America, respectively.

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**When taken together, these rankings make intuitive sense, as refrigerators and patient monitors in particular are likely to be required even at the lowest levels of the health system, such as smaller primary health facilities in rural areas. In contrast, specialized equipment such as viral load testing and microscopes are likely to be only needed for higher levels of service in bigger hospitals and clinics, which are usually only found in more urban areas.**



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# APPLIANCE SALES SNAPSHOT

Of the survey respondents, those who self-identified as an appliance manufacturer, solar home system company, mini-grid developer/operator, and/or solar home system/appliance distributor, were asked a follow up question regarding appliance sales.



Among this sub-group of respondents, we asked those who reported having sold any of the following products in 2017 (44 respondents answered positively) to indicate an approximate number of units for each product category sold in this timeframe (Figure 8).

The majority of sales reported were for radios (almost half of the total reported units sold), followed by solar water pumps (25% of the total reported units sold), and televisions

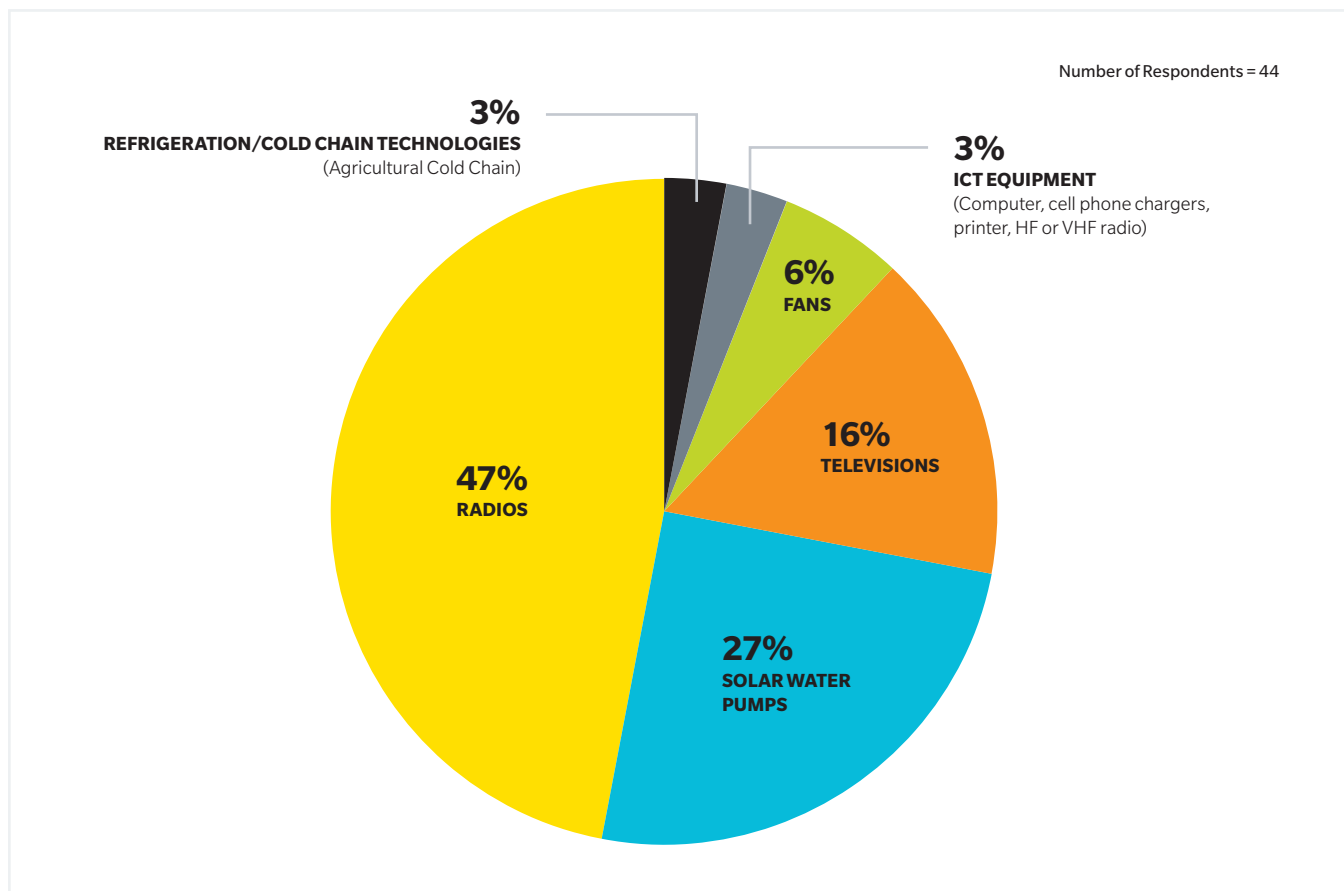
(16% of the total reported units sold). The remaining 12% of reported sales were a combination of refrigeration/cold chain technologies, fans, and ICT equipment.

Milk chilling units, refrigeration for light commercial/SME or household uses, milling equipment, and health/medical devices were included in the sales categories. Some respondents reported sales for these products, but the sales volume for these products were relatively small (less than 1% of the total reported units sold) compared to the appliances listed above.

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**These findings underscore the continued lack of commercial availability of larger appliances in off-grid markets, as well as their relatively high cost and load requirements, which renders wholesale applications difficult. Cost reductions and efficiency improvements for these appliances would be a significant asset to scaling the availability and commercial viability of these products.**

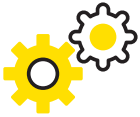
Figure 8: Relative volumes of appliance sales in 2017 reported by survey respondents





**Building on the previous two iterations of the off-grid appliance market survey, the 2018 edition featured a more sophisticated survey tool and methodology to allow respondents to self-select areas of interest. This approach reduced the potential for bias or double-counting and, ultimately, provided more nuanced results.**





## Survey Design

Efficiency for Access conducted the 2018 survey to assess the demand for and impact of off-grid solar-powered appliances across different applications.

The survey was open from June 19 to July 6, 2018. It organized a total of 46 product categories into three groups, with some categories being repeated across two or more groups; some being disaggregated into specific applications relevant to two or more groups; and some being specific to one group:

- Off-grid household applications
- Off-grid business and/or productive use applications
- Healthcare and clinical facility applications



## Appliance Category Selection

Appliance categories across all three segments were chosen based on:

- The previous two surveys' categories,
- Additional products suggested by multiple respondents to the previous surveys,
- Additional products and/or framing in consultation with several market and/or subject matter experts, including United Nations Foundation, CHAI, and IFC.

We then randomized the list of categories for each question to control for bias based on order or presentation. All questions as well as a full list of appliance categories under each segment are provided verbatim in the Annex – survey questionnaire.

Each respondent was prompted to self-select which one(s) among the three groups they wanted to provide feedback on. The respondents then only saw branched segment(s) pertinent to the group(s) they had expressed interest in ranking. For the health segment, the data provided reflect views of industry stakeholders who responded, and not health practitioners, as none participated in the survey.



## Dissemination

Efficiency for Access reached out to participants online via their affiliation with the following groups: United Nations Foundation's Energy Access Practitioner Network (EAPN), the Global Off-Grid Lighting Association (GOGLA), Power for All, and Global LEAP, as well as the International Finance Corporation's Lighting Global and the Clean Energy Access Network (CLEAN) — our thanks goes out to these partners and their members and stakeholders for their participation.

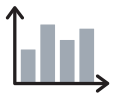
Efficiency for Access and our partners also disseminated the survey through Twitter and direct emails, including newsletters, as well as through outreach to the Clean Energy Access Google Group.



## Quality Control

All survey responses went through a validation process for data quality control. In instances where the same respondent completed the survey twice, we counted the instance with the most answered questions and deleted the duplicate instance. There were six instances where the same person completed the survey twice; the results, after this validation process, reflect only one response per person.

Additionally, there were nine instances where multiple respondents from the same organization completed the survey. We kept these responses since they corresponded to larger institutions where the respondents played different roles, and as such, had different perspectives to offer.



## Ranking Calculations and Data Analysis

We assigned points to products based on their rankings. A '1' ranking earned fifty (50) points, a '2' ranking earned forty (40) points, and so on. Products outside of the top five ranking received zero (0) points. We summed the points earned by each product, and ranked the products based on total cumulative points. This method was used across all ranking questions.

For charts that compared results based on perspective, we filtered the data accordingly (e.g. by gender) and in some cases (e.g. consumer demand versus impact potential charts) we did a side-by-side comparison of the final ranking results.

Some questions allowed respondents to select more than one option, e.g. the region(s) in which a respondent operates. Consequently, the counts of each answer option on these multiple selection questions do not reflect the total number of respondents who selected it; instead, it shows the number of instances that option was selected.

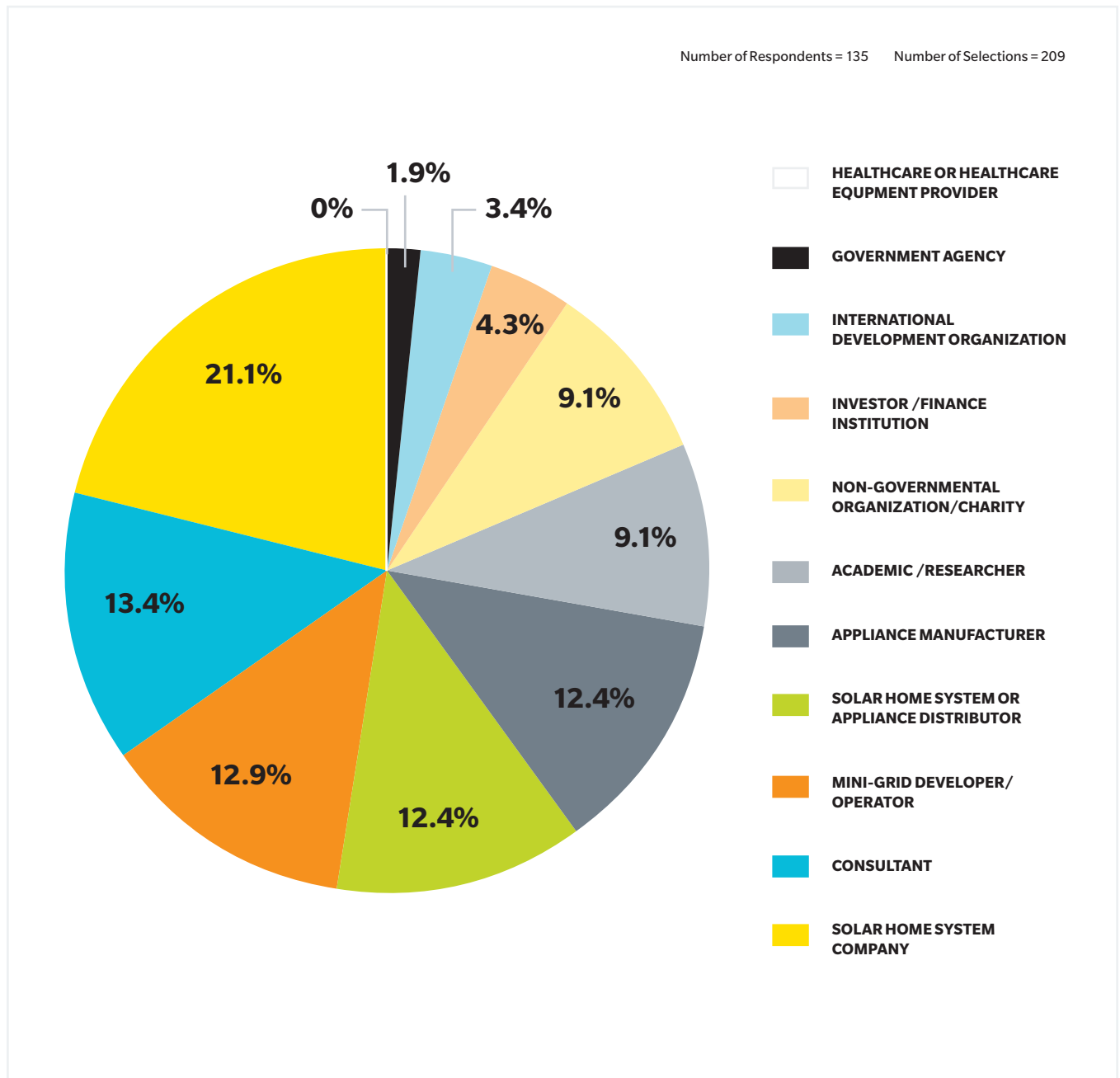
All rankings and associated insights presented in this report are based on the collective perceptions of the respondent pool and may not always represent industry-wide characteristics. Despite best efforts to ensure participation from a variety and large number of respondents, surveys are limited to their respondents and their opinions.

**The 2018 Survey received 135 responses from participants around the world and represented a diversity of affiliations and interests. An overwhelming response from energy service providers active across sub-Saharan Africa color the results.**



Respondents were able to select multiple professional affiliations. Solar home system companies (21.1%), mini-grid developers and operators (12.9%), consultants (13.4%), and solar home system or appliance distributors (12.4%) as well as appliance manufacturers (12.4%) made up the majority of respondents. NGOs and academics or researchers each accounted for 9.1% the total responses (Figure 9).

**Figure 9: Survey respondents' professions**



The responses received for this year’s survey showcase a good diversity in terms of geographical coverage. Respondents were able to select multiple regions of operation, and those most common across the respondent pool were East Africa (22%), West Africa (16%), South Asia (12%) and Southeast Asia (9%) (Figure 10).

Other technologies proposed by respondents for inclusion in future surveys spanned productive use items including:

- **Water purification systems**, other agro-processing equipment such as **pasteurization, irrigation systems, power saws, egg incubators**, and transport options such as **e-bikes** or **e-scooters**.

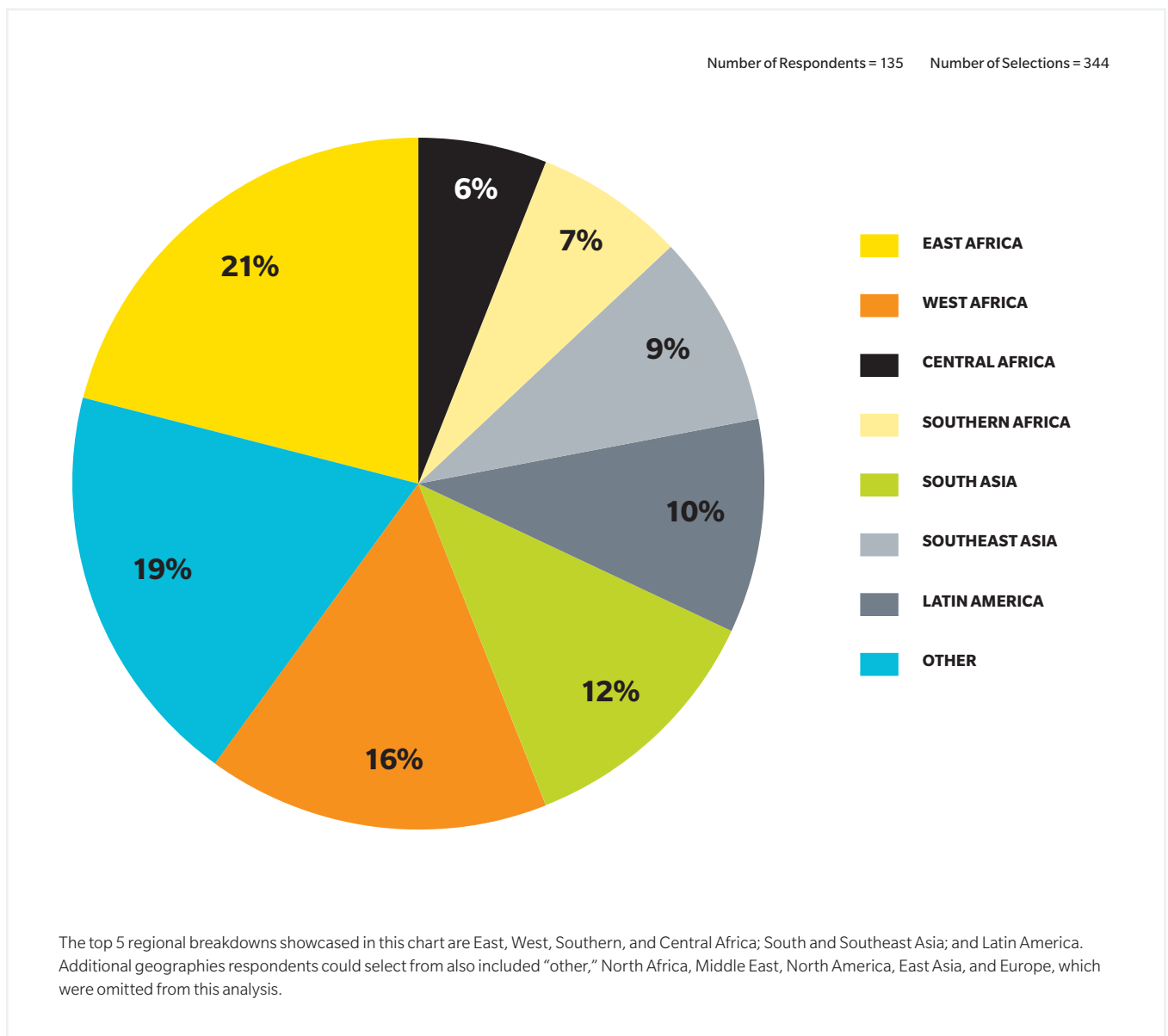
Household use items of note included:

- **Hair dryers**, motors for applications in household items such as **spinning looms**, and food preparation-related appliances including **butter churners, juice blenders**, and **roti rolling machines** which could also have income generating benefits.

Multiple mentions of appliances applicable in various settings included:

- **Water heaters**, or components often used with appliances, such as **inverters**, were also observed.

**Figure 10: Distribution of survey respondents’ operations based on combined regional groups**



**The off-grid appliance market is still nascent, and there is limited market intelligence to help actors throughout the supply chain make informed decision and target resources more efficiently. This collection of surveys is intended to provide a high-level overview of perceived demand for, and potential impacts of, off-grid appropriate appliances, and is a resource for market actors and donors interested in supporting and participating in the off-grid appliances market.**

Online surveys such as this are limited by their structure and the number and characteristics of their corresponding respondent pool. The sales data collected through this survey is especially limited and was submitted anonymously by a sub-set of market actors. However, it is still a useful benchmark given the lack of data for this nascent market. These first insights will serve as the beginnings of a concerted effort under the Efficiency for Access Coalition to collect, verify, and publish data on the sales and market potential for off-grid appliances. Beginning in 2019, the Coalition will work with the Global Off-grid Lighting Association (GOGLA) to collect data on appliance sales from off-grid solar companies. The Coalition will also project the future sales of a suite of off-grid appliances for both household and productive use applications in key markets.

Looking ahead, much more data and market intelligence is needed for the off-grid appliance sector to continue to grow and thrive. Additional market research efforts such as supply chain mapping, appliance pricing, and market size estimates would allow for a more systematic look at these and related questions, and will be among the research priorities of the LEIA programme – and the Efficiency for Access Coalition – in the near term.

# SURVEY QUESTIONNAIRE

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

Respondents who selected the household use segment 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 from a male and a female user’s perspective.

The questions posed in each segment are provided verbatim below:

## Household segment:

- Of the following appliance product categories that might be appropriate for **off-grid households**, please rank the top five (5) product categories that – in your estimation – will see the most off-grid consumer demand over the next three years. **Please rank your top five choices, from 1 being the highest consumer demand, to 5 being the 5<sup>th</sup> highest consumer demand.**
- Of the following **household** appliance product categories, please rank 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 impact, to 5 being the 5<sup>th</sup> highest impact.**

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 the same household appliance product categories in terms of their **potential positive impact on socioeconomic development and poverty reduction** from the perspective of a **female** user.
- Please rank the same household appliance product categories in terms of their **potential positive impact on socioeconomic development and poverty reduction** from the perspective of a **male** user.

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

<b>LED ROOM LIGHTING APPLIANCES</b> (Includes task and multi-point general lighting)	<b>MOBILE PHONE CHARGING BANKS</b>
<b>TELEVISIONS</b>	<b>TEA KETTLES</b>
<b>FANS</b> (Household pedestal or ceiling fans)	<b>RICE COOKERS</b>
<b>REFRIGERATION/FREEZER UNITS</b> (Household)	<b>CLOTHES IRONS</b>
<b>RADIOS</b>	<b>CLOTHES WASHER</b>
<b>SEWING MACHINES</b>	<b>MODEMS, WEB ROUTERS, INTERNET/CONNECTIVITY EQUIPMENT</b>
<b>TABLETS/LAPTOPS</b>	<b>MOBILE/SMART PHONES</b>
<b>HAIR CLIPPERS</b>	<b>AIR CONDITIONING UNITS</b>
<b>HAND POWER TOOLS</b>	<b>ELECTRIC COOKSTOVES</b>



## Business/productive use segment:

- Of the following appliance product categories that might be appropriate for **businesses and productive use**, please rank the top five (5) product categories that – in your estimation – will see the most **off-grid consumer demand** over the next three to five years. **Please rank your top five choices, from 1 being the highest consumer demand, to 5 being the 5<sup>th</sup> highest consumer demand.**
- Of the following **businesses and productive use** appliance product categories, please rank 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 impact, to 5 being the 5<sup>th</sup> highest impact.**

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

<b>LED ROOM LIGHTING APPLIANCES</b> (Includes task and multi-point general lighting)	<b>MILLS</b>
<b>TELEVISIONS</b>	<b>GRINDERS</b>
<b>FANS (INDUSTRIAL)</b>	<b>SOLDERING IRONS/WELDING TOOLS</b>
<b>SEWING MACHINES</b>	<b>MOBILE/SMART PHONES</b>
<b>SOLAR WATER PUMPS</b>	<b>REFRIGERATION/COLD CHAIN TECHNOLOGIES</b> (Agricultural Cold Chain)
<b>TABLETS/LAPTOPS</b>	<b>FOOD DRYING UNITS</b>
<b>HAIR CLIPPERS</b>	<b>AIR CONDITIONING UNITS</b>
<b>HAND POWER TOOLS</b>	<b>MILK CHILLING UNITS</b>
<b>MOBILE PHONE CHARGING BANKS</b>	<b>REFRIGERATION/FREEZER UNITS</b> (Light Commercial/SME)
<b>TEA KETTLES</b>	<b>ICE MAKERS</b>

## Healthcare segment:

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 rank the top five (5) product categories in terms of demand (i.e. the relative importance of each in delivering healthcare services to rural and/or under-electrified populations) **from 1 being the highest demand, to 5 being the 5th highest demand**.

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

Infrastructure	Medical Services
<b>LED ROOM LIGHTING APPLIANCES</b> (Includes task and multi-point general lighting)	<b>PORTABLE ULTRASOUND MACHINES</b>
<b>ICT EQUIPMENT</b> (computer, cell phone chargers, printer, HF or VHF radio)	<b>OXYGEN CONCENTRATORS</b>
<b>FANS</b>	<b>FETAL HEART MONITORS</b>
<b>AIR CONDITIONING UNITS</b>	<b>PATIENT MONITOR FOR VITAL SIGNS MEASUREMENTS</b> (e.g. NiBP, SpO <sub>2</sub> , HR, RR, EtCO <sub>2</sub> , blood glucose and ECG)
<b>WATER HEATERS</b> (including tea kettles)	<b>BRIGHTFIELD WHITE LIGHT MICROSCOPE</b>
<b>WATER PURIFIERS</b>	<b>REGULATED IV PUMPS</b>
<b>WATER PUMPS</b> (for clinics)	<b>REFRIGERATION</b> (including vaccine and blood bank refrigerators)
<b>STERILIZERS/AUTOCLAVES</b>	<b>CENTRIFUGES</b>
	<b>VIRAL LOAD TESTING FOR HIV, HCV, HBV, AND HPV</b>
	<b>NEONATAL INFANT WARMERS</b>
	<b>ANESTHESIA MACHINES</b>
	<b>OTHER DEVICES (PLEASE SPECIFY)</b>

## Sales




In addition to the product categories provided across the board, we asked respondents to specify any sales of appliance categories in 2017 – only appliance manufacturers, solar home system companies, mini-grid developers/operators, and solar home system or appliance distributors saw this question.

Finally, all respondents were provided with the opportunity to suggest other appliance product categories they might deem important that had not been included in the segment(s) they saw.

# EFFICIENCY FOR ACCESS



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