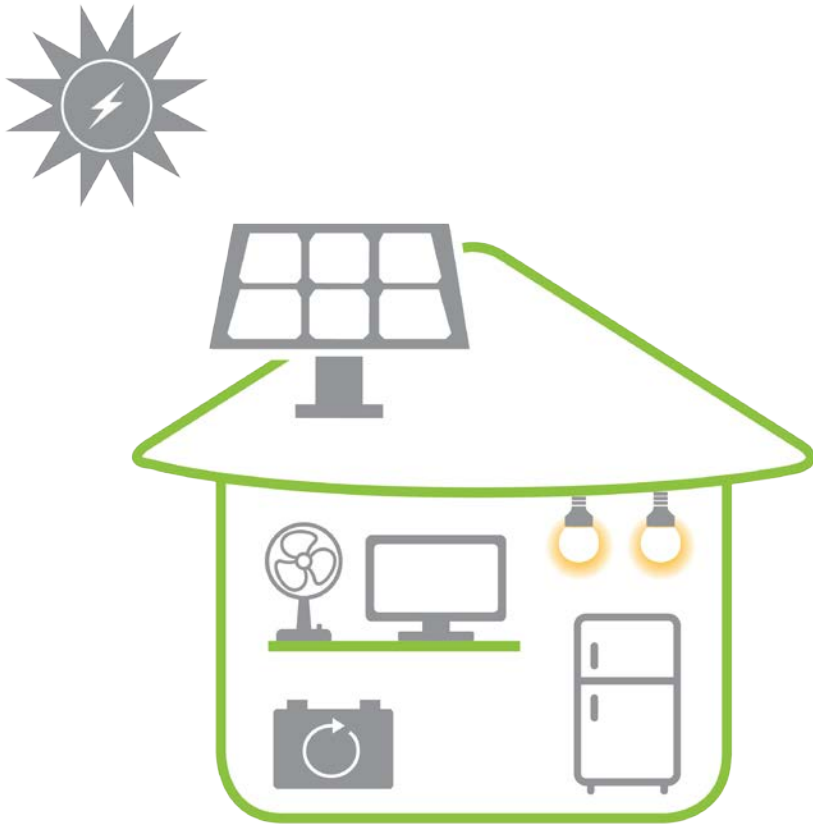


Appliances that Drive Economic Growth and Energy Access

Sam Grant
January 2018

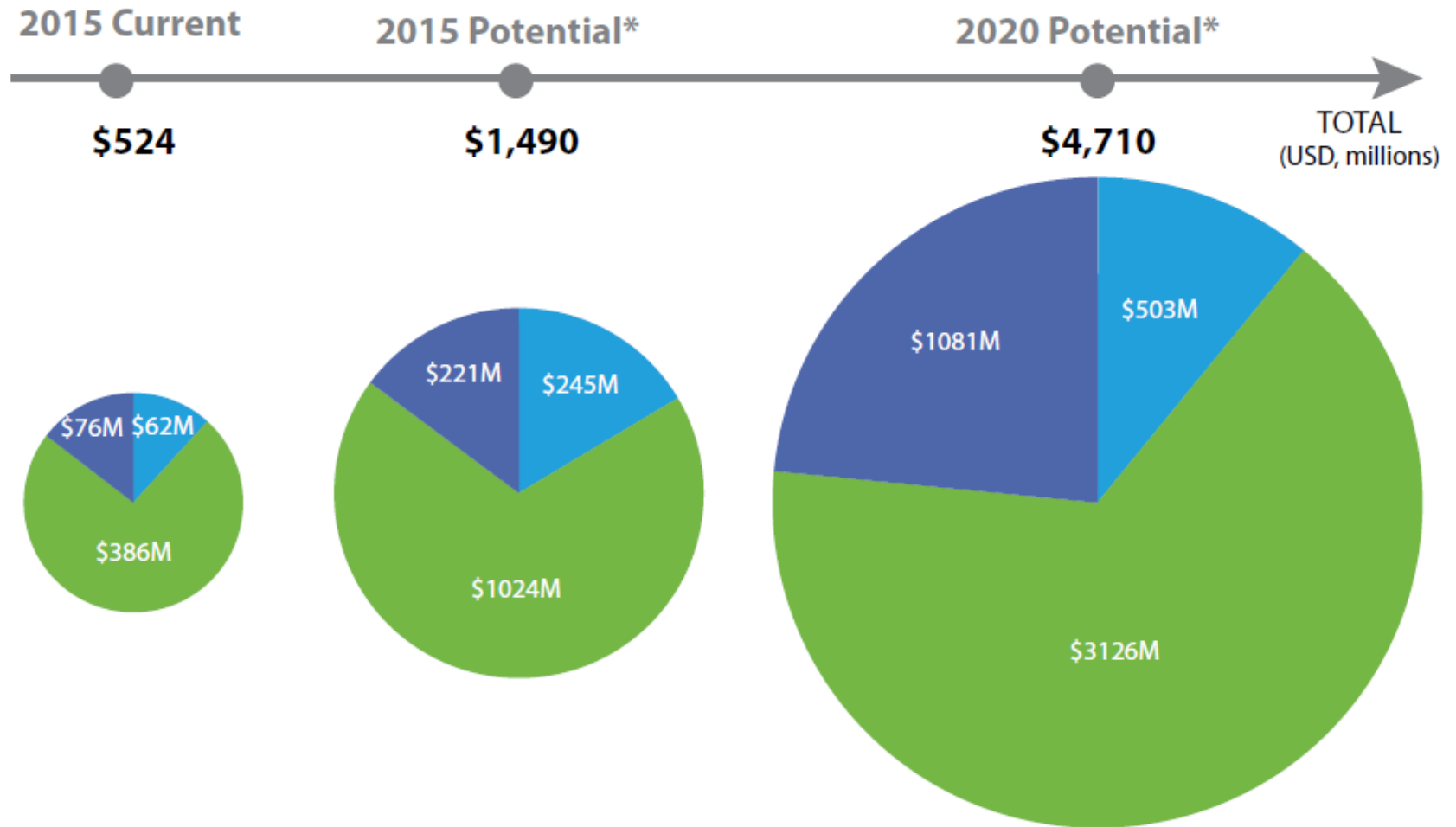


Energy services are evolving...



- Appliances turn electrons into energy service
- Consumers moving beyond basic needs to higher tiers
- Growing demand for refrigeration, cooling, entertainment, and income-generating products
- Suppliers and technology rising to meet the demand
- More can always be done to improve efficiency, scale markets, and reduce costs!

... and demand for appliances is growing

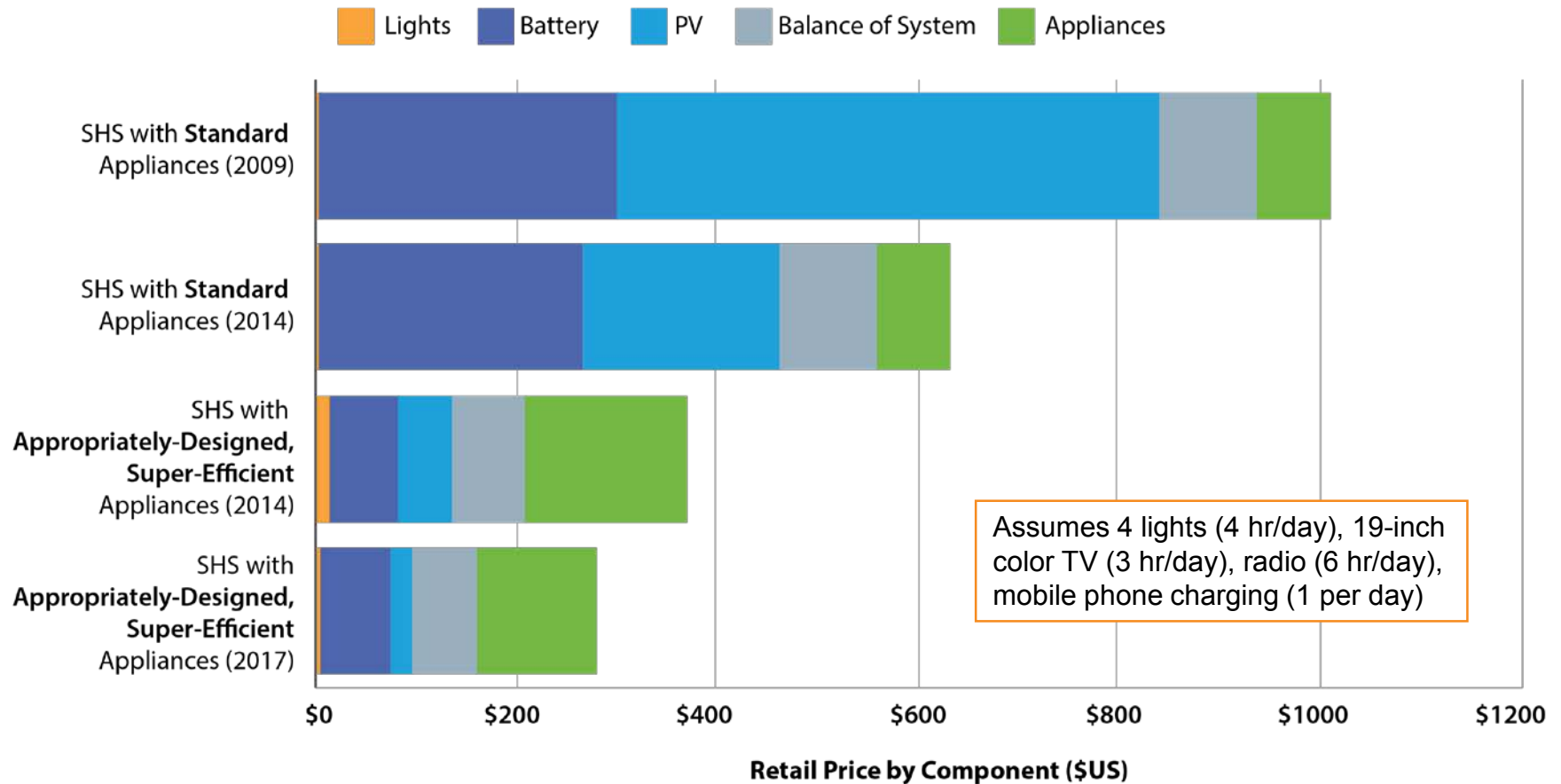


Market growth by appliance product category (CAGR), 2015 potential to 2020 potential

- Refrigerators (15%)
- Fans (25%)
- Televisions (37%)

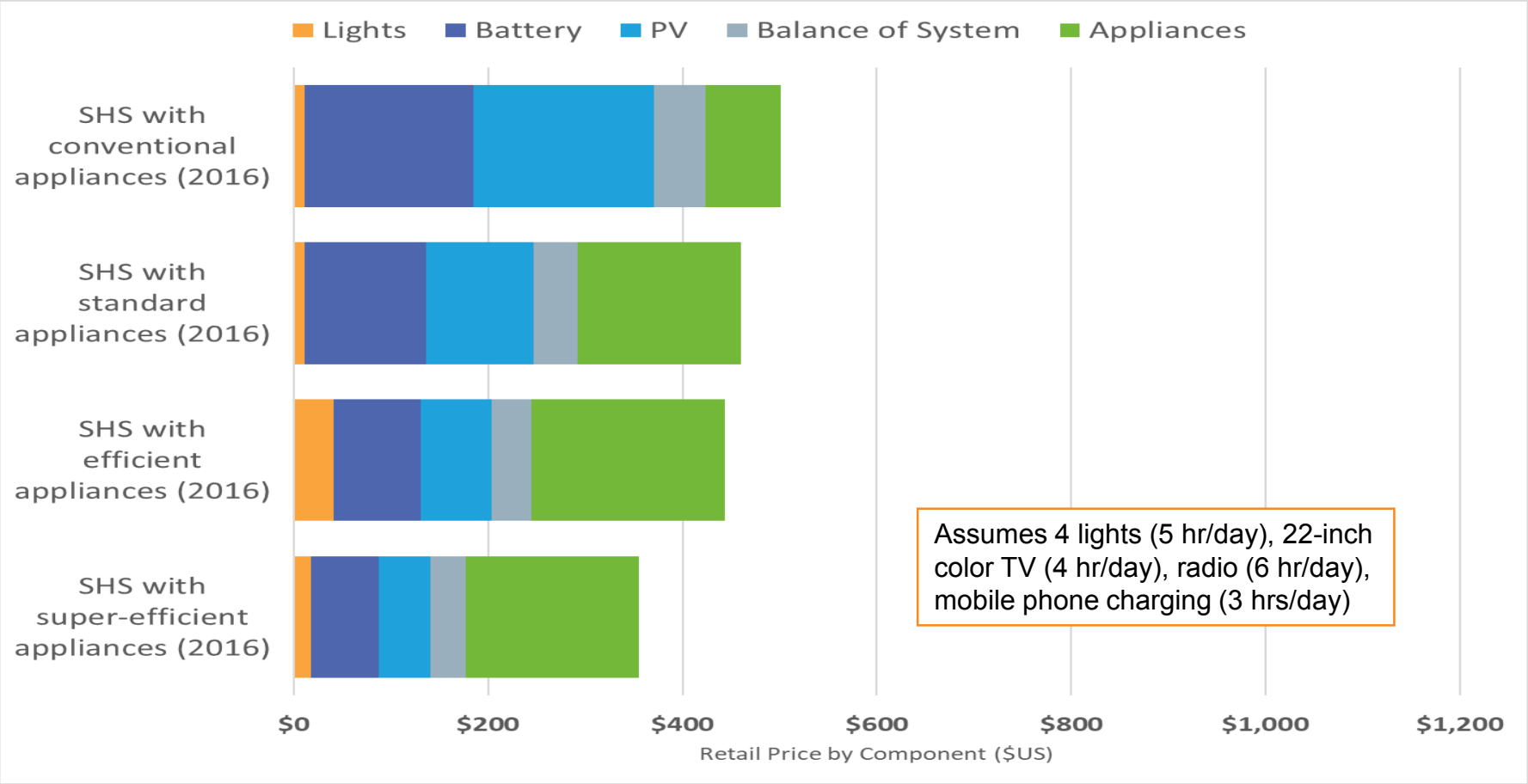
... by reducing overall energy access costs

Solar Home System (SHS) Purchase Price (2014 data)



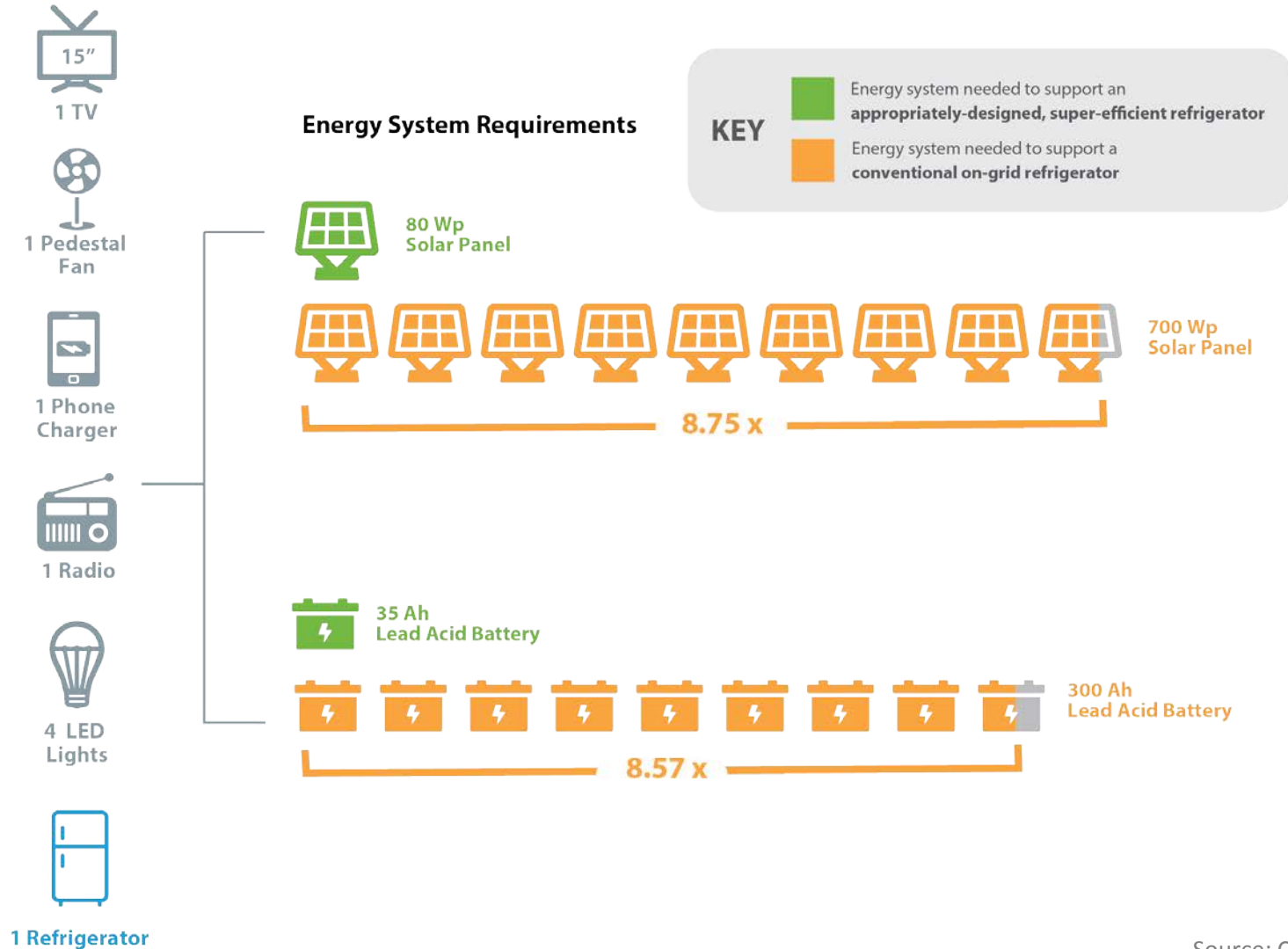
Efficiency baselines are improving...

Solar Home System (SHS) Purchase Price (2016 data)



Source: CLASP

Energy System Requirements to Power a Conventional and Super-efficient Refrigerator



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.



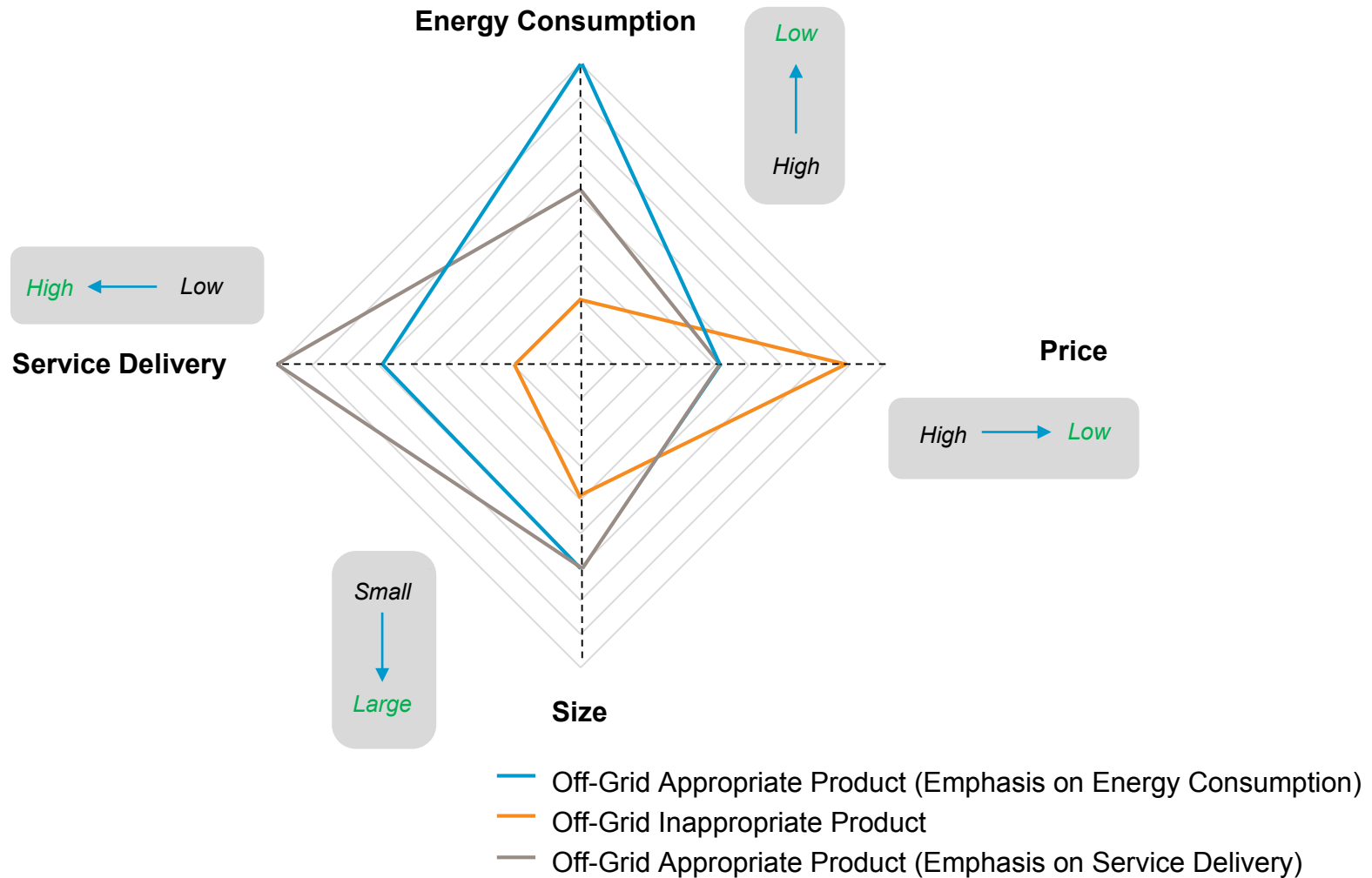
Investors & MFIs lack reliable benchmarks against which to target investment or evaluate and incentivize appropriate appliance procurement



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.

Off-Grid Appropriateness = A “Sweet spot” of Value



Global LEAP Off-Grid Appliance Test Methods

Product Category	Commonly-Used Test Methods for On-Grid Household Products	Additional Tests to Address Off-Grid Performance/Requirements
Fans	<ul style="list-style-type: none"> • IEC 60879 (air delivery, power input, and energy efficiency value) • IEC 60335-2-80 (fan blades and guards) 	<ul style="list-style-type: none"> • Quality and workmanship inspections • Voltage fluctuation conditions ($\pm 15\%$ of rated voltage) • Harsh environment exposure conditions ($40\text{C} \pm 2^\circ\text{C}$ temperature and $93\% \pm 3\%$ relative humidity) • Drop test (IEC TS 62257-9-5)
Televisions	<ul style="list-style-type: none"> • IEC 62087 (On Mode power consumption) • IEC 62301 (Standby Mode power consumption) • ENERGY STAR® Televisions Test Method (luminance) 	<ul style="list-style-type: none"> • Quality and workmanship inspections • Voltage fluctuation conditions ($\pm 15\%$ of rated voltage) • Harsh environment exposure conditions ($40\text{C} \pm 2^\circ\text{C}$ temperature and $93\% \pm 3\%$ relative humidity) • Physical Ingress Protection (IEC 62257-9-5) • Viewing Angle (IEC 60107)
Refrigerators	<ul style="list-style-type: none"> • IEC 62552 (steady-state operation power consumption, freezing capacity) • WHO/PQS/E003/RF05-VP.4 (autonomy time, pull-down time) 	<ul style="list-style-type: none"> • Quality and workmanship inspection • Voltage fluctuation conditions ($\pm 15\%$ of rated voltage) • Harsh environment exposure conditions ($40\text{C} \pm 2^\circ\text{C}$ temperature and $93\% \pm 3\%$ relative humidity)

Global LEAP Off-Grid Appliance Data Platform



Product Sampling

Sample off-grid appliances from retail markets, distributors and manufacturers



Product Testing

Test products according to international best practice, using new Global LEAP test methods



Data Cataloguing

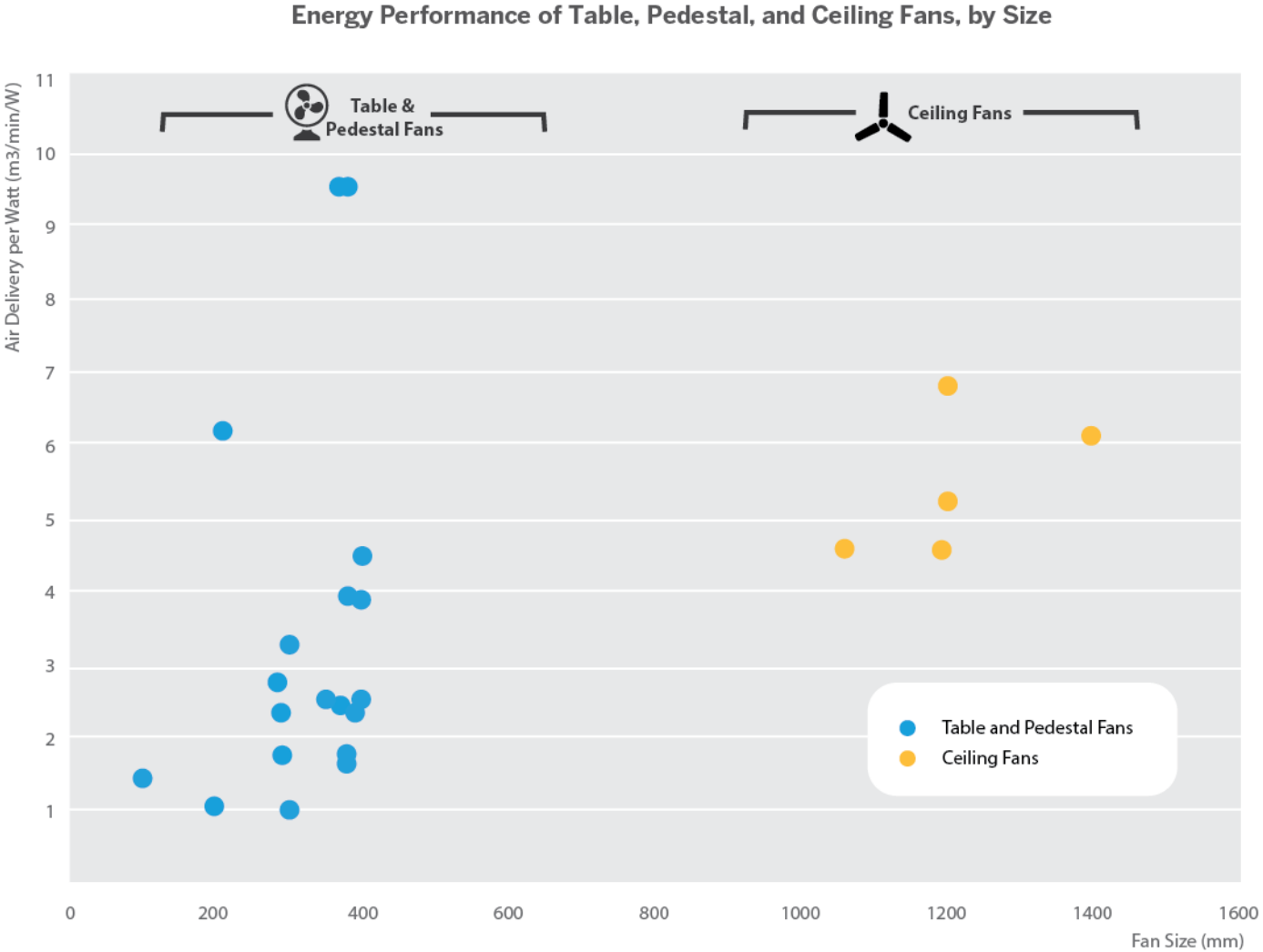
Organize product performance, quality and market data in interactive, user-friendly online platform



Data Sharing

Share data with policymakers, investors, DESCOs, and manufacturers to inform off-grid appliance design, business decisions, and policy

Energy Performance of Table, Pedestal, and Ceiling Fans, by Size



Fan performance (Drivers & impacts)

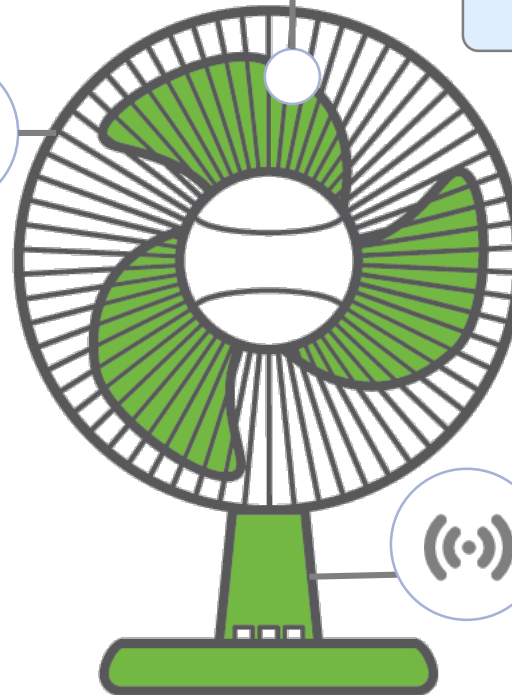
Motor

- The absence of brushes in BLDCs means that more electricity is transferred into rotational force, making them more energy efficient.
- Typically, brushed motors are 75-80% efficient at the transference of energy to force, while BLDCs are 85-90% efficient.



Blade

- Blade design can optimize energy-to-air flow ratios, lowering energy consumption while maintaining adequate airflow.

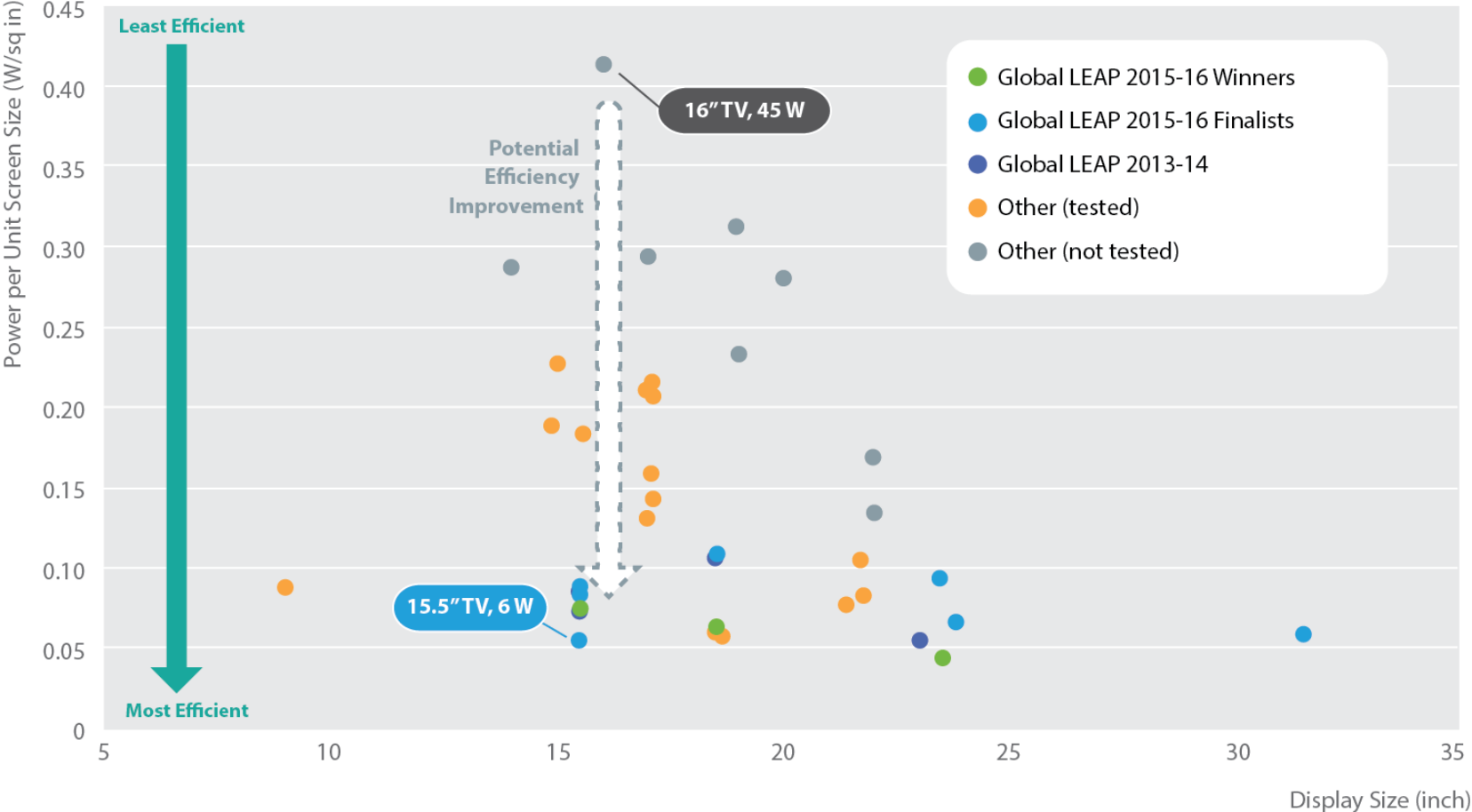


Motion Sensor

- Operating fans while people are out of a room can deplete stored energy quickly.
- Readily available technologies like occupancy, motion and/or infrared sensors can greatly mitigate the waste of energy caused by user behavioral challenge.



Power Consumption of Off-grid Televisions, by Size



TV Performance (Drivers & impacts)

Backlight Technology

- Transitioning from CCFL-LCD screen to LED-LCD screen improves the efficacy of panels
- *“LED-LCD TVs are 20% to 30% more efficient on average than CCFL-LCD TVs.”* [2]

Reflective Polarizer

- Efficient optical films allow more of a backlight's light through, requiring less light and less energy.
- *“Recent tests by 3M found that DBEFs reduced power by 24% in LED-LCD TVs.”*

Signal Receiver / Decoder

- Rural, peri-urban and off-grid contexts often depend on a variety of TV signals (analog, digital, satellite).
- Increasing the efficiency of the signal receivers and decoders can reduce TV energy consumption.

Backlight Dimming

- Lowering the backlight of a display to reduce energy consumption
- *“With 0D, 1D, and 2D dimming techniques, a sample movie consumed 83%, 71%, and 50% of the original backlight power.”*[1]

Ambient Light Sensors

- Adjusting TV brightness level in response to ambient light levels
- *“In case the ambient light level decreases from 300 lx to 10 lx, it is reasonable to expect a power reduction of about 20% on average...”* [2]

Speaker System

- A TV's power consumption can increase by 20% when adjusting the volume from 0 to the highest setting. [3]
- Smartphone and Bluetooth speakers produce rich, loud sound, and range between 30 mW and 3W.



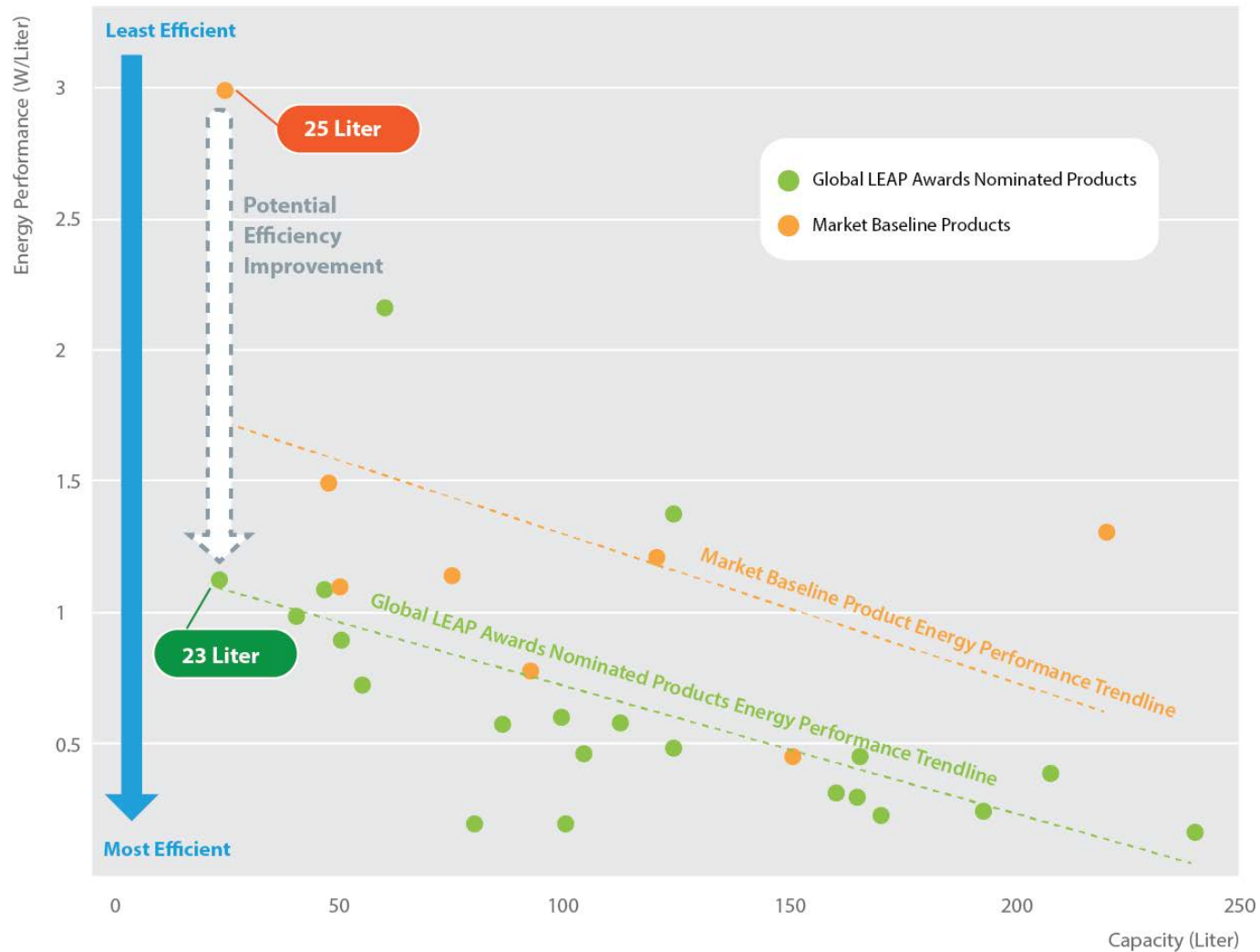
Source:

[1] Park et al. 2014. <http://bit.ly/1Kc01eF>

[2] Park et al. 2013. <http://bit.ly/1XiPNet>

[3] Data from Schatz Energy Research Center (SERC)

Energy Performance of Select Off-grid Appropriate Refrigerators



Fridge Performance (Drivers & impacts)

Compressor

- Innovations in variable speed compressors (VSC), which can result in energy savings of up to 40 percent, offer more immediate efficiency gains.
- Brushless DC compressors that have variable speed can adjust the refrigeration capacity by controlling the motor speed, and are more energy efficient.



Refrigerants

- A change in refrigerant also improved overall efficiency. Products sold in European markets now primarily use isobutene as opposed to other common refrigerants (e.g., R134A).
- This transition improved refrigerator efficiency by approximately 5% over the past few years, and has the potential to unlock further improvement in compressor efficiency in the future.

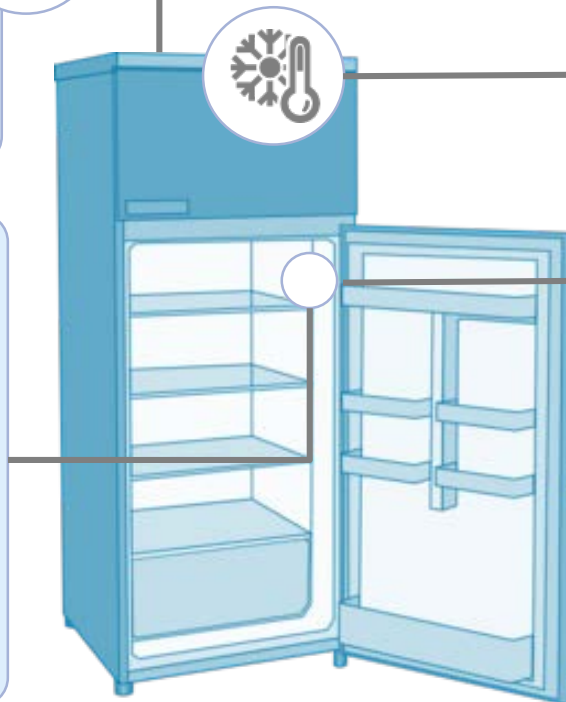


Conventional Insulation

- Most refrigerators currently use about 1.5 inches of polyurethane foam for insulation.
- By increasing the thickness of foam insulation to 4–4.5 inches, effective insulation can help increase the overall energy efficiency of a refrigerator by up to 30 percent.

Advanced Insulation Technology

- Better thermal insulation technology, such as vacuum insulated panels (VIPs) is much more effective at preventing heat loss than other insulation materials.
- VIPs that are one-inch thick have the same insulation performance as six-inch thick polyurethane insulation.



Global LEAP Awards Competitions



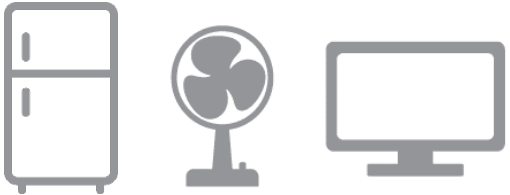
2013-14 (17 nominations)



2015-16 (53 nominations)



2016-17 (128 nominations)



Efficiency for Access Coalition



**EFFICIENCY
FOR
ACCESS**



Low Energy Inclusive Appliances Programme (LEIA)



Scale Deployment of Near-to-Market Products

Targets include refrigerators, solar water pumps, televisions and fans.



Stimulate Innovation & Knowledge for Horizon Technology

Targets include brushless DC motors, advanced electric cooking, connectivity and compatibility/ interoperability



Develop Market Intelligence & Coordinate Partnerships

Address gaps in market data and improve market function through partnership coordination and knowledge-sharing

Off-grid Cold Chain Challenge & Innovation Prizes



CoolBot - India



Cold Hubs - Nigeria

- Off-grid cold storage container companies have the potential to:
 - prevent food spoilage
 - raise incomes and increase food security.
- The OGCCC will try to bridge technology gaps and reward promising business models.
- First round of awards will launch in March 2018.



Lighting Global Quality Assurance



Promote and support good policy



Drive uptake of quality products



Develop market & product intelligence



Develop standards & administer certifications

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