Empowering Livelihoods: New Research on Off-grid Appliances and Equipment

23 October 2018 / 10:00 a.m. EST | 4:00 p.m. CET
Energy Efficiency for Energy Access

A Theory of Change on promoting energy efficiency – specifically efficient appliances – as a potent catalyst in global clean energy access efforts
Appliance Efficiency Unlocks Greater Energy Access Outcomes

Energy System Requirements

Source: CLASP
### Efficient Appliances Enable Cost-Effective, Holistic Electrification

#### Source: CLASP/CHAI analysis

**Medical device sample sizes:** 12 refrigerators; 11 autoclaves; 6 fetal heart monitors; 5 pulse oximeters

<table>
<thead>
<tr>
<th>System Size</th>
<th>Run Time (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>351 Wp Solar Panel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
</tr>
<tr>
<td>314 Ah LiFePo4 Battery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
</tr>
</tbody>
</table>

**KEY**
- **Load Configuration & System Run Time with a Super-Efficient Off-Grid Refrigerator**
- **Load Configuration & System Run Time with a Conventional Vaccine Refrigerator**

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### Diagram Description:

- **System Size**
  - 351 Wp Solar Panel
  - 314 Ah LiFePo4 Battery

- **Run Time**
  - 24 hours for both Solar Panel and Battery systems

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Efficiency for Access Coalition

A coalition to accelerate global energy access through energy-efficient appliances
Low Energy Inclusive Appliances (LEIA)

A research & innovation programme to accelerate the availability, affordability, efficiency, and performance of appliances particularly suited to developing country contexts.
LEIA will help **halve the cost and double the efficiency** of a range of off- and weak-grid appliances in least developed countries.

**Driving scale in near-to-market technologies:**
- Televisions
- Fans
- Solar Water Pumps
- Refrigerators

**Enabling innovation in horizon and enabling technologies:**
- Brushless DC Motors
- Connectivity/Internet of Things
- Advanced Electric Cooking
- Agricultural Processing
- Interoperability
- Advanced Cooling
<table>
<thead>
<tr>
<th>ACTIVITY TYPE</th>
<th>Solar Water Pumps</th>
<th>Refrigerators</th>
<th>Agricultural Processing</th>
<th>Horizon Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Market Stimulation &amp; Incentives</strong></td>
<td>2019 Global LEAP Awards Solar Water Pump Competition</td>
<td>2019 Global LEAP Awards Off-Grid Refrigerator Competition</td>
<td>N/A</td>
<td>Horizon technology innovation prizes (e.g., induction cooking, motors)</td>
</tr>
</tbody>
</table>
| **Product Testing & Quality Assurance** | • Test method development  
  • Outreach re: testing harmonization  
  • Field sample procurement, product testing, data-sharing (upcoming) | • Field sample procurement, product testing, data-sharing (ongoing)  
  • Field test protocol development  
  • Expansion of product performance database | N/A | • Test method development  
  • Field sample procurement, product testing, data-sharing |
| **Coordination, Communication & Market Education** | • Market development roundtable  
  • Priority theme for comms campaign  
  • Newsletter feature | • Market development roundtable  
  • Priority theme for comms campaign  
  • Newsletter feature (upcoming) | Priority theme for communications campaign | Socializing appliances & technologies of interest or direct activity for EforA Coalition |
| **Market Intelligence & Technology Roadmapping** | • Global Market Trends Report  
  • Convene Technical Working Group  
  • Technology R&D roadmap | • Market segmentation to identify likely/viable customer groups  
  • Convene Technical Working Group  
  • Technology R&D roadmap | Pilot deployment of Agsol milling machines in Kenya | Landscape analysis medical appliance supply chain |
2018 Off-Grid Appliance Market Survey
Market Survey Report: Approach & Methodology

Approach
1. Third iteration of online survey of energy access professionals, conducted semiannually
2. Branched & self-selected sections to ensure accurate aggregation of views
3. Regional, sectoral and yearly comparisons to plot changing signals

Segmentation
- Household use
- Business/ productive use
- Healthcare/ clinic use

- Gender differentials for household appliances
- Demand and socio-economic impact comparisons
- Appliance sales snapshot
Key Takeaways

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

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

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

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

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

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

There is a critical difference between theoretical needs versus market realities.
2018 Household Appliance Demand & Impact Rankings
2018 Productive Use Appliance Demand & Impact Rankings

- Solar Water Pumps: Impact Potential 1, Consumer Demand 1
- Refrigeration/Cold Chain: Impact Potential 2, Consumer Demand 2
- Refrigeration/Freezer Units: Impact Potential 3, Consumer Demand 3
- LED Room Lighting Appliances: Impact Potential 4, Consumer Demand 4
- Mobile/Smart Phones: Impact Potential 5
- Milk Chilling Units: Impact Potential 5
- Televisions: Impact Potential
- Mobile Phone Charging Banks: Impact Potential
- Hand Power Tools: Impact Potential
- Food Drying Units: Impact Potential
- Mills: Impact Potential
- Soldering Iron/Welding Tools: Impact Potential
- Ice Makers: Impact Potential
- Tablets/Laptops: Impact Potential
- Grinders: Impact Potential
- Air Conditioning Units: Impact Potential
- Sewing Machines: Impact Potential
- Fans (Industrial): Impact Potential
- Hair Clippers: Impact Potential
- Tea Kettles: Impact Potential

**Legend**
- Impact Potential
- Consumer Demand

Survey details:
- 76 Respondents
- 77 Respondents
## Productive Use Appliance Rankings Through Time

<table>
<thead>
<tr>
<th><em><em>2014 SURVEY RESULTS (MODIFIED</em>)</em>*</th>
<th><em><em>2016 SURVEY RESULTS (MODIFIED</em>)</em>*</th>
<th><strong>2018 SURVEY RESULTS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANTICIPATED CONSUMER DEMAND</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 LED lighting appliances</td>
<td>LED lighting appliances</td>
<td>Solar water pumps</td>
</tr>
<tr>
<td>2 Mobile charging banks</td>
<td>Televisions</td>
<td>Refrigeration/Cold chain technologies (Agricultural cold chain)</td>
</tr>
<tr>
<td>3 Televisions</td>
<td>Mobile/Smart phones</td>
<td>Refrigeration/Freezer units (Light commercial/SME)</td>
</tr>
<tr>
<td>4 Refrigeration</td>
<td>Mobile phone charging banks</td>
<td>LED lighting appliances</td>
</tr>
<tr>
<td>5 Fans</td>
<td>Fans</td>
<td>Mobile/Smart phones</td>
</tr>
<tr>
<td>6 Laptops</td>
<td>Refrigeration (Light commercial/SME)</td>
<td>Milk chilling units</td>
</tr>
<tr>
<td>7 Solar Water Pumps</td>
<td>Solar water pumps</td>
<td>Televisions</td>
</tr>
<tr>
<td>8 Tablets</td>
<td>Refrigeration (Agricultural cold chain)</td>
<td>Mobile phone charging banks</td>
</tr>
<tr>
<td>9 Clothes irons</td>
<td>Laptops</td>
<td>Hand power tools</td>
</tr>
<tr>
<td>10 Grinders</td>
<td>Hand Power Tools</td>
<td>Food drying units</td>
</tr>
</tbody>
</table>

| **DEVELOPMENT IMPACT POTENTIAL**   |                                    |                         |
| 1 LED lighting appliances          | LED lighting appliances             | Solar water pumps       |
| 2 Refrigeration                    | Mobile/Smart phones                 | Refrigeration/cold chain technologies (Agricultural cold chain) |
| 3 Mobile phone charging banks      | Solar Water Pumps                   | Refrigeration/Freezer units (Light commercial/SME) |
| 4 Solar water pumps                | Refrigeration (Agricultural cold chain) | LED lighting appliances  |
| 5 Televisions                      | Refrigeration (Light commercial/SME) | Milk Chilling units |
| 6 Laptops                           | Mobile Phone Charging Banks         | Mills                   |
| 7 Fans                              | Televisions                         | Food drying units       |
| 8 Rice mills                        | Hand power tools                    | Hand power tools        |
| 9 Grinders                          | Mills                               | Sewing machines         |
| 10 Hand power tools                 | Sewing Machines                     | Mobile/smart phones     |
# Healthcare Appliance Demand Rankings in 2018

<table>
<thead>
<tr>
<th>Medical Equipment</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED ROOM LIGHTING APPLIANCES (Includes task and multi-point general lighting)</td>
<td>1</td>
</tr>
<tr>
<td>WATER PURIFIERS</td>
<td>2</td>
</tr>
<tr>
<td>ICT EQUIPMENT (Computer, cell phone chargers, printer, HF or VHF radio)</td>
<td>2</td>
</tr>
<tr>
<td>STERILIZERS/AUTOCLAVES</td>
<td>3</td>
</tr>
<tr>
<td>WATER PUMPS (For clinics)</td>
<td>3</td>
</tr>
<tr>
<td>WATER HEATERS (Including tea kettles)</td>
<td>4</td>
</tr>
<tr>
<td>FANS</td>
<td>5</td>
</tr>
<tr>
<td>AIR CONDITIONING UNITS</td>
<td></td>
</tr>
<tr>
<td>REFRIGERATION (Including vaccine and blood bank)</td>
<td>1</td>
</tr>
<tr>
<td>PORTABLE ULTRASOUND MACHINES</td>
<td>2</td>
</tr>
<tr>
<td>PATIENT MONITOR FOR VITAL SIGNS MEASUREMENTS (e.g. NIBP, SpO₂, HR, RR, ETCO₂, blood glucose and ECG)</td>
<td>3</td>
</tr>
<tr>
<td>NEONATAL INFANT WARMERS</td>
<td>4</td>
</tr>
<tr>
<td>VIRAL LOAD TESTING FOR HIV, HCV, HBV, AND HPV</td>
<td>3</td>
</tr>
<tr>
<td>OXYGEN CONCENTRATORS</td>
<td></td>
</tr>
<tr>
<td>BRIGHTFIELD WHITE LIGHT MICROSCOPE</td>
<td></td>
</tr>
<tr>
<td>FETAL HEART MONITORS</td>
<td></td>
</tr>
<tr>
<td>CENTRIFUGES</td>
<td></td>
</tr>
<tr>
<td>ANESTHESIA MACHINES</td>
<td></td>
</tr>
<tr>
<td>REGULATED IV PUMPS</td>
<td></td>
</tr>
</tbody>
</table>
Gender Differentials for Household Use Appliances

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.
Next Steps

• Continued **lack of commercial availability** of larger appliances in off-grid markets, with relatively high cost and load requirements.

• **Cost reductions & efficiency improvements** = a significant asset to scaling availability and commercial viability.

Efficiency for Access Coalition will collect, verify, and publish **data on sales and market potential** for off-grid appliances going forward:

• Beginning in 2019, work with GOGLA to collect data on appliance sales from off-grid solar companies.

• Project the future sales of a suite of off-grid appliances for both household and productive use applications in key markets.
Off-Grid and Weak-Grid Appliance Data Trends
Critical Barriers Inhibiting the Off-Grid Appliance Market

The global off-grid clean energy market needs a complementary market of high-quality, super-efficient off-grid appliances to reach its full potential, but significant barriers inhibit that market’s development:

- **Off-Grid Energy Service Companies** struggle to identify, develop and source super-efficient, high-quality, and affordable appliances.

- **Appliance Manufacturers** often are not familiar enough with the off-grid marketplace to design and market their products effectively.

- **Investors & MFIs** lack reliable benchmarks against which to target investment or evaluate and incentivize appropriate appliance procurement.

- **Policymakers** lack the market and product performance data to target and scope market transformation policies or programs.

These barriers inhibit growth and scale in the global off-grid clean energy market and exclude off-grid communities from the socioeconomic, health, and environmental benefits of improved and expanded modern energy services.
Building Technical Foundations for Off-Grid and Weak-Grid Appropriate Appliances

- Partner/Stakeholder Engagement
- Product Sourcing & Testing
- Market Scoping
- Test Lab Network Management
- Test Methods Development
Data Trends Report: Approach & Methodology

Approach
1. Mapping product efficiency and pricing
2. Developing year-by-year baselines
3. Comparing performance of off-grid and on-grid products

Sample sources
“Baseline” vs “Awards” products

Laboratory Testing
- Energy performance and efficiency
- Service delivery
- Durability & safety
- Quality & workmanship
Off-Grid Refrigerator Energy Efficiency Trends
Off-Grid Refrigerator Price Trends
Comparison to Refrigerators Available in the On-Grid Market

<table>
<thead>
<tr>
<th></th>
<th>REFRIGERATORS</th>
<th>OFF-GRID</th>
<th>ON-GRID</th>
<th>DIFFERENCE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest EEI</td>
<td>11</td>
<td>63</td>
<td></td>
<td>472</td>
</tr>
<tr>
<td>Mean EEI</td>
<td>69</td>
<td>133</td>
<td></td>
<td>93</td>
</tr>
<tr>
<td>Highest EEI</td>
<td>173</td>
<td>245</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>REFRIGERATOR-FREEZER COMBINATION UNITS</td>
<td>OFF-GRID</td>
<td>ON-GRID</td>
<td>DIFFERENCE (%)</td>
</tr>
<tr>
<td>Lowest EEI</td>
<td>9</td>
<td>58</td>
<td></td>
<td>560</td>
</tr>
<tr>
<td>Mean EEI</td>
<td>25</td>
<td>92</td>
<td></td>
<td>265</td>
</tr>
<tr>
<td>Highest EEI</td>
<td>60</td>
<td>135</td>
<td></td>
<td>125</td>
</tr>
</tbody>
</table>
Additional Insights

Discrepancies Between Laboratory versus Field Performance
Despite best efforts to simulate real-world conditions, laboratory testing can never truly predict a product’s actual energy performance. Field testing is a necessary complement to support continued progress towards improved appliance quality and energy efficiency.

Accuracy of Claimed Energy Performance Values
Greater accuracy and consistency in product energy performance ratings & communication about performance variations in real-life settings is critical for consumer protection and to support the ongoing development of off-grid appliance markets.

Enhancing Product Durability & Quality
Off-grid consumers often live in remote areas with almost no access to repair technicians or replacement components. Product failures and bad user experiences can quickly erode consumer confidence. Quality and durability also improve investor confidence, enhance consumer safety, and help minimize e-waste.
Off-Grid Appliance Data Platform … Coming Soon!

DATA PLATFORM

Efficiency for Access Data Platform

Providing access to off-grid appliances resources and product testing data

SELECT A PRODUCT TYPE

Browse, download and share global off-grid appliances product specifications and testing data.

- TELEVISION
- FAN
- REFRIGERATION