

THE STATE OF THE OFF-GRID APPLIANCE MARKET

**EXECUTIVE SUMMARY
OCTOBER 2019**

EFFICIENCY FOR ACCESS COALITION



This report analyzes major trends in the off-grid appliance sector, establishes its position as a fast-growing and attractive market, and seeks to mobilize investment and policy support to accelerate the sector's growth.

The report builds on the 2016 *State of the Off-grid Appliance Market* report, published by Global LEAP, which represented the first comprehensive accounting of the state of the household appliance sector. It provided the first-ever snapshot of the global off-grid appliance market via data-driven analysis of the scale, market trends, and barriers for three important and promising appliance categories: televisions, refrigerators, and fans. This report refreshes the 2016 analysis and builds upon its earlier findings, adding further data from recent Efficiency for Access Coalition research, GOGLA survey data on appliance sales, a review of the broader scholarly literature, updated interviews with key off-grid appliance enterprises, and country deep-dive profiles for Côte d'Ivoire, Ethiopia, India, Kenya, Myanmar, Nigeria, Sierra Leone, and Uganda to illustrate the diversity of sector challenges and opportunities.

This report was developed by Dalberg Advisors in close collaboration with CLASP as part of the Low Energy Inclusive Appliances program, a flagship program of the Efficiency for Access Coalition. Efficiency for Access is a global coalition promoting energy efficiency as a potent catalyst in clean energy access efforts. Currently Efficiency for Access Coalition members lead 12 programs and initiatives spanning three continents, 44 countries, and 22 key technologies.

The Efficiency for Access Coalition is jointly coordinated by CLASP, an international appliance energy efficiency and market development specialist non-for-profit organization, and the UK's Energy Saving Trust, which specializes in energy efficiency product verification, data and insight, advice, and research.

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EXECUTIVE SUMMARY



In the past few years, efficient off-grid appliances¹ have moved from the fringes of the energy access dialogue to its very center. The growth of off-grid and mini-grid electrification to address the basic energy needs of more than two billion off-grid and weak-grid² households and small businesses worldwide is a critical first step up the energy access ladder. Capturing the full socio-economic benefits of access to energy, however, requires the provision of higher levels of energy services. The private sector, funders, and governments are increasingly recognizing the essential role that efficient off-grid appliances can play to meet household needs at scale, generate new income and entrepreneurship opportunities, and, simultaneously advance energy enterprise profitability and sustainability through increased energy demand.

The off-grid appliance sector, while still nascent, is on the cusp of transformational growth in 2020 and beyond. Appliance sales are growing rapidly. The efficiency, performance, and range of available household and productive use appliances is increasing almost daily. While still prohibitive for many, prices continue to decline, boosting sales and growing the size of the obtainable market. The overall ecosystem for off-grid appliances has also evolved dramatically in the past few years, with many new private sector enterprises, dedicated initiatives, and intermediary organizations; rising interest from donors, implementers, and industry associations; and growing activity by commercial investors. Nevertheless, many challenges persist and there are ample opportunities to further accelerate sector progress while ensuring that quality appliances are developed and distributed in ways that maximize household-level impact while also protecting consumer safety and financial sustainability.

This report by the EforA Coalition tracks the evolution of the fast-moving off-grid appliance market. The report builds on the Global LEAP Awards' seminal *The State of the Off-grid Appliance Market* report, published in 2016,³ and offers:

- Updated information about the off-grid household appliance space including new evidence on the impacts of off-grid appliances
- Recent intelligence on underlying technology and market trends
- Deeper insights into consumer needs and demand
- Fully updated and revised estimates of the off-grid appliance market size and growth trajectory
- Off-grid appliance market profiles for eight countries in Asia and Africa.

The report focuses exclusively on household off-grid appliances and, in particular, on three of the most in-demand product categories: televisions, fans, and refrigerators.⁴ There are also exciting dynamics in the very early stage off-grid productive appliance market, so this report is launched alongside a supplement report on small-scale solar water pumps (SWPs),⁵ currently the most commercially mature category of off-grid productive use appliances. This report also complements the World Bank Lighting Global program's 2019 report on Productive Use Leveraging Solar Energy (PULSE), which focuses on a broader range of off-grid appliances for smallholder agriculture.⁶

The infographic on the next page provides an overview of key household off-grid appliance sector statistics. The pages that follow offer an overview of key report findings and recommendations.

1. Efficient off-grid appliances are defined as electrical appliances appropriate for use in both off-grid and unreliable or 'weak' grid contexts where standalone solar energy systems are insufficient to power conventional appliances. Because they run on lower-load energy systems, off-grid appliances are typically compatible with DC systems, but also include AC appliances combined with inverters.

2. The 'weak-grid' market, also sometimes labelled as 'under-electrified', refers to households and businesses which have sporadic, low-quality grid connectivity, typically only a few hours daily with a high degree of intermittency (i.e., frequent and unpredictable power outages). For brevity and simplicity, where not otherwise noted, all references in this report to off-grid markets refer to both off-grid and weak-grid households, the latter specifically defined as those that have access to grid electricity for less than 50% of the day.

3. The earlier report was published by CLASP in partnership with the Global Lighting and Energy Access Partnership (Global LEAP) Awards, a Clean Energy Ministerial initiative led by the U.S. Department of Energy. See <https://efficiencyforaccess.org/publications/the-state-of-the-global-off-grid-appliance-market-2017>

4. See top appliances categorized by perceived demand in CLASP, *Off-Grid Appliance Market Survey: Perceived Demand and Impact Potential of Household, Productive Use and Healthcare Technologies*, Efficiency for Access Coalition, 2018, <https://efficiencyforaccess.org/publications/off-grid-appliance-market-survey>.

5. Solar Water Pump Outlook 2019: Global Trends and Market Opportunities. Efficiency for Access Coalition, 2019, <https://efficiencyforaccess.org/publications/solar-water-pump-outlook-2019-global-trends-and-market-opportunities>

6. World Bank & Dalberg Advisors, *Productive Use Leveraging Solar Energy (PULSE)*, World Bank Lighting Global Program, 2019. <https://www.lightingglobal.org/resource/pulse-market-opportunity/>

OFF-GRID APPLIANCE MARKET SNAPSHOT

Energy Consumption

Household energy consumption in the United States and Europe



5-10x
greater than in India

10-20x
greater than in Nigeria

20-200x
greater than in most of rural Africa

Appliance Ownership

Number of appliances per household



15-40
developed countries

3-10
middle-income countries (e.g. India)

2-5
rural Africa

Appliance Penetration

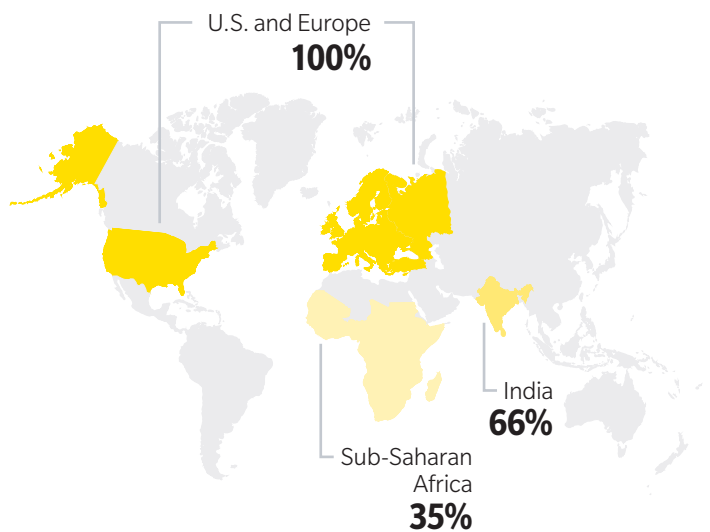
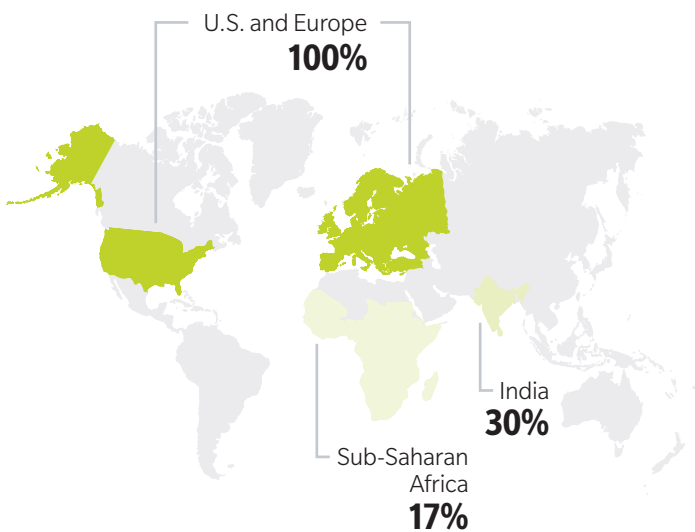
Penetration of household appliances is low in many parts of the world. In rural areas, the penetration is even lower—4% for refrigerators and 18% for televisions in rural Africa.



Refrigerators



Televisions



0-100% PENETRATION

0-100% PENETRATION

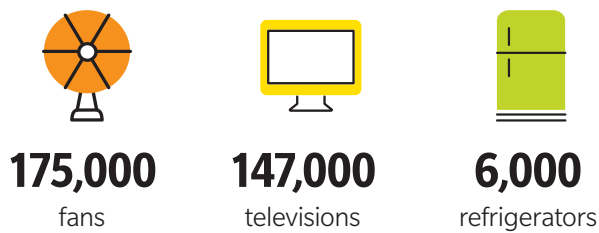
OVERVIEW OF KEY REPORT FINDINGS

TECHNOLOGY AND SUPPLY DYNAMICS

Sales for off-grid appliances have grown 50-80% annually. The total number of off-grid TVs, refrigerators and fans distributed is estimated between 1.4 and 5 million.

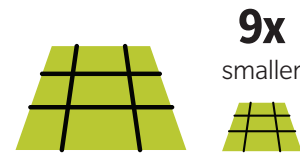
Off-Grid Appliance Sales Are Growing

30-80% of solar home system kits now include an off-grid appliance. In the second half of 2018 GOGLA affiliates reported sales of:



Off-Grid Appliance Energy Efficiency is Improving

The size of the solar panel required to power a best-in-class off-grid refrigerator is nine times smaller than what is required to power a conventional refrigerator.

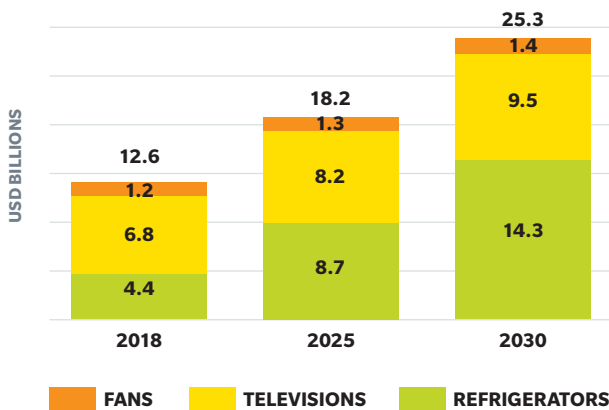


Between 2014 and 2017, the energy efficiency of televisions improved by **45%**

DEMAND AND MARKET POTENTIAL

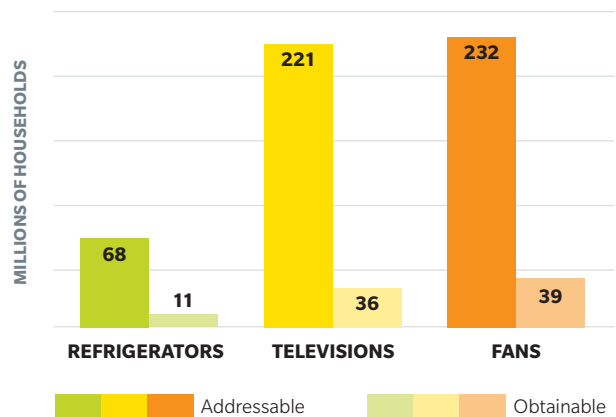
Cumulative Market Potential

The cumulative market opportunity across televisions, refrigerators and fans is estimated at USD 12.6 billion globally at the end of 2018. The market is predicted to grow to 25.3 billion by 2030.



Addressable vs Obtainable Market

The total obtainable market for off-grid appliances is significantly smaller than the addressable market largely due to limited access to finance and consumer accessibility.



Impact of Off-Grid Appliances



Refrigerators

help address food losses of 30% in sub-Saharan Africa (USD 4 billion)

Fans

reduce mortality during heat waves and increase overall health and wellbeing in households

Televisions

lead to improved educational outcomes and positive behavior change



Why are off-grid household appliances important?

Efficient appliances that are appropriate for off-grid and weak-grid markets are critical for increasing access to energy-dependent services. There are 475 million households globally with no grid access or unreliable access to electricity, 90% of which are in sub-Saharan Africa (149 million) and South Asia (275 million).⁷ Renewable energy technologies, especially solar, are helping to bridge this gap. As of 2018, off-grid solar systems were already providing more than 73 million households, or 360 million people, with access to energy globally, and their reach was growing quickly.⁸ While the solar and hybrid mini-grid market is more nascent than that for off-grid solar, mini-grids reached an estimated 10 million households in 2019, a number that is likewise projected to grow rapidly in the next few years due to major inflows of funding, falling component costs, and continued mini-grid business model innovation.⁹

Most off-grid solutions sold today provide only basic, low-power energy services, such as lighting and mobile phone charging. Off-grid populations are unable to access enough energy to power additional household services, such as home cooling, refrigeration, entertainment, and cooking. The new generation of increasingly affordable and efficient off-grid and weak-grid appliances—appliances that are substantially more efficient than conventional appliances and can accommodate energy-constrained environments and intermittent power supplies—can address many of these unmet household needs.

Off-grid appliances create foundational demand for energy services and help to make off-grid business models viable. The most far-reaching impact of off-grid appliances—and the reason that such appliances are becoming the primary focus for many energy access sector leaders—is the role they play in driving demand for off-grid energy and thus toward universal energy access by 2030. The uptake of appliances establishes a base level of demand to justify

future investment into energy generation and distribution by both private sector actors and governments. It also provides a means for distributed energy service providers to generate and monetize greater value per customer, thus supporting more sustainable energy businesses that can support the high overheads of building out rural sales and service channels.

Off-grid household appliances have wide-ranging positive impacts on economic livelihoods, health, and education. Off-grid and mini-grid consumers are not seeking electrification for its own sake, but as a pathway to goods and services that can improve their lives in tangible ways. Appliances such as televisions, fans, refrigerators, connectivity devices (e.g. Wi-Fi routers), and electric cookstoves have broad positive impacts across multiple Sustainable Development Goals (SDGs), in addition to their role in advancing energy access (SDG 7). Off-grid appliance impacts are most notable for SDG 1 (poverty reduction), SDG 2 (food security), SDG 3 (health and well-being), SDG 4 (education), SDG 5 (gender equality), and SDG 8 (jobs and entrepreneurship). In most cases the impact evidence is anecdotal, but where it can be quantified the numbers are very substantial. In the case of economic impacts, for instance, data from a recent survey in Uganda showed that micro, small, and medium enterprises (MSMEs) who had purchased off-grid refrigerators, on average, increased their daily incomes 2.5-fold.¹⁰

Off-grid appliances are also becoming a critical element of the global push towards greater energy efficiency and greenhouse gas emissions reduction. Satisfying the appetite for energy access and modern life-changing appliances with efficient off-grid and weak-grid appliances represents a major opportunity to ensure that the next billion households to be electrified will start from the outset with high quality energy-efficient devices that minimize costs to the consumer and net impacts to the environment. The efficiency improvements should in time also influence the conventional appliance segment as the industry converges.

7. Dalberg estimate based on extrapolation from International Energy Agency (IEA) and country grid quality survey data.

8. World Bank & Dalberg Advisors, Off-grid Solar Market Trends Report, World Bank Lighting Global Program, 2018, <https://www.lightingglobal.org/2018-global-off-grid-solar-market-trends-report/>.

9. For off-grid solar estimate of 73 million households and 360 million people, see *ibid*. For the mini-grid estimate of 47 million people covered by mini-grids (around 10 million households, assuming 4.5 people per household), primarily in Asia, see World Bank, *Mini-Grids for Half a Billion People: Market Outlook and Handbook for Decisionmakers*, 2019, <https://openknowledge.worldbank.org/bitstream/handle/10986/31926/Mini-Grids-for-Half-a-Billion-People-Market-Outlook-and-Handbook-for-Decision-Makers-Executive-Summary.pdf?sequence=1&isAllowed=y>.

10. Global LEAP and Energy 4 Impact Refrigerator Field Testing. Report Forthcoming.

What is the off-grid appliance demand today and what will the market size be in 2030?

Levels of overall energy utilization and household appliance use are very low in Sub-Saharan Africa (SSA) and South Asia, the two primary geographies of focus for this report. Annual household energy consumption in the United States and Western Europe is 5-10 times greater than that for an average household in India, 10-20 times greater than for an average household in a country like Nigeria, and 20-200 times greater than for households in most of rural Africa.¹¹

Statistics on appliance access are equally stark:

- High income countries have 15-40 appliances, in contrast to 3-10 appliances for the average household in India, and 2-5 electric appliances (including mobile phones) for households in most of rural Africa.¹²
- In contrast to essentially universal TV and refrigerator access in middle and high income countries, in Sub-Saharan Africa, we estimate that only 17% of households have refrigerators and 35% have TVs, translating into a total of at least 33 million fans, 35 million refrigerators, and a mid-range estimate of 80 million TV sets.¹³ This means that the entire region has 25% fewer refrigerators and TVs than Japan, which has only a tenth of Africa's population.¹⁴
- Appliance ownership by off-grid households is substantially lower. Excluding the middle-income outlier of South Africa, approximately 4% of rural African households have refrigerators and 18% have TVs.¹⁵ Even in middle income India, for comparison, only 16% of rural households have refrigerators and roughly half have TVs.¹⁶

Potential demand for appropriately designed and efficient off-grid appliances is high. The gap in household appliance access and use in urban and rural Africa and South

Asia is a strong indicator of the immense latent market demand for off-grid appliances.

We know from the purchase behavior of electrified households in the same income segment that demand for off-grid appliances like televisions, fans, and refrigerators, as well as others such as radios, irons, hot plates, and internet connectivity devices is very high. Furthermore, self-reported purchasing preferences suggest very high levels of latent demand. A large-scale survey of off-grid households across 10 countries in Sub-Saharan Africa revealed that 28% of households (18-35% range) intended to purchase a television and 14% (6-24% range) had an interest in purchasing a refrigerator upon gaining access to electricity.¹⁷

Demand for off-grid appliances is particularly high for households that have already experienced some of the benefits of energy access via basic solar home systems. For instance, a 2016 survey of solar home system households in Kenya showed that 37% of such households had a strong interest in buying a television and demand was likewise higher for appliances such as radios (28%), irons (26%), refrigerators (24%), and cookstoves (23%).¹⁸

There is a significant potential market for off-grid appliances, which we estimate at USD 12.6 billion as of the end of 2018.¹⁹ The addressable market, defined as the number of households which could acquire an off-grid appliance if financing was available, is linked to the current price of any given appliance and consumers' disposable incomes.²⁰ Using fans, televisions, and refrigerators as a market proxy, we estimate that the addressable market for off-grid appliances is up to half of the total global off-grid and weak-grid population. Using the latest available market data, as of the end of 2018, the addressable market ranged from 68 million households for expensive products like off-grid refrigerators (i.e. 15% of total off-grid and weak-grid households) to 221 to 232 million households for televisions and fans (approximately 50% of off-grid and weak-grid households).

11. Average annual household energy consumption is approximately 11,000 kWh in the US (of which 35-40% is linked to household appliance use), in the 3,500-6,500 kWh range for Western Europe, 900-1200 kWh in India, 500-1000 kWh in Nigeria, and only 50-500 kWh for most rural Africa, in line with the IEA rural energy poverty line of 50 kWh per capita, or roughly 250 kWh per household annually (based on World Energy Council, GOGLA, and IEA data).

12. Dalberg review of national energy survey and utility data; the developed world average is based on the average household appliance figures for the United States, UK, Spain, Korea, Singapore, and Japan.

13. The Dalberg estimate for TV and refrigerator penetration in Sub-Saharan Africa is based on 2012-2018 Development Health Survey (DHS) data across the 20 largest Sub-Saharan African countries which account for 83% of the region's total population; penetration for the others is based on the regional average (excluding outlier of South Africa); assumes up to 1.2 televisions per household based on Nigeria energy survey data.

14. Japan estimate extrapolated from Matsumoto, S., "Household Income Structure and Electrical Appliance Ownership: Evidence from Japanese National Household Survey", IJEEP, 2016, <https://www.econjournals.com/index.php/ijeeep/article/view/1483/929>.

15. Dalberg analysis of the most recent regional DHS datasets (2012-2018) and using 2018 population and urban/rural share data.

16. Ibid.

17. Leo, B., et al, *What Can We Learn About Energy Access and Demand from Mobile-Phone Surveys? Nine Findings from Twelve African Countries*, CGDEV, 2018, <https://www.cgdev.org/sites/default/files/what-can-we-learn-about-energy-access-and-demand-mobile-phone-surveys.pdf>.

18. Lee, K., et al, "Appliance Ownership and Aspirations among Electric Grid and Home Solar Households in Rural Kenya", *American Economic Review: Papers and Proceedings*, 2016, http://emiguel.econ.berkeley.edu/assets/miguel_research/75/Lee_Miguel_Wolfram_2016a.pdf

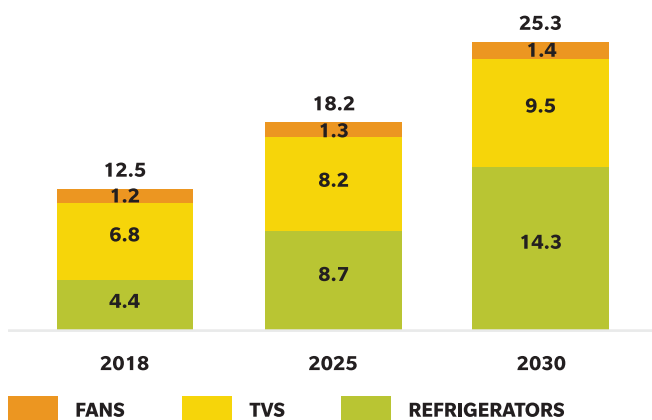
19. Dalberg analysis, 2019. Market data based on fans, televisions, and refrigerators.

20. We estimate the total addressable market size by overlaying affordability on off-grid and weak grid household numbers. The obtainable market is further constrained by the availability of consumer finance and accessibility of the household to off-grid appliance distributors. Market sizing was developed for eight deep-dive countries and then extrapolated globally. Further details on the methodology and data sources are provided in the body of the report.

We estimate that the total obtainable market, while still substantial, is significantly smaller than the addressable market because access to finance is limited across many markets in sub-Saharan Africa and South Asia. Customer accessibility is a further constraint—distributors must be able to physically reach households to sell, service, and, if necessary, reclaim appliances. Factoring in these access to financing and physical accessibility barriers reduces the number of obtainable households to around 39 million for fans, 36 million for TVs and 11 million for refrigerators.²¹

The cumulative market opportunity across televisions, fans, and refrigerators is estimated at USD 12.6 billion globally. The market has the potential to double to USD 25.3 billion by 2030, driven primarily by refrigerator and television demand.

Figure 1: Cumulative market potential (USD billions)



Source: Dalberg market sizing

How has the off-grid appliance sector evolved in recent years?

In the three years since the first State of the Off-Grid Appliance Market Report²² was published, the market has continued to grow rapidly. While comprehensive data on off-grid appliance sales is not currently available, self-reported data from individual manufacturers and distributors and other market proxies like solar home system sales suggest that, in aggregate, sales for off-grid appliances such as televisions, fans, and refrigerators have grown 50-80% annually. As a result of a few years of fast-growing sales, we estimate the total number of off-grid TVs, refrigerators, and fans in use in people’s homes and small businesses today to be in the low millions.²³

The members of GOGLA and companies that have participated in the Global LEAP Awards or engaged with the [Low Energy Inclusive Appliances Program](#) (LEIA) (collectively referred to as ‘affiliates’), which most likely account for a minority of all off-grid television sales in many markets, reported selling 147,000 off-grid televisions, largely in Sub-Saharan Africa, in the second half of 2018 alone.²⁴ Fan sales from the second half of 2018 across all affiliates totaled 175,000, and were mostly concentrated in South Asia. As with TVs, fan sales are only partly reflected in GOGLA data.²⁵ For instance, in 2018, a Bangladesh based results-based financing program supported by Energising Development (EnDev) led to the sale of over 120,000 off-grid fans, all meeting high performance requirements, but these sales were not all reflected in the GOGLA data. Off-grid refrigerator sales, due to the high prices of refrigerators and resulting affordability constraints, are an order of magnitude lower; approximately 6,000 were sold by affiliates in the second half of 2018.

There are several reasons for the rapid sales growth of the off-grid appliance market. One cross-cutting driver of this sales growth has been the rapid growth of the off-grid solar sector. Based on interviews with solar home system distributors and select appliance manufacturers, depending on the specific geography, 25-85% of solar home system kit sales, of which there are well in excess of a million annually across the developing world, now include an off-grid appliance.²⁶ Other drivers of sales growth include ongoing improvements in off-grid appliance performance and quality, growing investment into off-grid appliance manufacturers and distributors which allows them to build out their distribution networks, and—importantly—growing appliance affordability for some

21. Dalberg market sizing estimate, 2019.

22. CLASP & Dalberg Advisors, The State of the Off-grid Appliance Sector Report, 2017, <https://efficiencyforaccess.org/publications/the-state-of-the-global-off-grid-appliance-market-2017>

23. Assuming a 50-80% growth rate in sales and 20-50% share of GOGLA affiliate sales to the overall off-grid appliance market results in aggregate sales of 1.4 million to over 5 million TVs, refrigerators, and fans million since 2014. Adding in countries like Bangladesh and India, which are poorly reflected in GOGLA data, the aggregate number of off-grid fans, refrigerators, and televisions in use across the developing world is likely to be in the 5-10 million unit range. Of these, we estimate that the highly efficient branded off-grid appliances are still a minor (10-30%) share of the total market. More precise figures will become available in future publications as industry reporting and thus GOGLA and LEIA data improve.

24. GOGLA sales data based on an early 2019 GOGLA affiliate survey.

25. CLASP data, 2019.

26. Dalberg stakeholder interviews, 2019.

categories of products. For example, the average retail price of off-grid televisions tracked by CLASP fell by 23% (from USD 150 to USD 115) between 2015 and 2018.

Televisions have become a critical driver of off-grid solar uptake in many markets, representing the most in-demand appliance for off-grid households and the primary add-on for solar home system kits sales. Fans sales are gaining momentum in hot and humid markets – most notably in South Asia, South East Asia, and in specific markets in West Africa (e.g., Nigeria, Senegal, Côte d'Ivoire, Ghana)—and are seen as important “add-ons” to solar home system kits. While refrigerators and other large appliances continue to generate a lot of interest, products are not yet sufficiently affordable to enable distribution at scale, at least not for household use. Other household appliances like electric off-grid cookers, with an immediate focus on electric pressure cookers, are at an even earlier stage of product development and market maturity.

Alongside sales, other clear indicators of market growth include the number of manufacturers, distributors, and products in the market for off-grid appliances. Just five years ago, branded manufacturers of off-grid televisions, fans, and refrigerators which specialized in products designed for developing world off-grid and weak-grid consumers numbered just 2-5 enterprises per product category, with only a handful of products visible in Africa and South Asia during market visits.²⁷ By 2017, as part of the Global LEAP Awards program, CLASP was already tracking dozens of high-quality, off-grid appropriate appliance manufacturers – 11 refrigerator manufacturers with 20 products, 8 television manufacturers with 15 products, and 7 off-grid fan manufacturers with 17 products.²⁸ These numbers have continued to grow. As part of the 2019 Global LEAP Awards round for off-grid refrigerators, CLASP received 39 submissions from 21 manufacturers across 15 countries and Hong Kong—67% of manufacturers were first time participants. The resulting growth in manufacturer numbers and product variety is already visible on the ground. For example, in 2018, during a survey of off-grid appliances available for sale in 10 rural markets in Tanzania, CLASP identified 16 unique brands across 12 TVs, 11 fans, and 2 refrigerators.²⁹

Business models around off-grid appliance manufacturing and distribution are rapidly becoming more specialized as more players enter the space and the sector matures and becomes more competitive. Off-grid solar companies, the fastest growing segment of the off-grid appliance market, primarily focus on establishing long-term relationships with customers and upselling them appliances since selling durable, high-quality appliances is a great way to ensure sustained demand for solar system sales. Outside of this off-grid solar specialist segment, large, branded original equipment manufacturers (OEMs) are increasingly important as direct sellers to small retail outlets and as overall drivers of off-grid appliance market growth. Manufacturers of generic appliances (both AC and DC) are also growing, though due to a lack of publicly available data their pace of growth is difficult to quantify relative to other company segments. Their products are typically less energy efficient but more affordable than branded off-grid appliances, and are widely distributed in markets where there are few established off-grid solar home system players.

Beyond the off-grid solar sector, there is also increased interest from mini-grid developers in facilitating sales of appliances on-site to drive energy demand and generate value for their customers.^{30,31} Many mini-grid developers are focused on selling conventional rather than efficient appliances because their primary objective is to maximize energy consumption and thus tariff revenues. An increasing number of mini-grid actors, however, particularly those in Africa which are focused on household energy access, are starting to focus on the efficient appliance opportunity as a lever for extending the impact and viability of their business models. Several have now entered into or are exploring partnerships with efficient off-grid and weak-grid appliance manufacturers, a trend that will accelerate substantially in coming years.

The drive toward improved efficiency has been the central focus of off-grid appliance innovation. Among off-grid appliances tested by CLASP, the range in efficiency between average and best-in-class devices is high – the most efficient devices are 1.5x more efficient than the average for fans, 2x for TVs, and nearly 3x for refrigerators.³² This means that even with relatively higher costs for super-efficient off-grid appliances, the total system costs for the customer can be significantly reduced by investments in system efficiency, thereby improving overall affordability and customer uptake.

27. Dalberg proprietary research, 2019.

28. See Global LEAP Awards Global Buying Guides, 2016-2017. See, e.g., <https://clasp.ngo/publications/global-leap-awards-2017-buyers-guide-for-off-grid-fans-televisions>.

29. CLASP, Appliance Data Trends, Efficiency for Access Coalition, 2018, <https://efficiencyforaccess.org/publications/appliance-data-trends>.

30. McCall, M. & Santana, S., Closing the Circuit: Stimulating End-Use Demand For Rural Electrification, Rocky Mountain Institute (RMI), 2019, <https://rmi.org/insight/closing-the-circuit/>.

31. CrossBoundary and Energy 4 Impact. Innovation Insight: Appliance Financing. 2019. <https://www.crossboundary.com/wp-content/uploads/2019/08/CrossBoundary-Innovation-Lab-Innovation-Insight-Appliance-Financing-Final-07-Aug-2019-1.pdf>

32. CLASP testing data from the Global LEAP awards.

It is therefore not surprising that off-grid appliance manufacturers have been very focused on efficiency improvement. Success in this direction is most evident for televisions, where Global LEAP Awards data shows a 45% improvement in average off-grid TV efficiency from the 2013-2014 to the 2016-2017 Award rounds.³³ Efficiency gains for fans have been more modest, in the order of 10% from 2015 to 2017, but meaningful further improvement is possible with brushless DC motor and blade design innovation. In the case of refrigerators, much more significant efficiency improvement is required to improve affordability for households and small businesses. Promising innovations in brushless DC motors, variable speed compressors, and insulation materials and designs (e.g., phase-changing materials) suggest that efficiency improvements of 50% are achievable within the next few years and should help significantly grow the off-grid refrigerator market once achieved.³⁴

Beyond efficiency and affordability, innovation has also increasingly focused on quality and consumer-adapted performance. As the off-grid appliance industry grows, it is developing a better understanding of customer behavior, preferences and ability to pay for particular appliances. In particular, companies are focusing more on product performance and customer-ready features. Prominent examples of such off-grid appliance features includes resistance to dust and humidity that characterize rural off-grid settings or, for instance, the integration of internet connectivity into the off-grid television set-top box for greater customer convenience. Our interviews show that while product price continues to be the primary driver of purchasing behavior, off-grid and weak-grid customers also care deeply about product quality, convenience of use, and aspirational features such as modern, aesthetically-pleasing form factors.

Consumer financing models, which are critical to sales growth, have also evolved over the past three years, driven by a deepening financial inclusion effort across off-grid markets. In this period, there has been tremendous growth in mobile money use (e.g. a 20 – 50% uptick in mobile money penetration in East Africa depending on country), and a 50% average increase in bank account ownership in markets where mobile money penetration is low,³⁵ along with a broad trend of increasing availability of mobile money across many regions. As off-grid appliances become larger and more sophisticated, a corresponding growth in financing options is critical to making these products affordable and commercially viable. In India, microfinance institutions (MFIs) have been the driving force in access to off-grid appliances—many now provide asset financing for a variety of appliances, ranging from conventional on-grid appliances to off-grid appropriate appliances. In sub-Saharan African markets with high mobile

money penetration, such as Kenya, Rwanda, and Uganda, pay as you go (PAYGO) financing provides low-income consumers an affordable entry point for appliance access. For large developing markets with limited mobile money penetration such as Ethiopia and Nigeria, the lack of financing for off-grid appliances has constrained the growth of the market. Within the industry, there is a deeper understanding of these financing mechanisms in the past few years, along with a shared concern around default rates, especially with larger off-grid systems, and a growing recognition of the risks of over-burdening low income off-grid households with debt.

The broader ecosystem for energy access—including policymakers, regulators, investors, development actors—is gradually placing more emphasis on off-grid appliances. The off-grid appliance sector has been supported proactively in recent years by development partners such as UK aid, the World Bank, the German Society for International Corporation (GIZ), US Agency for International Development, Shell Foundation, and IKEA Foundation via bilateral initiatives such as the LEIA program as well as multi-donor programs. The Efficiency for Access (EforA) Coalition, a partnership of 15 public funders, philanthropies, and international agencies whose programs include LEIA and Global LEAP, among many others, was launched in 2018 to accelerate global energy access through energy efficient appliances. After rapid growth, EforA now has programs and initiatives spanning 44 different countries and 22 off-grid and weak-grid appropriate technologies.

In the meantime, impact investors looking to harness off-grid solar and mini-grid penetration are channelling growing volumes of patient equity capital and concessional debt to drive off-grid appliance sector growth. Civil society organizations such as CLASP and industry associations like GOGLA that play a role in market governance are furthering quality assurance and standards in an attempt to create a more transparent, competitive environment—and ultimately better choices for consumers. Growing grant funding is also supporting R&D for advancements in off-grid appliances, as exemplified by the EforA R&D fund, and the 2019 launch of a new specialized intermediary focused on global off-grid appliance innovation, the Access to Energy Institute (A2EI).

The growth of off-grid appliance ecosystem funders and intermediaries is expected to accelerate in the coming years as technologies improve, financing and distribution models are refined, and new appliance categories are introduced to the off-grid market.

33. Reflects an improvement in the TV efficiency index from approximately 38 to 55 inches per watt based on CLASP research.

34. Efficiency for Access Coalition. Off-grid Refrigeration Technology Roadmap. 2019. https://storage.googleapis.com/e4a-website-assets/Refrigeration-Roadmap_FINAL.pdf

35. World Bank, Global Findex Database, 2019.

What are the main barriers to growth?

Consumer affordability is the most significant constraint for the growth of the off-grid appliance market; access to capital for product innovators and distributors is also important. For example, in Kenya, which is one of the leading hubs of off-grid appliance innovation and uptake globally, nearly half of consumers are still unable to afford an average priced off-grid television and solar home system bundle even with standard consumer financing terms.³⁶ On the supply side, manufacturers struggle to lower the retail price of off-grid appliances given the high costs of distributing to off-grid and often last-mile regions. Given the nascency of most off-grid appliance technology, and still emerging demand in most markets, many manufacturers are unable to offer competitive pricing due to small order volumes. Furthermore, at this early stage of market development, even as underlying appliance component costs decline and provide opportunities to manufacturers to improve their margins, market actors are investing their profits into continued product innovation and scale-up of sales operations rather than by lowering prices for consumers to build market demand. These market dynamics constrain sector growth. This is especially true for larger, more expensive products such as off-grid refrigerators, which retail at around USD 900 in various African markets and have not had notable reductions in absolute price levels even while the performance to cost ratio has improved dramatically in recent years. This will likely change, however, as off-grid appliance manufacturers and distributors reach larger scale thereby driving down costs, and as the entry of new manufacturers and distributors puts competitive pressure on appliance prices in the most mature markets.

Governments are working to change or create policies in favor of off-grid solar expansion; however, off-grid appliances are not explicitly included in many of those efforts. Most countries have established ambitious electrification plans that are at various stages of implementation. In Nigeria, Kenya, and India, for example, there are dedicated national programs to increase off-grid electricity access. These plans, however, do not explicitly include off-grid household appliances. The lack of quality assurance policies exposes off-grid appliance customers to the real risks of poor-quality products. Few countries have subsidy programs or results-based financing (RBF) facilities targeting appliances, though several do for solar home systems. Most markets do not have tax incentives for off-grid appliances, and those that do have inconsistent application, making products more expensive for customers than they should be.

What needs to happen to accelerate growth?

The off-grid appliance market has the opportunity to drive substantial gains in—and greater impact of—electrification efforts by unlocking latent demand for energy-enabled services. We expect the market to evolve significantly over the next 5-10 years based on increased affordability due to higher incomes, declining appliance prices in line with historical trends (e.g. 30% decline in TV prices), and better access to consumer financing as well as growing access to off-grid and mini-grid electricity. Factoring in these trends, we estimate that the potential market could double to a USD 25 billion market opportunity by 2030. Likewise, the potential reach of off-grid appliances should grow substantially, from an obtainable market of 39 million households in 2018 to almost 60 million households in 2030, a roughly 50% growth in the number of households who should have the opportunity to benefit from off-grid appliance access and resulting quality of life improvements and economic benefits.

The market fundamentals for off-grid appliances are strong, they just require the right encouragement and support. The key to reaching this market potential are greater affordability which can be achieved through improved access to low-cost consumer financing tailored for off-grid appliances, better economies of scale in production and distribution, and ongoing technology innovation focused on boosting product efficiency and lowering costs. Other important drivers for faster off-grid appliance sales growth include deeper manufacturer and distributor insights into consumer needs to inform appropriate product development and distribution strategies, investment into customer awareness of off-grid appliances and their benefits, and donor and government support for enabling regulations and initiatives including: tax/tariff abatement for off-grid appliances, policy support for DC mini-grid development, public good investment into appliance R&D, support for market intelligence activities, and critical support for off-grid appliance quality standards which protect consumers.

36. Dalberg analysis, 2019, based on World Bank income data.

In line with these drivers for sector growth, several recommendations feature prominently in the report:



Government policies should further recognize the importance of driving energy demand through off-grid and weak-grid appliances within their electrification initiatives, and act accordingly.

National energy policies should explicitly support off-grid appliance technologies. Today, many policy actors and some donors consider off-grid appliances such as televisions, fans, and refrigerators to be luxury items. Likewise, some developing countries provide tax incentives for agricultural or fisheries equipment, without including productive use appliances like solar powered refrigerators or solar water pumps under such tax and duty exemptions. This narrative should be challenged and reframed to ensure that decision makers understand the transformative impact that efficient appliances—including both household and productive use appliances—can have on off-grid households and small businesses.

The argument for privileged regulatory and trade treatment of efficient off-grid appliances is particularly compelling for productive use equipment, but even in the case of household appliances covered in this report there is a strong case for governments to treat efficient appliances designed for off-grid settings, which contribute to energy access and drive demand, differently from on-grid appliances. Understanding this narrative and the role of appliances in reaching many of the SDGs can help governments move forward in developing sector support programs that incentivize efficient appliance uptake and adoption at scale.

Beyond taxes and tariffs, policy support for off-grid appliances requires governments to embrace well-designed off-grid appliance quality and efficiency standards. Furthermore, as mini-grid markets develop with the massive upcoming investments into the mini-grid sector that are projected over the next decade, support will be needed to create tariff structures and delivery models that incentivize the deployment of high quality, energy efficient appliances. Mini-grid developers do not have the same incentives to encourage the use of energy efficient appliances as solar home system providers because, in many cases, their business models depend on increasing energy consumption. However, as a number of mini-grid sector leaders are starting to acknowledge, it is more sustainable in the long term and in the best interest of customers to deploy high quality and energy efficient appliances on mini grids as it will improve the amount of energy services that customers receive for each watt paid for. Moreover, many of the technical innovations that have been made in the solar home system (SHS) sector to improve appliance durability and efficiency, while also considering affordability constraints and user preferences, will also be applicable to the mini grid sector.³⁷



The financing of off-grid and weak-grid appropriate appliances should continue to be supported by donors and impact investors.

Even with business model innovation and falling appliance costs, the widespread scale-up of off-grid appliances will require many USD billions of consumer financing. Developing the consumer financing market for appliances will require substantial amounts of concessionary debt and risk capital from donors and impact investors.

As the off-grid appliance industry matures, not all of the consumer financing should be channeled via vertically integrated appliance distribution businesses as is currently the norm. Instead, donors and sector intermediaries should encourage banks, micro-finance organizations, and new specialist financiers which have relevant financial risk assessment and risk management competencies (and access to capital) to engage on the off-grid appliance financing opportunity. Such a shift would allow for more needed financial innovation—for example, adjustment of repayment periods to match harvest seasons in rural areas—and more streamlined and asset light business models for appliance distributors in line with a general move to greater business model specialization apparent in the off-grid solar sector.

The wealth of data produced by off-grid appliances should also enable development finance institutions (DFIs), philanthropic donors, and impact investors to develop new types of financial instruments, most notably, results-based financing schemes for consumers or value chain intermediaries (i.e., incentive payments tied to appliance uptake and use) that should address affordability constraints and thus help drive much broader consumer demand.

37. For a discussion of the linkages between mini-grid development policies and the off-grid appliance market see: Kopec, G., et al., The future of direct current electrical systems for the off-grid environment, Smart Villages, 2017, <https://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/TR8-The-future-of-direct-current-electrical-systems-for-the-off-grid-environment-web.pdf>.



Consumer protection should become a more prominent feature of donor and sector intermediary off-grid appliance promotion initiatives.

One of the more pressing consumer protection issues for off-grid appliances is the development and dissemination of well-defined product quality standards, support for product testing and certification programs to help consumers differentiate between low and high quality products, and related consumer protection measures like the broader adoption of consumer warranties to limit consumers' financial risk and promote uptake. At the same time, appliance quality standards should not be overly restrictive during this early stage of market development to avoid impeding experimentation and innovation.³⁸

The off-grid appliance industry should also ensure that consumer lending is done responsibly and does not overburden off-grid households with debt, particularly because the average transaction size for off-grid appliance purchases (e.g. refrigerators) is substantially higher than for basic off-grid energy access kits. Repeated experience in other sectors such as micro-finance shows that self-regulation is challenging without significantly improved transparency on customer transactions, common financing standards, and appropriate intermediary bodies.

In addition, the off-grid appliance industry must provide regulations for data collection, security, and privacy since many off-grid household appliances feature Internet of Things (IoT) functionality (e.g. to monitor and remotely optimize appliance performance) and are thus starting to capture significant amounts of data on customer behavior, often with minimal disclosure and a lack of systematic thinking about customers' data privacy and security concerns.



Donors and other off-grid sector intermediaries should build multinational company and investor awareness around the large financial opportunity in appliances and provide targeted market entry support.

The potential of multi-national actors to bring incremental R&D resources and manufacturing scale could be transformative for the industry. This includes long-established global branded appliance and electronics players as well as large scale generic appliance manufacturers in Asia, most notably China. The entrance of such multi-national corporations into the market could precipitate a step change in technology and significantly lower prices in the off-grid market, increasing the competitiveness of the industry. Furthermore, the energy efficiency advancements made in off-grid appropriate appliances could also be retrofitted to on-grid appliances already being distributed by large corporates at scale throughout the developing world, helping support a move to reduced fossil fuel emissions globally.




While some multi-national companies and commercial investors are beginning to see the potential—in particular, the USD 10 billion television opportunity—donors and governments could play a decisive role to encourage this by providing more support for private sector actors to enter the off-grid appliance market. Potential levers of support relevant for large corporations and commercial investors include: developing market intelligence and business cases to highlight the economic opportunity, which can help regional executives and product development staff win internal arguments about resource allocation and customer prioritization; targeted advocacy and recognition (e.g. off-grid impact awards) for those private sector actors that are interested in garnering recognition for their SDG contributions; and—critically—improvements in the enabling environment, including streamlined certification and importation procedures and beneficial tax and tariff regimes (e.g. tax holidays, tariff/VAT reduction) for high priority appliances that advance government priorities.

38. Efficiency for Access. Promoting High Performing Off-grid Appliances. 2019. https://storage.googleapis.com/e4a-website-assets/Promoting_High-Performing_Off-Grid_Appliances.pdf

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