FACTOR[e] VENTURES

# Factor[e] Appliance Workshop
## Webinar

05.15.2019

# Introductions

# The Challenge: Beyond Lights

| | Tier 1 | Tier 2 | Tier 3 | Tier 4 | Tier 5 |
|---|---|---|---|---|---|
| Application | Task lighting<br>Phone charging | General lighting<br>Television<br>Fan | Tier 2 AND any medium-power appliances | Tier 3 AND any high-power appliances | Tier 4 AND any very high-power appliances |
| Power | Min 3W | Min 50W | Min 200W | Min 800W | Min 2kW |
| Daily supply | Min 12Wh | Min 200Wh | Min 1.0kWh | Min 3.4kWh | Min 8.2kW |
| Typical source | Solar lanterns | Solar home systems | Generator or mini-grid | Generator or grid | Grid |

Moving up the energy ladder is **imperative** for rural economic development.

* SE4All Tiers of Electricity Access, adapted from the WHO

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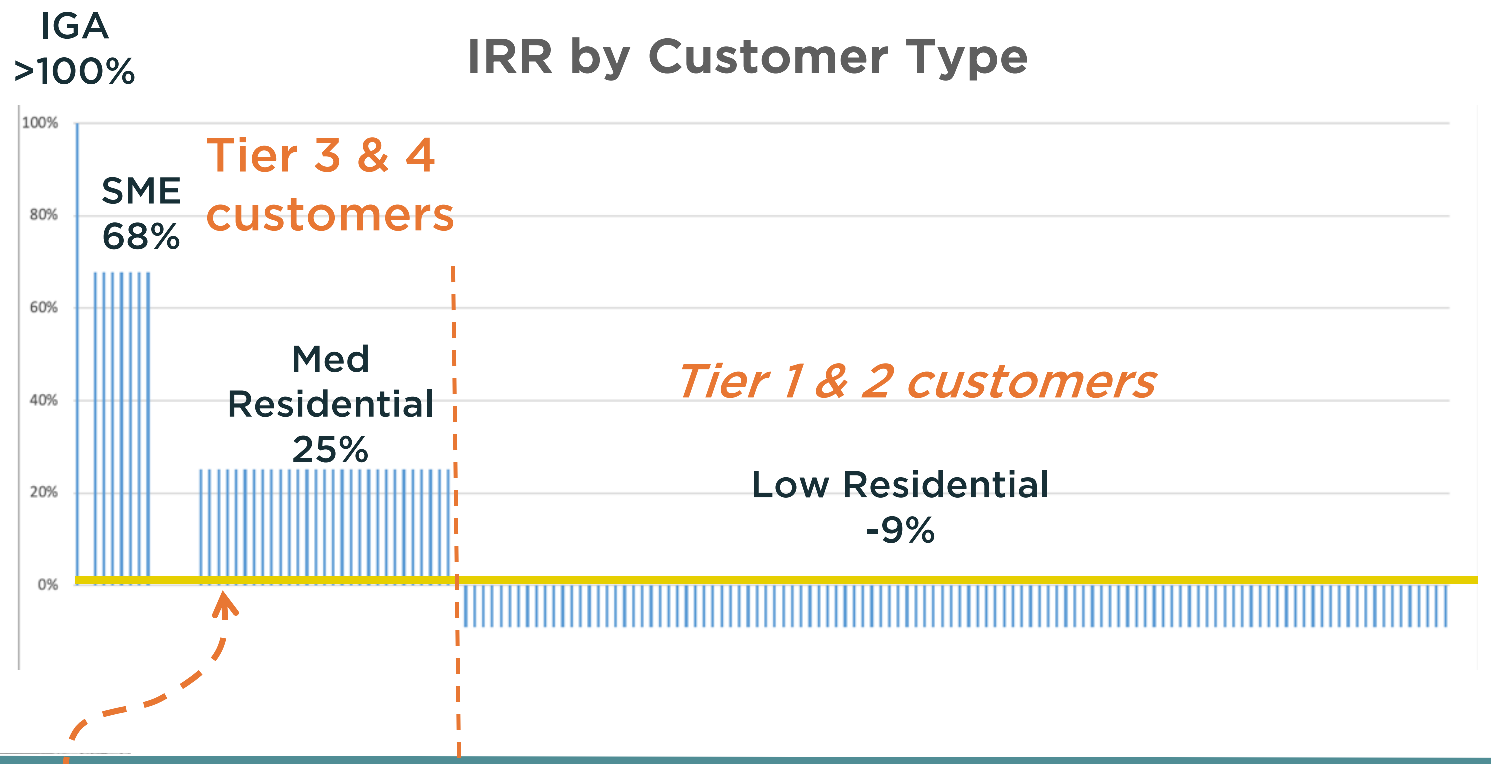
# The Challenge: Energy for Economic Vibrancy

**Diesel** engines or diesel generators still remain the **primary energy source** for many rural communities.

For example, even in the communities with electricity, there is **a lack of highly efficient electric appliances for agri-processing.**

# The Challenge: Minigrid Profitability

A “long tail” of low consuming customers hurt project IRR potential, especially **if there are NO IGA or SME** (small-medium enterprise) customers.




It only takes 1-2 IGA customers: who will they be?

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# The Challenge: Minigrid Profitability

**Minigrids are often oversized for their predicted demand,**

In some case, only **25%** of Predicted Demand

converts to

Actual Demand*

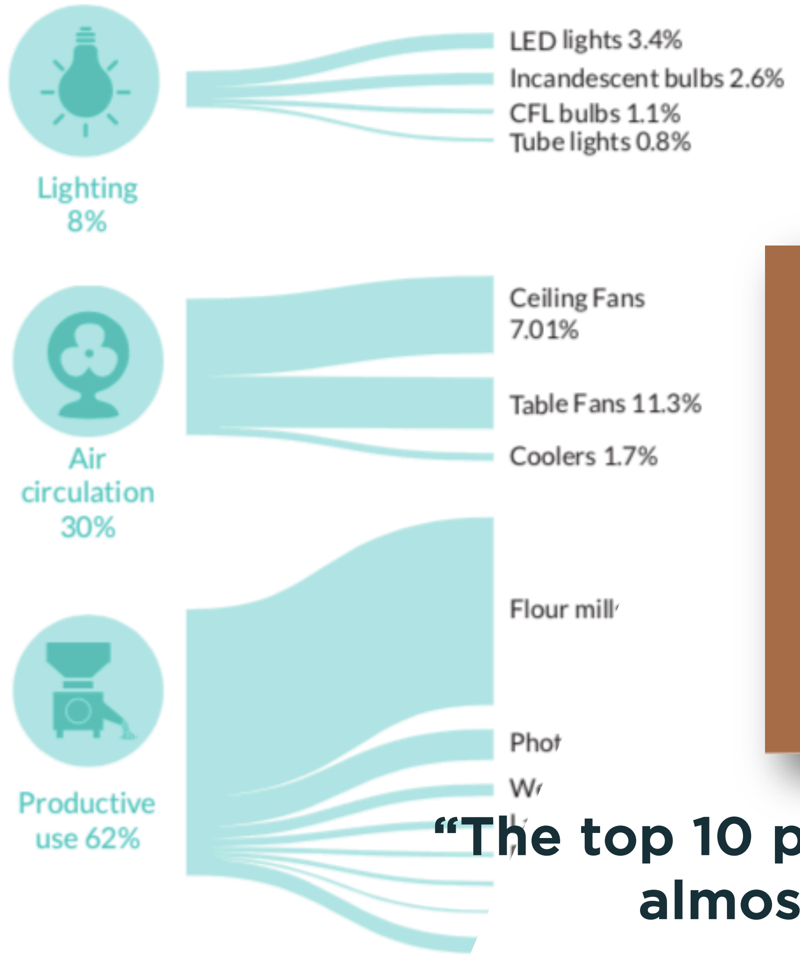
**but under-sizing a minigrid can jeopardize reliability.**

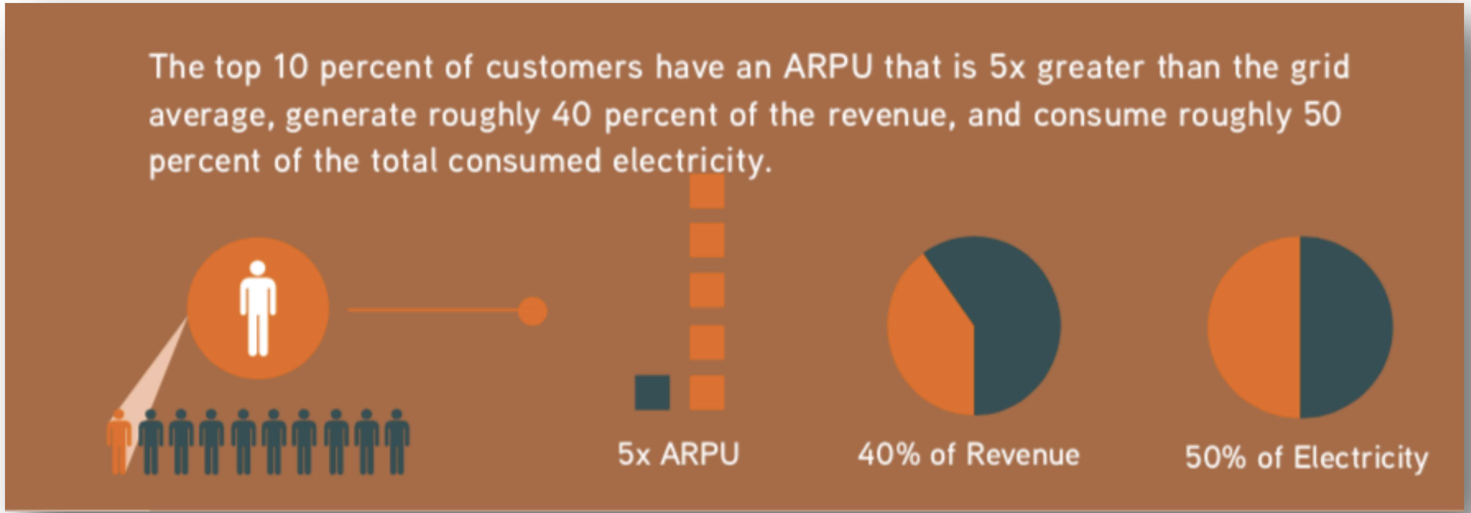
* Blodgett et al. Vulcan *Accuracy of energy-use surveys in predicting rural mini-grid user consumption*

# Solution: Connect the Largest Energy Consumers

The largest energy consumers already exist; they own and operate diesel engines when they could be using electricity.

Many are engaged in agriculture-related activities. Capturing this demand captures a meaningful share of the rural economy.




"The top 10 percent of customers generate an annual ARPU almost 5x that of the portfolio annual ARPU"

\- *Powering Productivity*, Vulcan, Inc.

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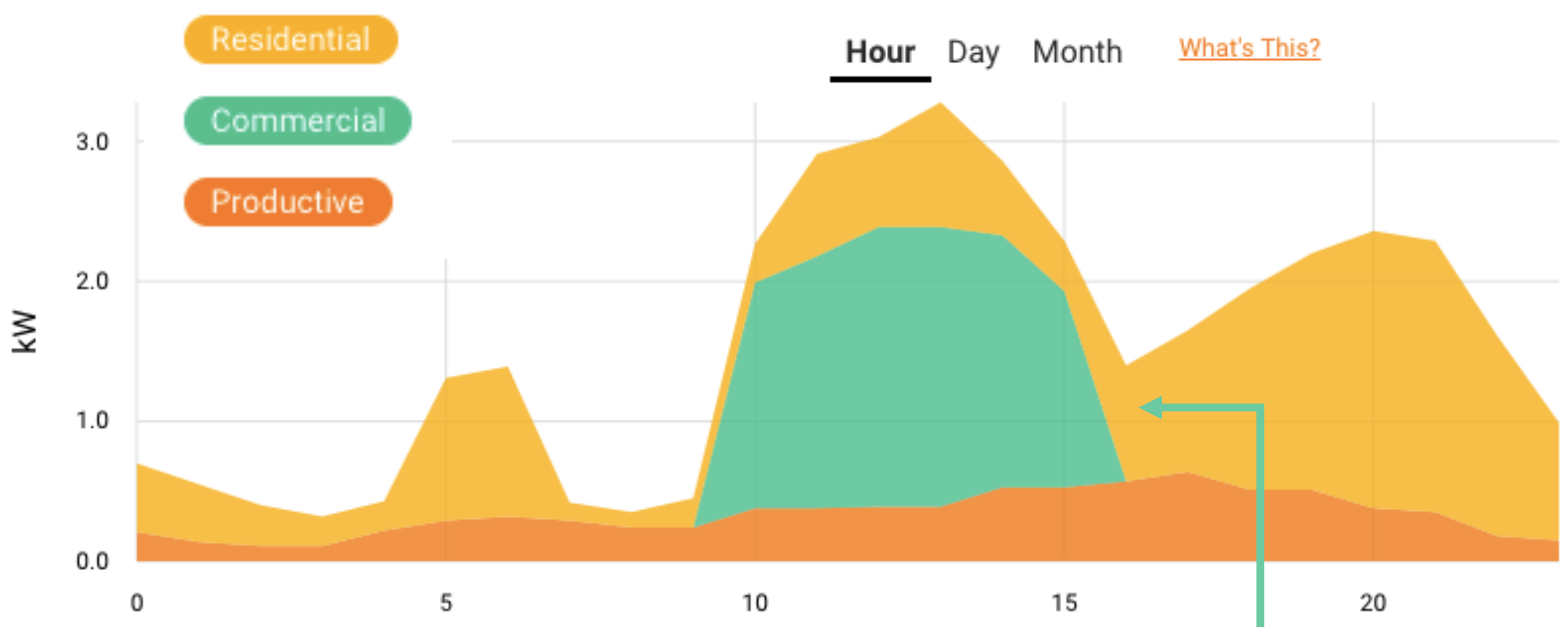
# Income Generating Appliance Effect

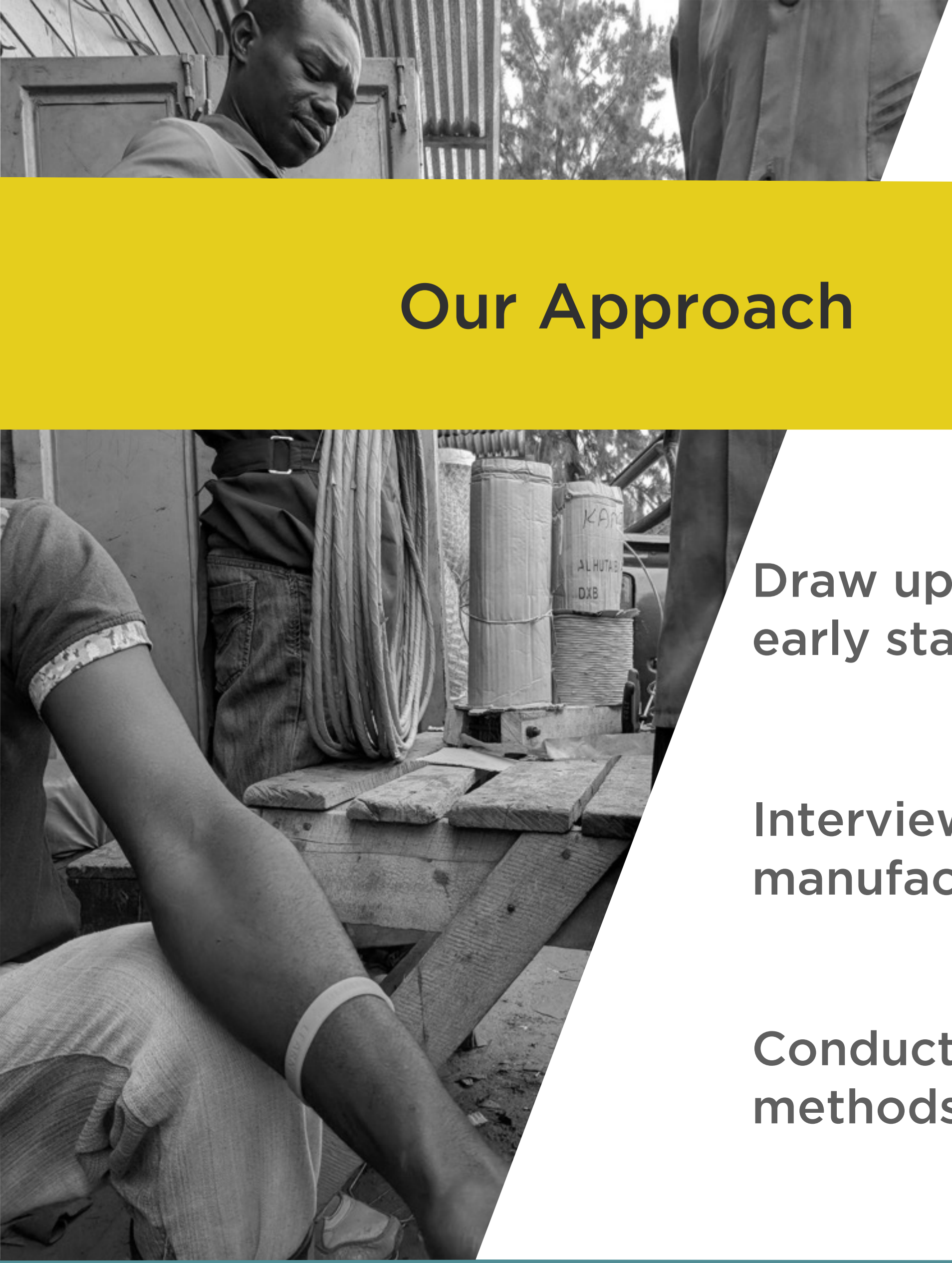



Project IRR = **2-4 percentage points higher** with significant daytime-only load

Cost of electricity = **$0.17/kWh cheaper** with “business heavy load profiles”

**Income generating appliances are already widely used, and could be a predictable source of daytime revenue for minigrids.**

**Takeaway:** business-heavy load profile results in increased IRR, reduced capital expenditures (CAPEX), operating expenditures, and LCOE values.



# Our Approach

## An **informed** and **guided** approach to appliance selection

Draw upon experience working in-market with early stage companies working related fields

Experience-driven insights

Interviewed stakeholders: appliance manufacturers, minigrid developers, financiers

Identification of needs and gaps

Conducted a literature review for off-grid test methods, productive-use studies, etc.

Survey of pre-existing work

# Framing the Investigation

Powering **income generating appliances** with **remote, renewable** electric power systems is not straight-forward

**Technical**

- Energy consumption
- Power specification
- Efficiency
- Power system / appliance compatibility

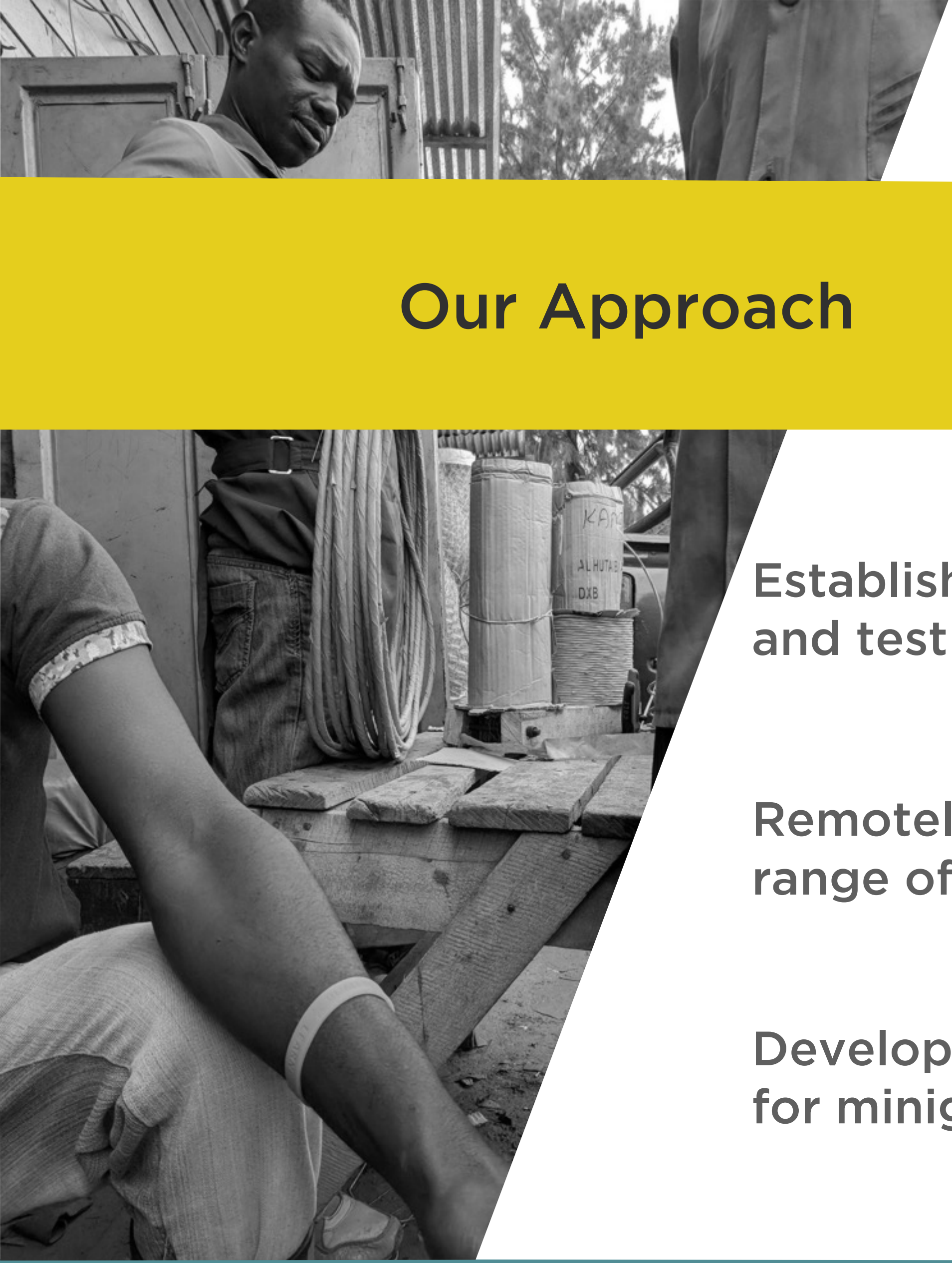
**Economic**

- Value proposition
- Working capital

**Supply Chain**

- Global procurement
- Shipping
- Distribution

Prioritize the right appliances and the right approach



# Our Approach

## An **informed** and **guided** approach to appliance selection

Establish open-access appliance test methods and test representative appliances

Remotely monitor appliances operating under a range of conditions

Develop an interactive appliance selection tool for minigrid operators

High Resolution Laboratory Testing

Low Resolution On the Ground Sensing

Online Decision Making TEA

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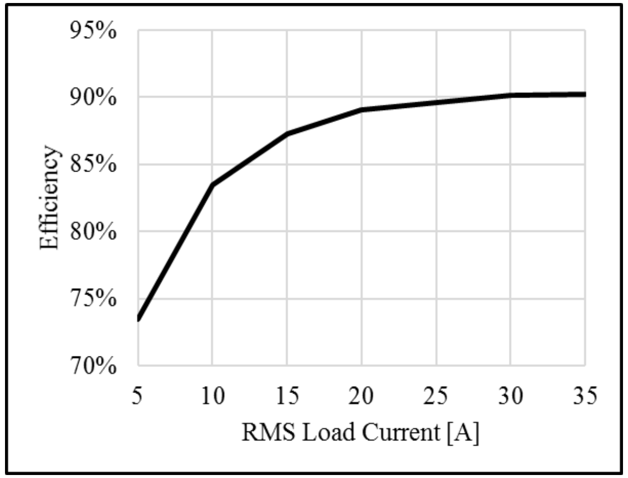
# Filling Knowledge Gaps Along the Way

## Characteristics

*What is the productivity?*

*What is the Efficiency?*

*What additional equipment is needed?*

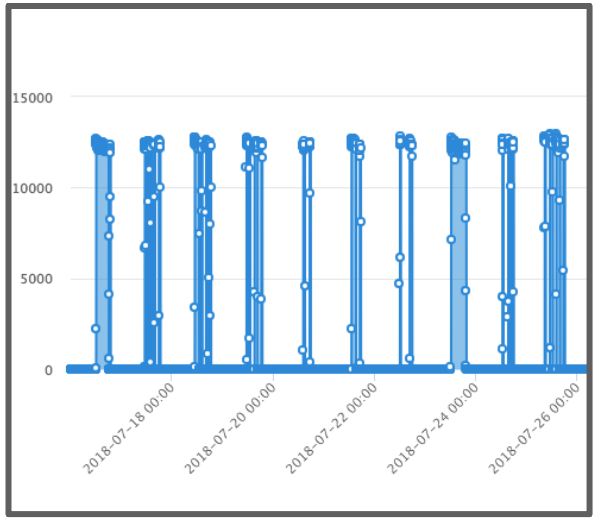



## Use-Patterns

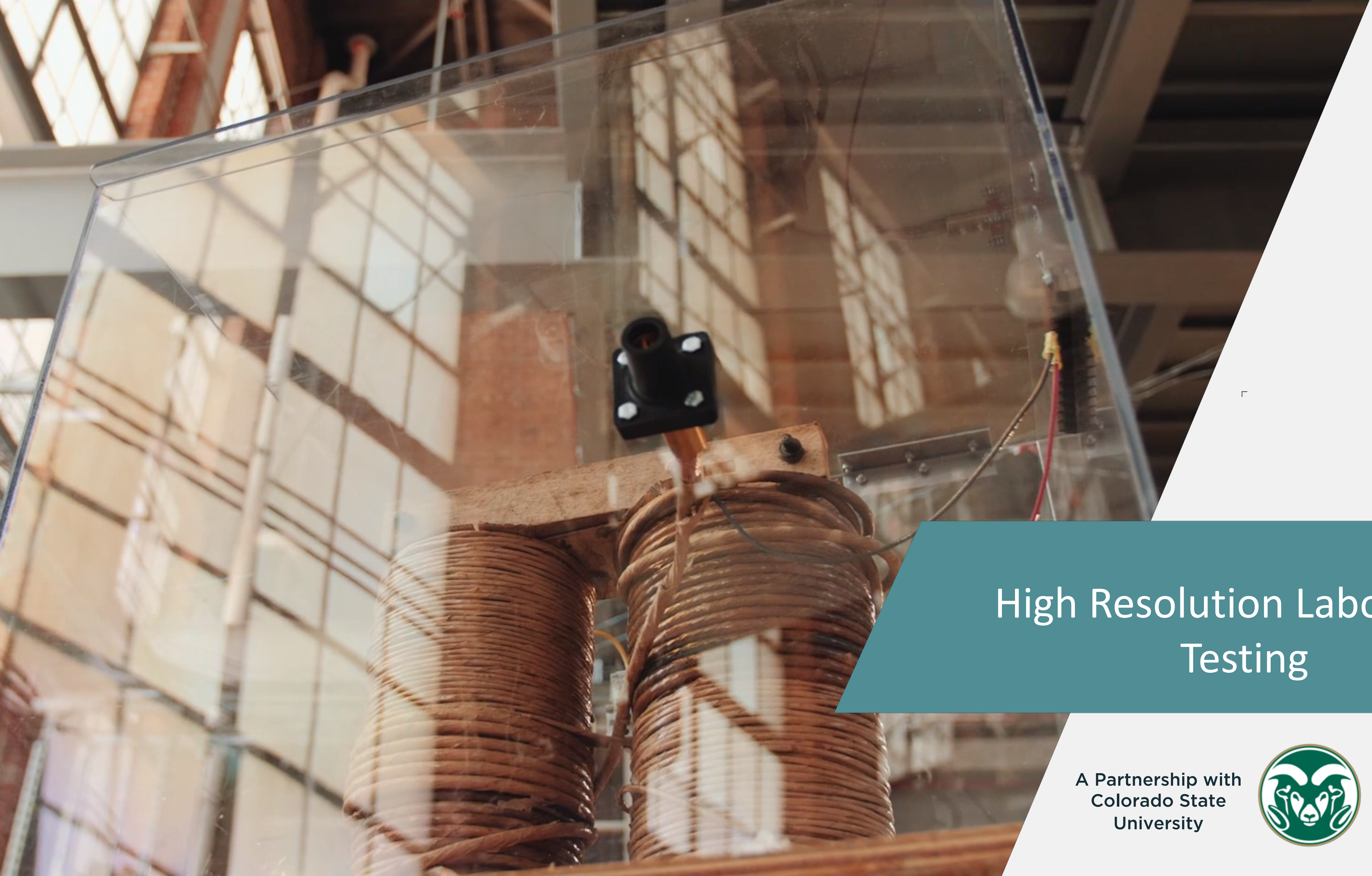
*How much solar and battery are needed?*

*What time of day is the appliance active?*

*What is the utilization?*




*Informed* Techno-Economic Analysis



# High Resolution Laboratory Testing

A Partnership with Colorado State University

# Appliances We Sourced for Testing


Futurepump Solar Water Pump: Made in India

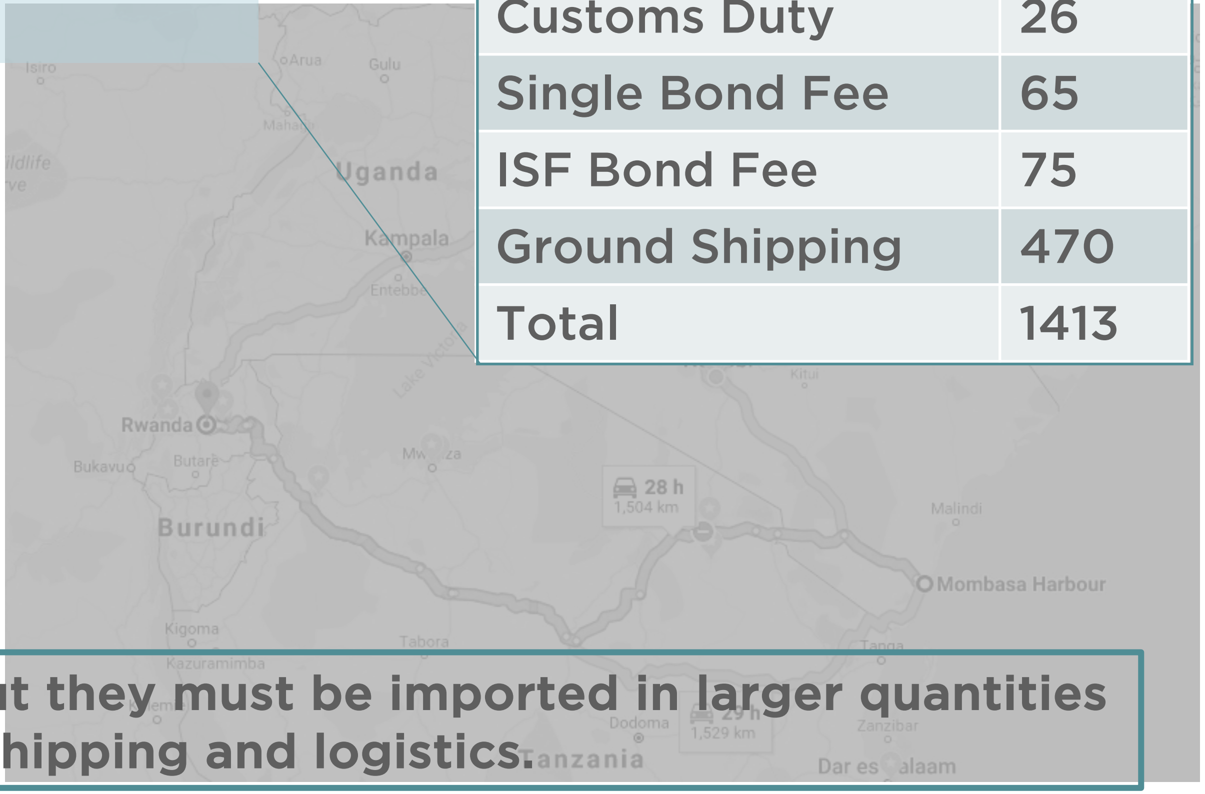
Informal Stick Welder: Made in Rwanda

Multi-Purpose Agricultural Mill: Made in China

# Side Note: The Expense of Appliance Sourcing

| Shipping & Duties (percent of total costs) | Mill |
|---|---|
| | 85% |

| Mill | 250 |
|---|---|
| Sea Freight | 150 |
| Shanghai Charges | 312 |
| Destination Charges | 315 |
| Customs Duty | 26 |
| Single Bond Fee | 65 |
| ISF Bond Fee | 75 |
| Ground Shipping | 470 |
| Total | 1413 |


**Relevant appliances are manufactured globally, but they must be imported in larger quantities to spread out the costs of shipping and logistics.**

Shipping to Fort Collins, Colorado (a landlocked state) might be similar to shipping to a remote or landlocked part of East Africa.

# Laboratory Methods and Testing

**Method:** modified IEC 62253 with unique test bench
**Variables:** flow rate, head, voltage, current, and efficiency over time
**Variations:** small and large pulley

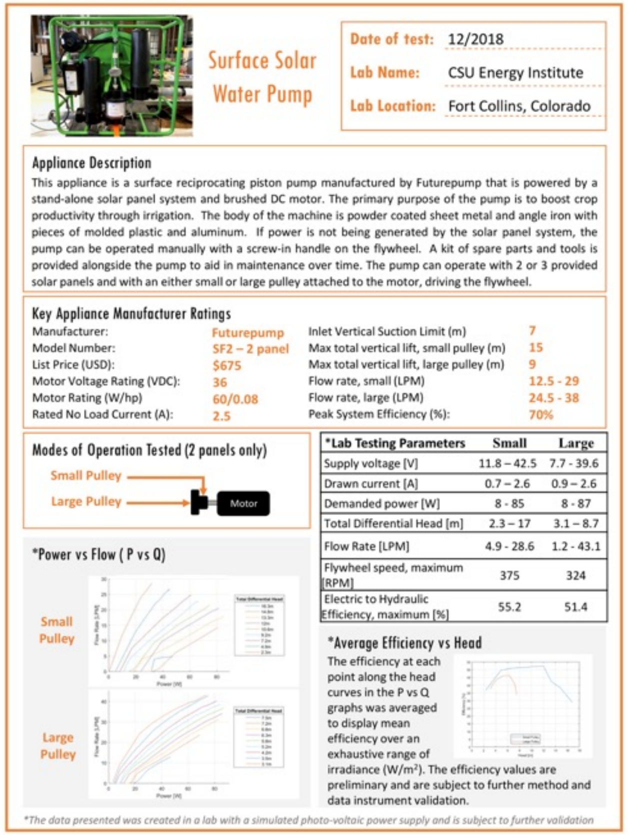
**Method:** original to CSU
**Variables:** grain throughput, voltage, current, efficiency, RPM, harmonic distortion over time
**Variations:** coarse and fine screen size

**Method:** original to CSU
**Variables:** throughput, voltage, current, efficiency and, harmonic distortion over time
**Variations:** short and long arc

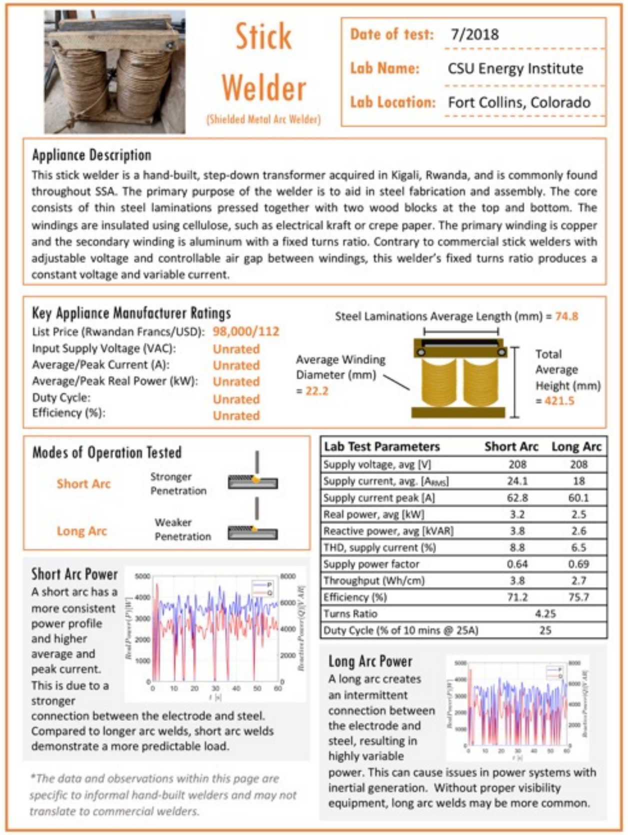
# Lab Test Takeaways

POWER FOR ALL | PEAK BETA

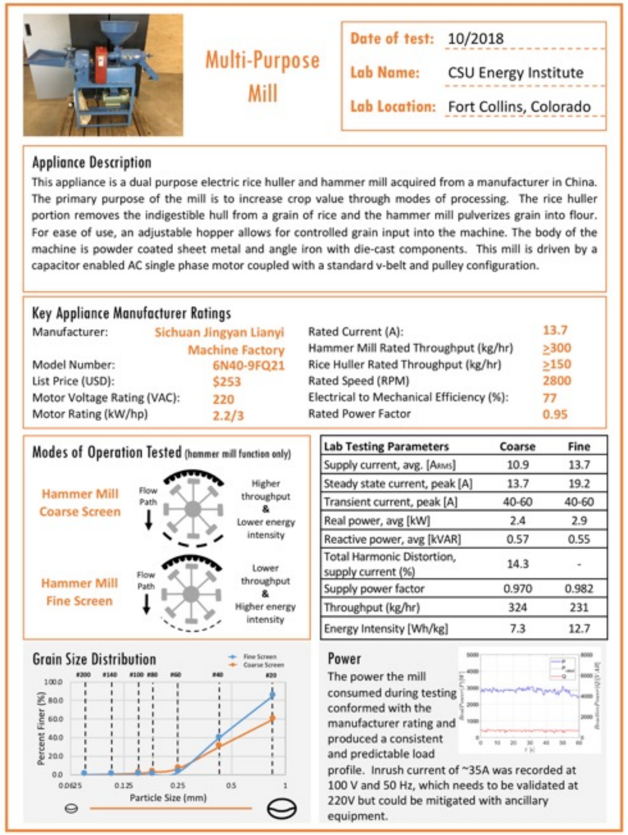
## Pump




## Welder




## Mill



# Stick Welder

(Shielded Metal Arc Welder)

| | |
|---|---|
| Date of test: | 7/2018 |
| Lab Name: | CSU Energy Institute |
| Lab Location: | Fort Collins, Colorado |

## Appliance Description

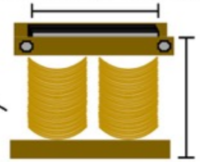
This stick welder is a hand-built, step-down transformer acquired in Kigali, Rwanda, and is commonly found throughout SSA. The primary purpose of the welder is to aid in steel fabrication and assembly. The core consists of thin steel laminations pressed together with two wood blocks at the top and bottom. The windings are insulated using cellulose, such as electrical kraft or crepe paper. The primary winding is copper and the secondary winding is aluminum with a fixed turns ratio. Contrary to commercial stick welders with adjustable voltage and controllable air gap between windings, this welder's fixed turns ratio produces a constant voltage and variable current.

## Key Appliance Manufacturer Ratings

| | |
|---|---|
| List Price (Rwandan Francs/USD): | 98,000/112 |
| Input Supply Voltage (VAC): | Unrated |
| Average/Peak Current (A): | Unrated |
| Average/Peak Real Power (kW): | Unrated |
| Duty Cycle: | Unrated |
| Efficiency (%): | Unrated |

Steel Laminations Average Length (mm) = 74.8

Average Winding Diameter (mm) = 22.2

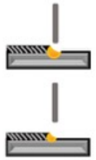


Total Average Height (mm) = 421.5

## Modes of Operation Tested

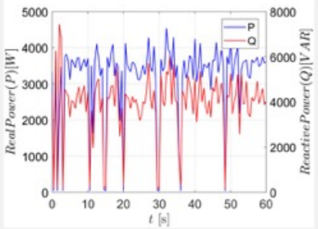
Short Arc — Stronger Penetration

Long Arc — Weaker Penetration



| Lab Test Parameters | Short Arc | Long Arc |
|---|---|---|
| Supply voltage, avg [V] | 208 | 208 |
| Supply current, avg. [$A_{RMS}$] | 24.1 | 18 |
| Supply current peak [A] | 62.8 | 60.1 |
| Real power, avg [kW] | 3.2 | 2.5 |
| Reactive power, avg [kVAR] | 3.8 | 2.6 |
| THD, supply current (%) | 8.8 | 6.5 |
| Supply power factor | 0.64 | 0.69 |
| Throughput (Wh/cm) | 3.8 | 2.7 |
| Efficiency (%) | 71.2 | 75.7 |
| Turns Ratio | 4.25 | |
| Duty Cycle (% of 10 mins @ 25A) | 25 | |

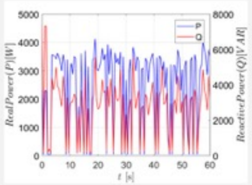
### Short Arc Power




A short arc has a more consistent power profile and higher average and peak current. This is due to a stronger connection between the electrode and steel. Compared to longer arc welds, short arc welds demonstrate a more predictable load.

**The data and observations within this page are specific to informal hand-built welders and may not translate to commercial welders.*

### Long Arc Power




A long arc creates an intermittent connection between the electrode and steel, resulting in highly variable power. This can cause issues in power systems with inertial generation. Without proper visibility equipment, long arc welds may be more common.

# Welder Test Overview

- **Welders CAN be powered by a minigrid** as long as batteries are exporting power to the AC bus and input current does not exceed smart meter breaker ratings
- **Welder power consumption varies widely** and is influenced by arc strength; better welding technique could smooth out variability
- **Power factor and efficiency of informal welders is mediocre**; if better power factor is desired, industrially manufactured welders (inverter type) may be used

# Multi-Purpose Mill

| | |
|---|---|
| Date of test: | 10/2018 |
| Lab Name: | CSU Energy Institute |
| Lab Location: | Fort Collins, Colorado |

## Appliance Description

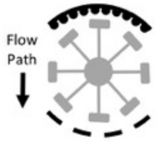
This appliance is a dual purpose electric rice huller and hammer mill acquired from a manufacturer in China. The primary purpose of the mill is to increase crop value through modes of processing. The rice huller portion removes the indigestible hull from a grain of rice and the hammer mill pulverizes grain into flour. For ease of use, an adjustable hopper allows for controlled grain input into the machine. The body of the machine is powder coated sheet metal and angle iron with die-cast components. This mill is driven by a capacitor enabled AC single phase motor coupled with a standard v-belt and pulley configuration.

## Key Appliance Manufacturer Ratings

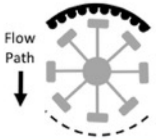
| | | | |
|---|---|---|---|
| Manufacturer: | Sichuan Jingyan Lianyi Machine Factory | Rated Current (A): | 13.7 |
| | | Hammer Mill Rated Throughput (kg/hr) | ≥300 |
| Model Number: | 6N40-9FQ21 | Rice Huller Rated Throughput (kg/hr) | ≥150 |
| List Price (USD): | $253 | Rated Speed (RPM) | 2800 |
| Motor Voltage Rating (VAC): | 220 | Electrical to Mechanical Efficiency (%): | 77 |
| Motor Rating (kW/hp) | 2.2/3 | Rated Power Factor | 0.95 |

## Modes of Operation Tested (hammer mill function only)

Hammer Mill Coarse Screen

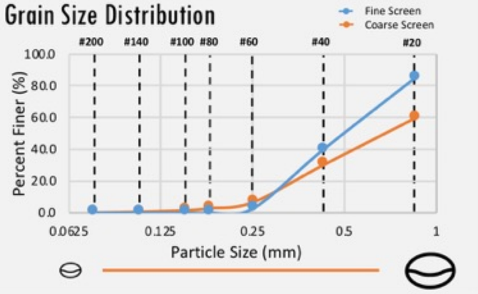



Hammer Mill Fine Screen

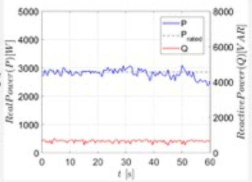



| Lab Testing Parameters | Coarse | Fine |
|---|---|---|
| Supply current, avg. [ARMS] | 10.9 | 13.7 |
| Steady state current, peak [A] | 13.7 | 19.2 |
| Transient current, peak [A] | 40-60 | 40-60 |
| Real power, avg [kW] | 2.4 | 2.9 |
| Reactive power, avg [kVAR] | 0.57 | 0.55 |
| Total Harmonic Distortion, supply current (%) | 14.3 | - |
| Supply power factor | 0.970 | 0.982 |
| Throughput (kg/hr) | 324 | 231 |
| Energy Intensity [Wh/kg] | 7.3 | 12.7 |

## Grain Size Distribution




## Power



The power the mill consumed during testing conformed with the manufacturer rating and produced a consistent and predictable load profile. Inrush current of ~35A was recorded at 100 V and 50 Hz, which needs to be validated at 220V but could be mitigated with ancillary equipment.

# Mill Test Overview

- Smaller, electrically powered mills CAN be powered by minigrids, and appear to have similar throughput as larger, more inefficient diesel mills
- High in-rush current from 1-phase motors must be mitigated by soft starters or 3-phase motors with a star-delta starter
- Poor motor construction can lead to high THD (as in this case)
- This particular motor exhibited good power factor and mediocre electrical efficiency (70%) but can be switched out for a better motor
- Milling maize into fine flour required 1.7x more energy

## Surface Solar Water Pump

**Date of test:** 12/2018
**Lab Name:** CSU Energy Institute
**Lab Location:** Fort Collins, Colorado

### Appliance Description

This appliance is a surface reciprocating piston pump manufactured by Futurepump that is powered by a stand-alone solar panel system and brushed DC motor. The primary purpose of the pump is to boost crop productivity through irrigation. The body of the machine is powder coated sheet metal and angle iron with pieces of molded plastic and aluminum. If power is not being generated by the solar panel system, the pump can be operated manually with a screw-in handle on the flywheel. A kit of spare parts and tools is provided alongside the pump to aid in maintenance over time. The pump can operate with 2 or 3 provided solar panels and with an either small or large pulley attached to the motor, driving the flywheel.

### Key Appliance Manufacturer Ratings

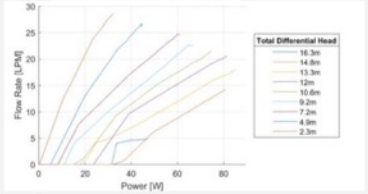
| | | | |
|---|---|---|---|
| Manufacturer: | Futurepump | Inlet Vertical Suction Limit (m) | 7 |
| Model Number: | SF2 – 2 panel | Max total vertical lift, small pulley (m) | 15 |
| List Price (USD): | $675 | Max total vertical lift, large pulley (m) | 9 |
| Motor Voltage Rating (VDC): | 36 | Flow rate, small (LPM) | 12.5 - 29 |
| Motor Rating (W/hp) | 60/0.08 | Flow rate, large (LPM) | 24.5 - 38 |
| Rated No Load Current (A): | 2.5 | Peak System Efficiency (%): | 70% |

### Modes of Operation Tested (2 panels only)

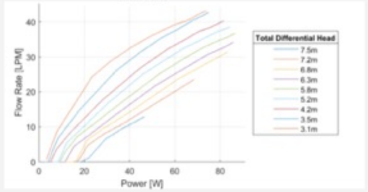

| *Lab Testing Parameters | Small | Large |
|---|---|---|
| Supply voltage [V] | 11.8 – 42.5 | 7.7 - 39.6 |
| Drawn current [A] | 0.7 – 2.6 | 0.9 – 2.6 |
| Demanded power [W] | 8 - 85 | 8 - 87 |
| Total Differential Head [m] | 2.3 – 17 | 3.1 – 8.7 |
| Flow Rate [LPM] | 4.9 - 28.6 | 1.2 - 43.1 |
| Flywheel speed, maximum [RPM] | 375 | 324 |
| Electric to Hydraulic Efficiency, maximum [%] | 55.2 | 51.4 |

### *Power vs Flow ( P vs Q)

Small Pulley

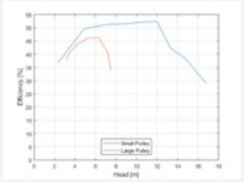



Large Pulley

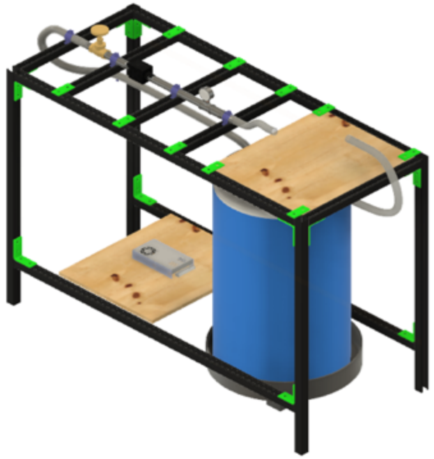


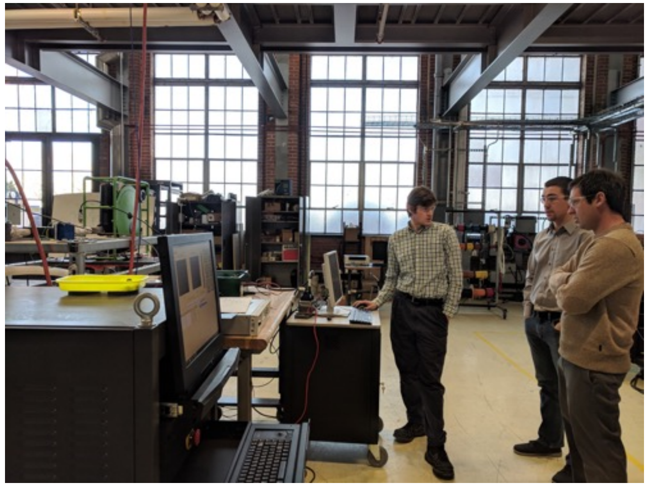

### *Average Efficiency vs Head

The efficiency at each point along the head curves in the P vs Q graphs was averaged to display mean efficiency over an exhaustive range of irradiance ($W/m^2$). The efficiency values are preliminary and are subject to further method and data instrument validation.



*The data presented was created in a lab with a simulated photo-voltaic power supply and is subject to further validation





# Pump Test Overview

- Pumps were the most difficult and demanding to test with the most widely varying results
- Technically, a pump of this power draw is a “friendly” load to a minigrid (however, was designed to be solar compatible)
- Small (<500W) solar pumps - if paired with a power converter - CAN operate on an AC minigrid. Value proposition is best without long distribution lines; consider other pump-minigrid business models
- Manufacturer performance test methods vary widely, but CLASP is developing new off-grid testing methods, which will help standardize solar water pump performance ratings

- *We only purchase assets locally, because* ***we don't know the performance or quality of foreign machines.***
  – East Africa Minigrid Developer

- *Many thanks for sharing the test results from this Chinese machine,* ***those are some really exciting numbers.***
  - East Africa Minigrid Developer

# Testimonials

- *As a water pump manufacturer, we are really happy to see 3rd-party testing. It helps us get* ***objective performance results that customers can trust****.*
  - Appliance manufacturer

- *Our inventor is interested to engage with you further on your test protocols* ***the industry certainly needs more of this****, and we will support it if we can.*
  - Appliance manufacturer



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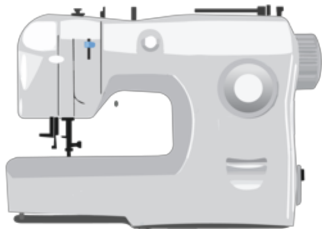
# Low Resolution On the Ground Sensing

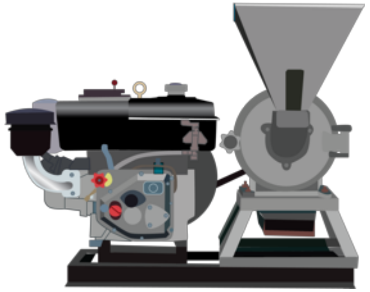
A Partnership with
Minigrid Developers

# Appliance Selection



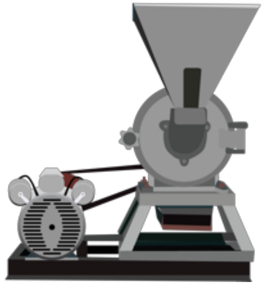
Sewing Machines

Welders



Diesel Mills

Refrigerators

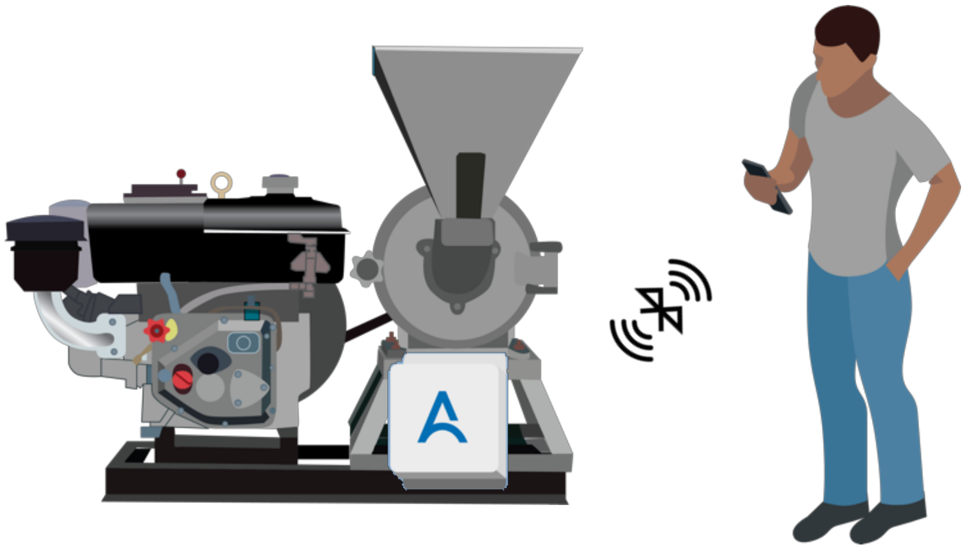


Electric Mills

Chilling Units

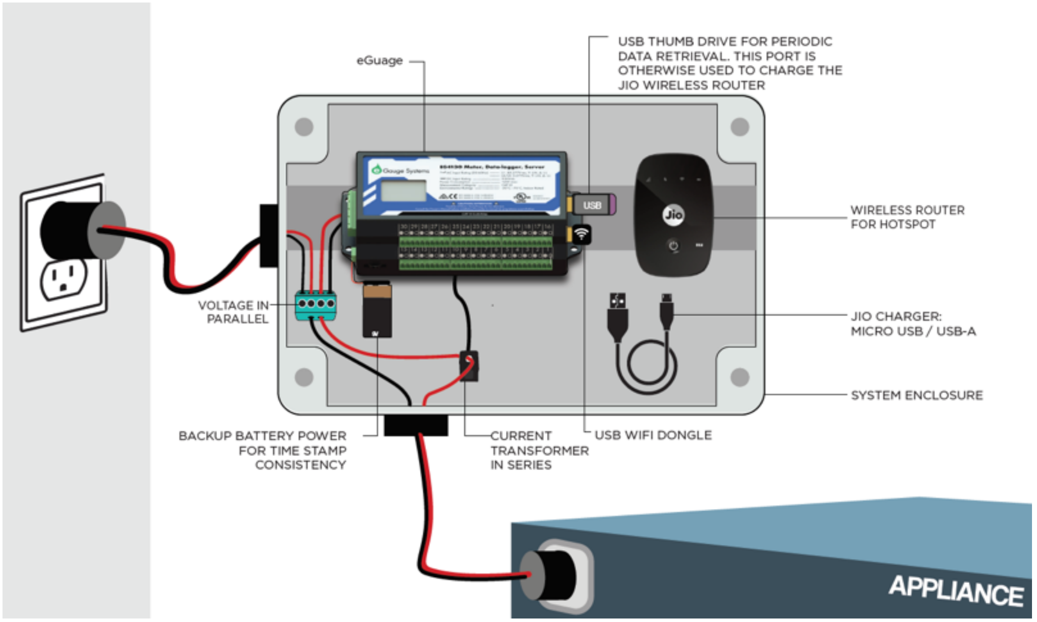
# Sensing Approach

## Rotational Speed Sensing
*Arch Systems, California*



Low energy
Local Bluetooth pickup

## Electrical Sensing
eGauge, Colorado




Cellular hotspot connectivity
USB thumb drive local pickup

# EQuota Energy:
# Data Disaggregation

*Investigating lighter-touch methods of higher-fidelity appliance use-pattern discovery*


- 20 smart meters with household and SME appliances
- EQuota uses a trained algorithm to disaggregate loads from an overall smart meter load profile
- End result will be a web-based dashboard and .csv files

# Data Gathering – Use Patterns

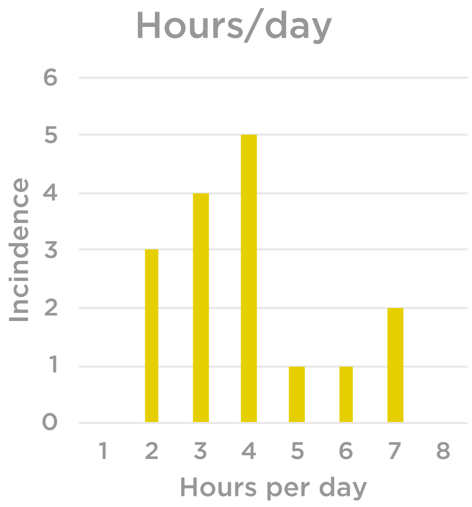
Diesel Mill RPM Monitoring

Welder Monitoring

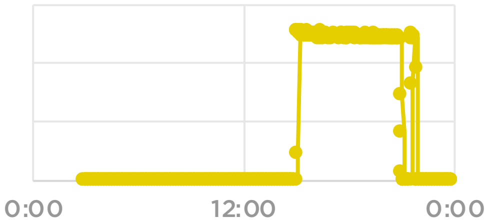

Sewing/Tailoring Monitoring

# Data Gathering: Use-Patterns

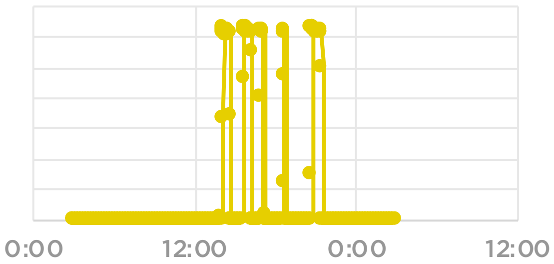
*Sensors quietly pick up the daily habits of people in the community. This community has a market day on Mondays, which is represented in the data.*



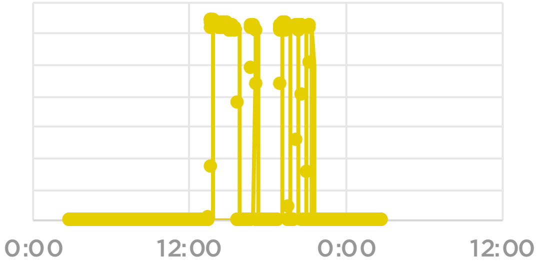

MONDAY



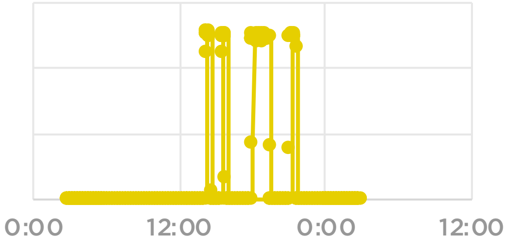

TUESDAY



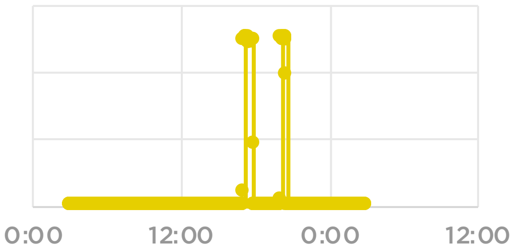

WEDNESDAY



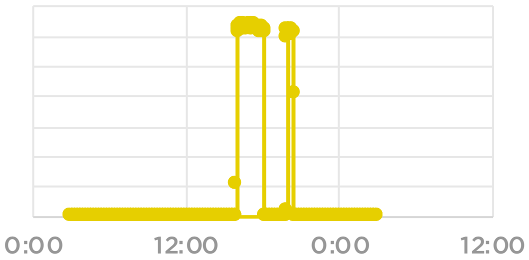

THURSDAY



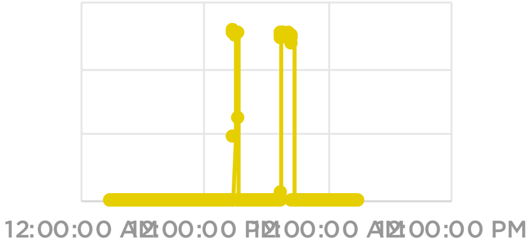

FRIDAY




SATURDAY




SUNDAY



# Data Gathering: Use-Patterns

***Real data illuminates the real conditions.***

*With surveys, appliance owners always(20-300%)* ***overestimated*** *utilization.*

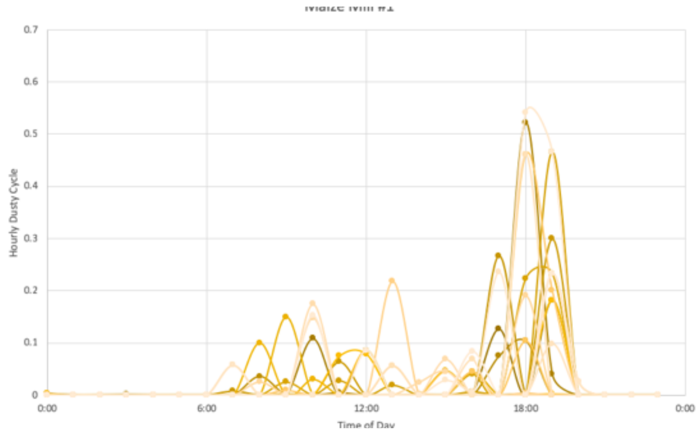
|  |  |  |  |
|---|---|---|---|

| | Maize Mill #1 | Maize Mill #2 | Rice Huller | Welder |
|---|---|---|---|---|
| Average Hours in Operation (Daily) | 1.4 | 3.36 | 2 | 0.2 |
| Average Utilization (total waking hrs.) | 9% | 21% | 12% | 1% |
| Daytime Operation | 63% | 95% | 91% | 89% |
| Dusk/Night time Operation | 37% | 5% | 8% | 11% |

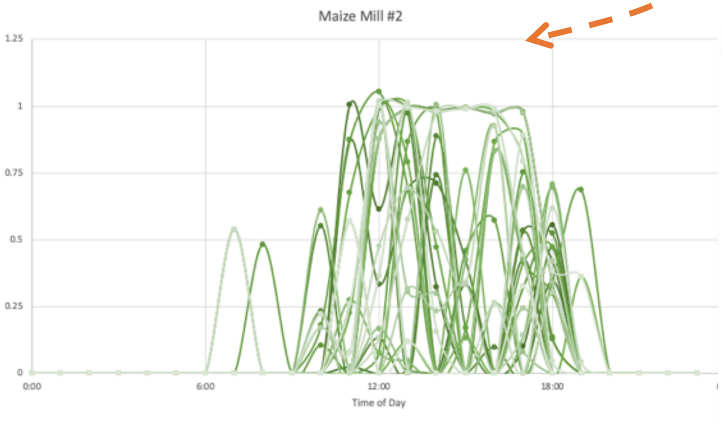
# Data Gathering: Use-Patterns

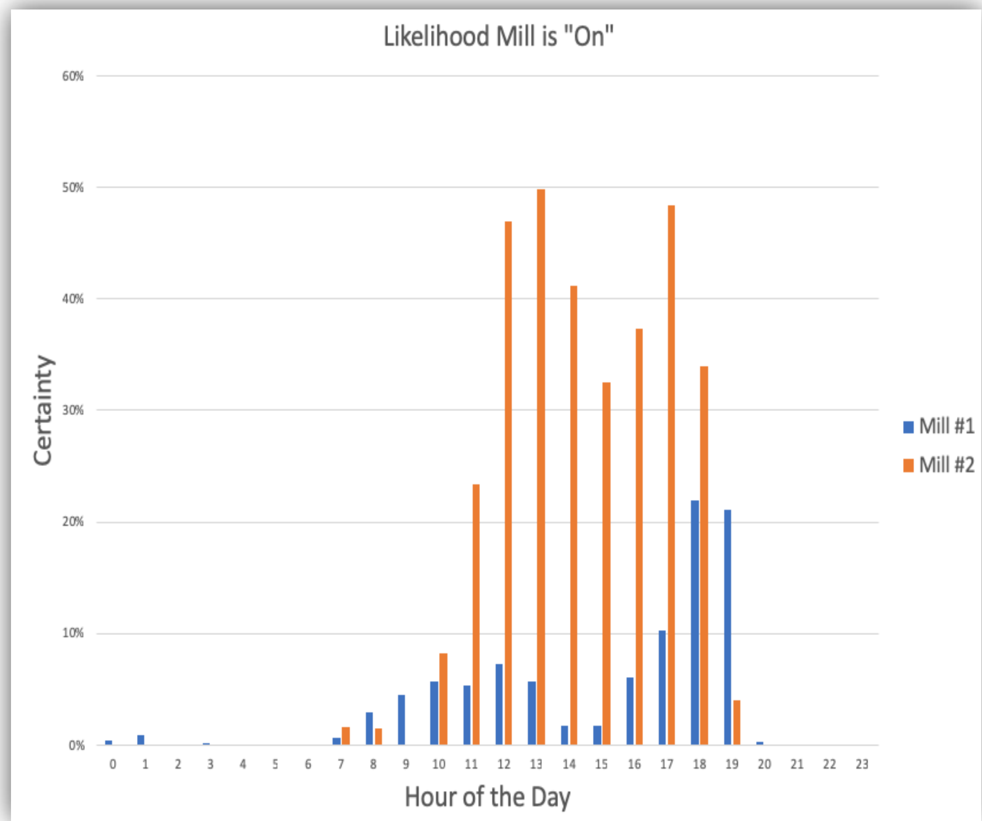
**Real data, sampled and extrapolated out to a yearly load profile**

## Mill #1

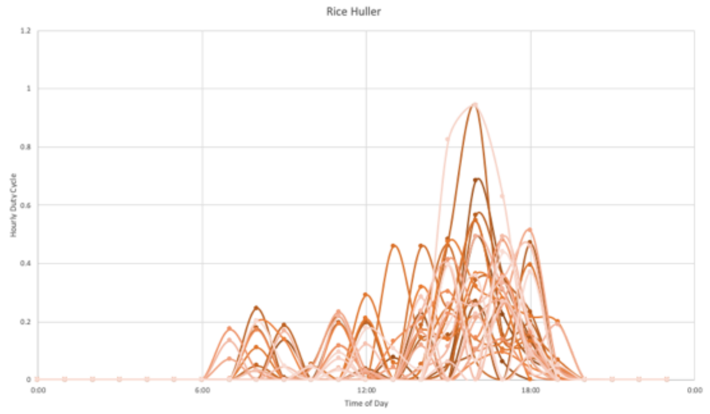



## Mill #2

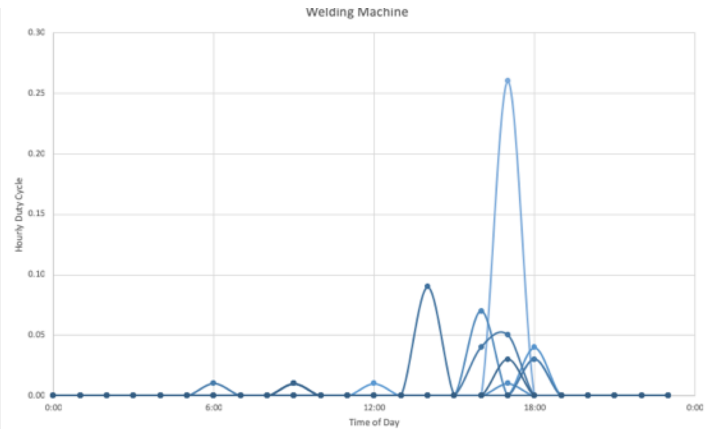



## Rice Huller




## Welding Machine



- *This sensor would be really helpful, because operators can only state their utilization for the last week, and* ***we need better data fidelity to build our power systems.***

  – India Minigrid Developer

- *This tool would be really valuable to any company or organization that is trying to convince the operator of diesel-powered machine* ***to switch to a solar/hybrid model.***

  - Impact Investor

# Testimonials

- *We've met several SMEs who we want to support. For example, there is a local who operates a large (1.5kW) water pump, but* ***we don't have a good way to measure or estimate his energy consumption.***

  - Southeast Asia Minigrid Developer



FACTOR[e] VENTURES

Microgrid Appliance Analysis Tool

**Select Grid File:** 12-50 Oversize 20

**Select Appliance Usage Profile:** Rice Mill (Tanzania)

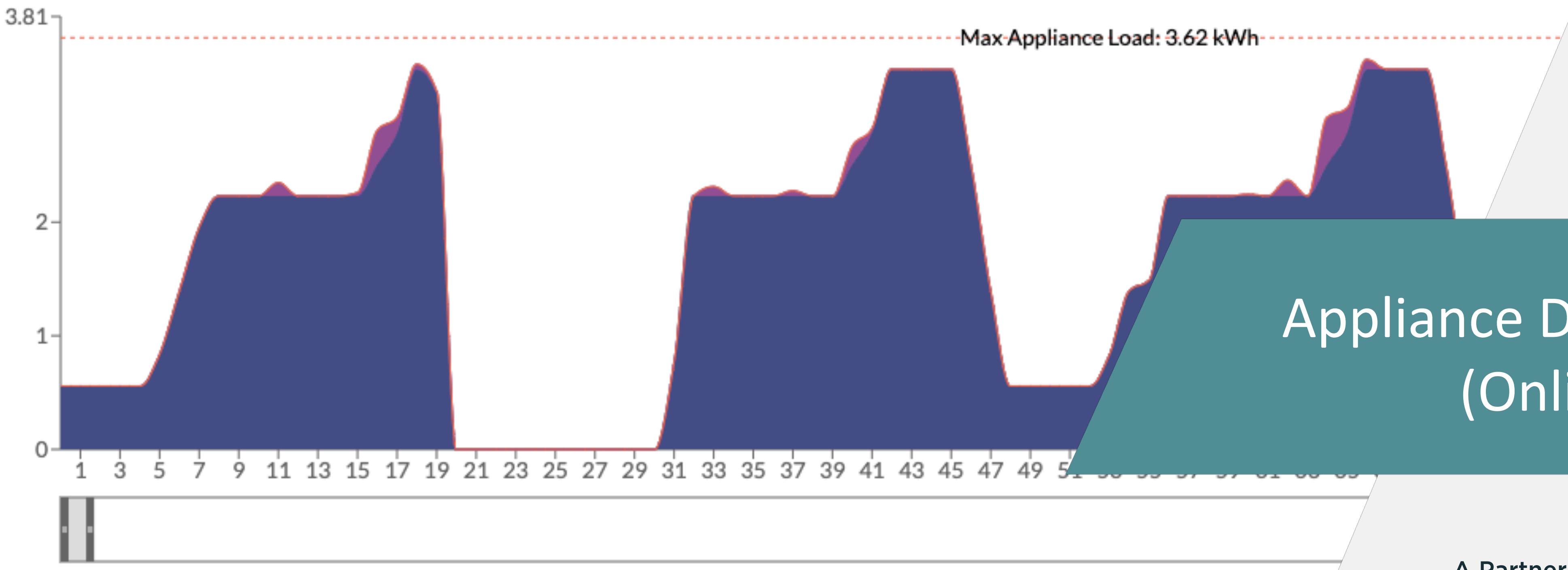
**Selected Ancillary Equi** Soft Starter

Summary | Ancillary Equipment | Data | **Loads** | Time Segments | Battery Energy Content | Grid Components

## Loads by hour of year

Each data point unit is average kW for 1 hour (kWh)

| | |
|---|---|
| Max Appliance Load | 3.62 kWh |
| First hour of year hitting max load | 594 |




**Hour of Year**

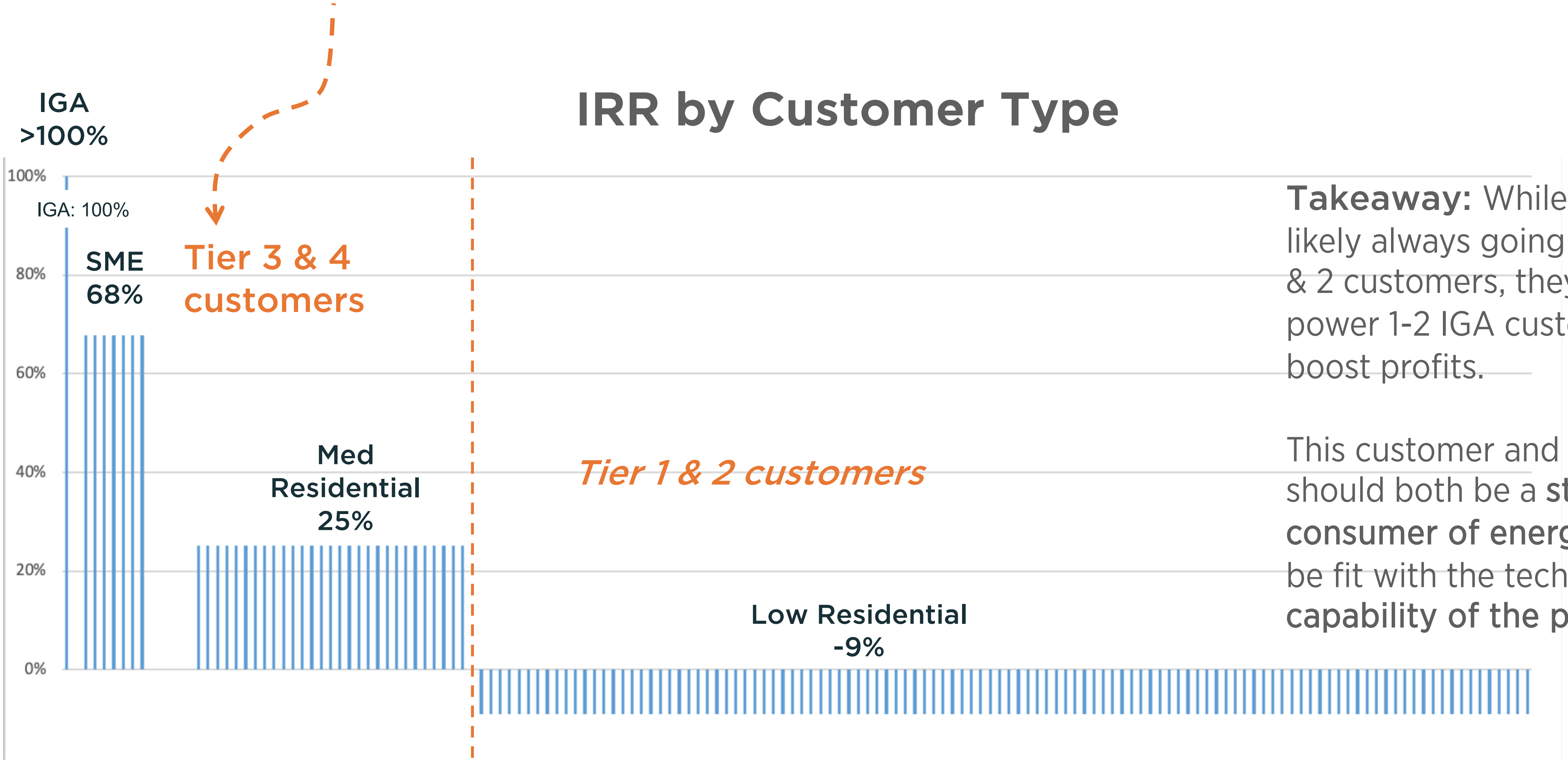
Hover over chart to see details.

Brush and slide grey handle above to explore more hours

# Appliance Decision Making (Online TEA)

A Partnership with Radiant Labs

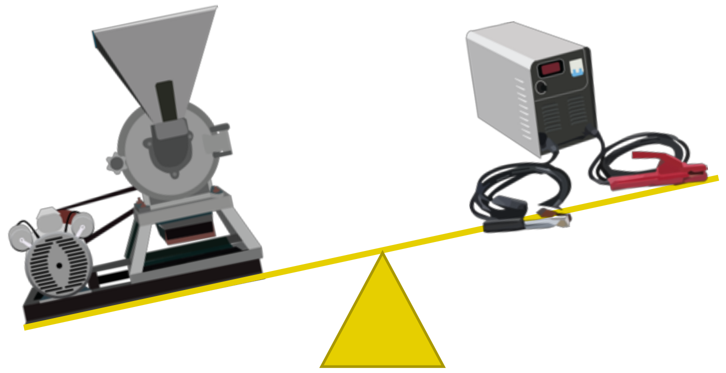
# It only takes 1-2 IGA customers: Who will they be?




**Takeaway:** While minigrids are likely always going to serve Tier 1 & 2 customers, they should also power 1-2 IGA customer to help boost profits.

This customer and appliance should both be a **steady consumer of energy** as well as be fit with the technical **capability of the power system.**

# Solving a multi-variable, multi-stakeholder problem



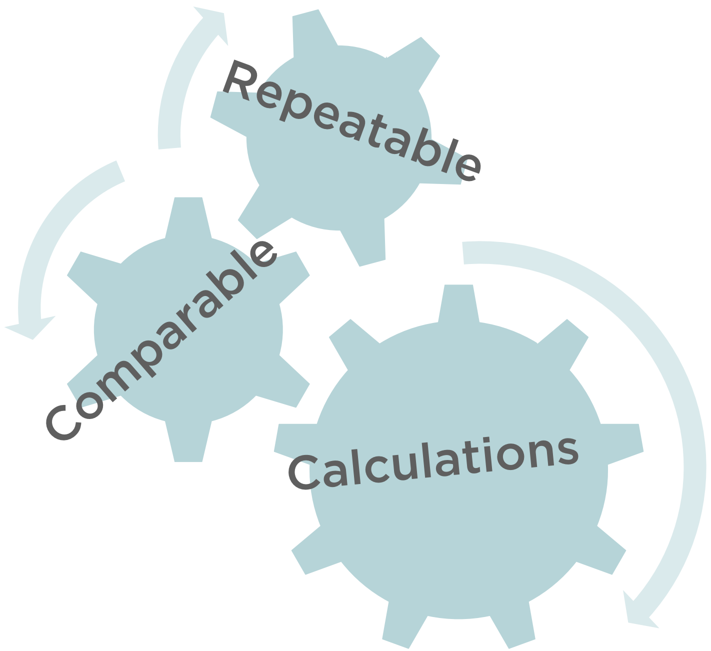
Energy Needs

Performance Characteristics

Ancillary Equipment

Power System

Costs




| Appliance Owner | Grid Operator |
|---|---|

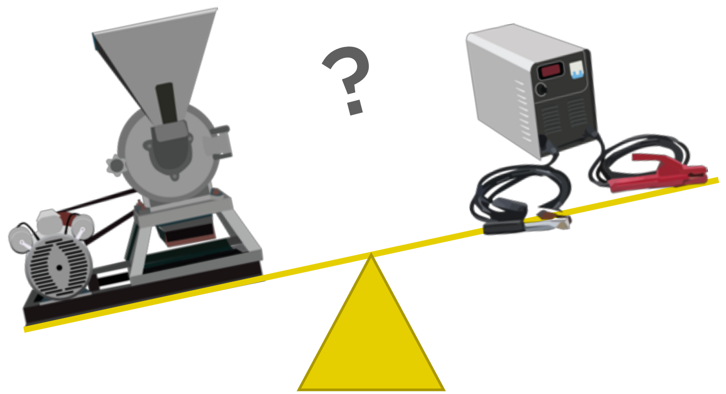
ROI

Simple Payback

Technical Outputs

Compatibility

# Solving a multi-variable, multi-stakeholder problem



Energy Requirements

+

Performance Characteristics

+

Ancillary Equipment

Renewable System

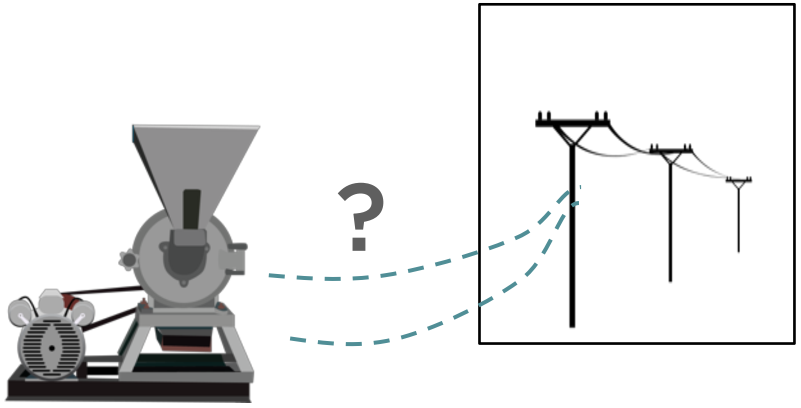
Economic Value Proposition

**Appliance Owner**
- ROI
- Simple Payback

**Electricity Retailer**
- Additional Revenue
- ROI

**Customers**
- Cost of service

# Incorporating Technically-Advanced Characteristics




Ancillary Equipment

| | Overall efficiency | Machine start-up | Safety / Protection | AC/DC Conversion | Cost |
|---|---|---|---|---|---|
| Variable Frequency Drive | ✓ | ✓ | ✓ | ✓ | $$$ |
| Soft Starter | | ✓ | ✓ | | $ |
| Correction Capacitor | ✓ | | | | $$ |
| Inverter | ✓ | | | ✓ | $$ |

# Repeatable Problem-Solving with an Online TEA/calculator

**Select Grid Characteristics:** 12-50 Baseline

**Select Appliance Usage Profile:** Maize Mill (Tanzania)

## Model Inputs

| | |
|---|---|
| Full Capacity Usage Factor to kW | 2.2 |
| Duty Cycle Derate Factor | 1 |
| Usage Factor Seasonal Derate Curve | TBD |
| Wholesale Electricity Cost | 0 |
| Unmet Load Electricity Cost | 0.324 |
| Retail Electricity Price | 0.35 |
| Units of Production per kWh | 136.9 |
| Revenue Per Production Units | 0.0215 |

## Grid Operator Summary

| | |
|---|---|
| Yearly new appliance kWh | 192 kWh |
| Yearly new appliance revenue | $67 |
| Yearly new appliance electricity cost | $0 |
| New appliance unmet load cost | $13 |
| New appliance net revenue | $54 |

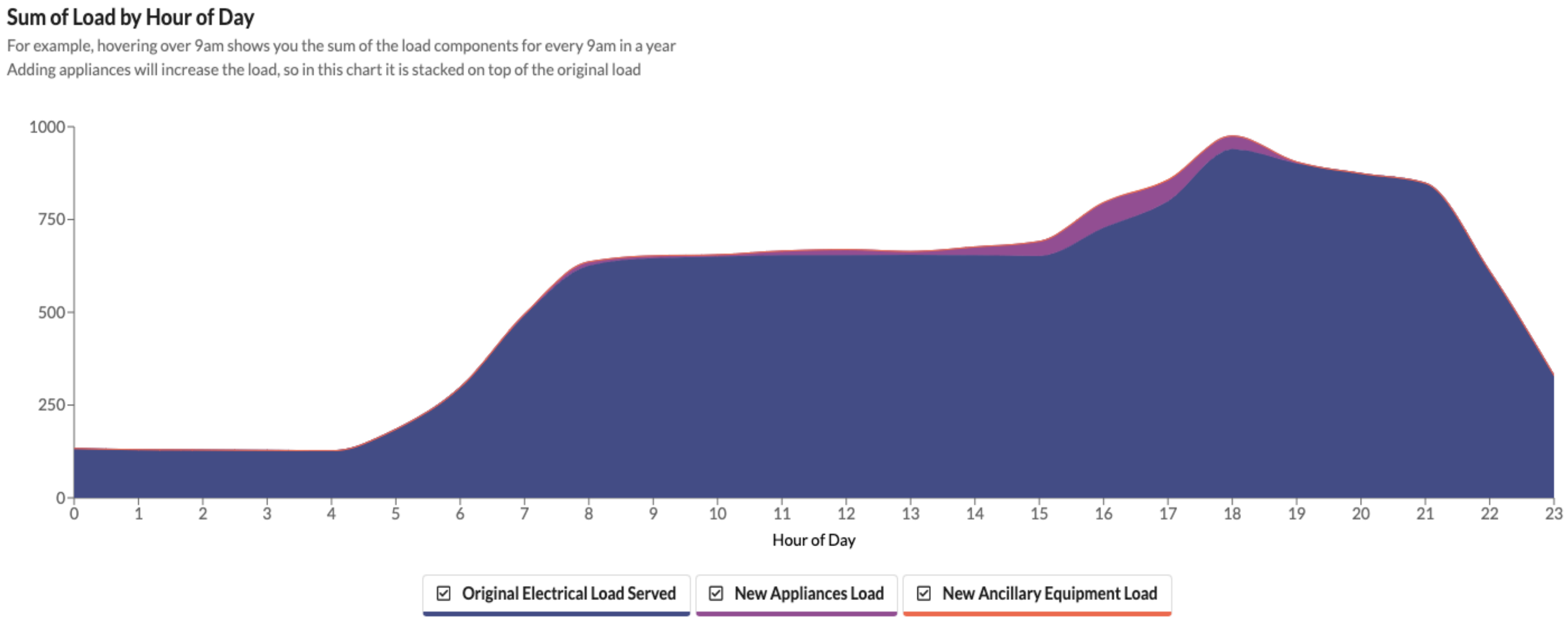
| | Count *hrs/year* | Sum *kWh* | Percent of Year |
|---|---|---|---|
| **Original unmet load** | 572 | 489 | 6.5% |
| **Additional unmet load** | 92 | 40 | 1.1% |
| **Total unmet load** | 616 | 529 | 7% |

## Appliance Operator Summary

| | |
|---|---|
| Yearly kWh from new appliance | 192 kWh |
| Yearly Appliance Electricity Cost | $67 |
| Yearly Units Produced | 26351.881 units |
| Yearly Production Units Revenue | $567 |
| Net Revenue | $499 |

# Example: Evaluating an Electric Grain Mill

The tool lets a minigrid developer know how this new, large appliance will likely affect their ability to meet the new demand with their existing power system. Especially, the time of day in which the power system may fall short of meeting demand.



# Example: Evaluating an Electric Grain Mill

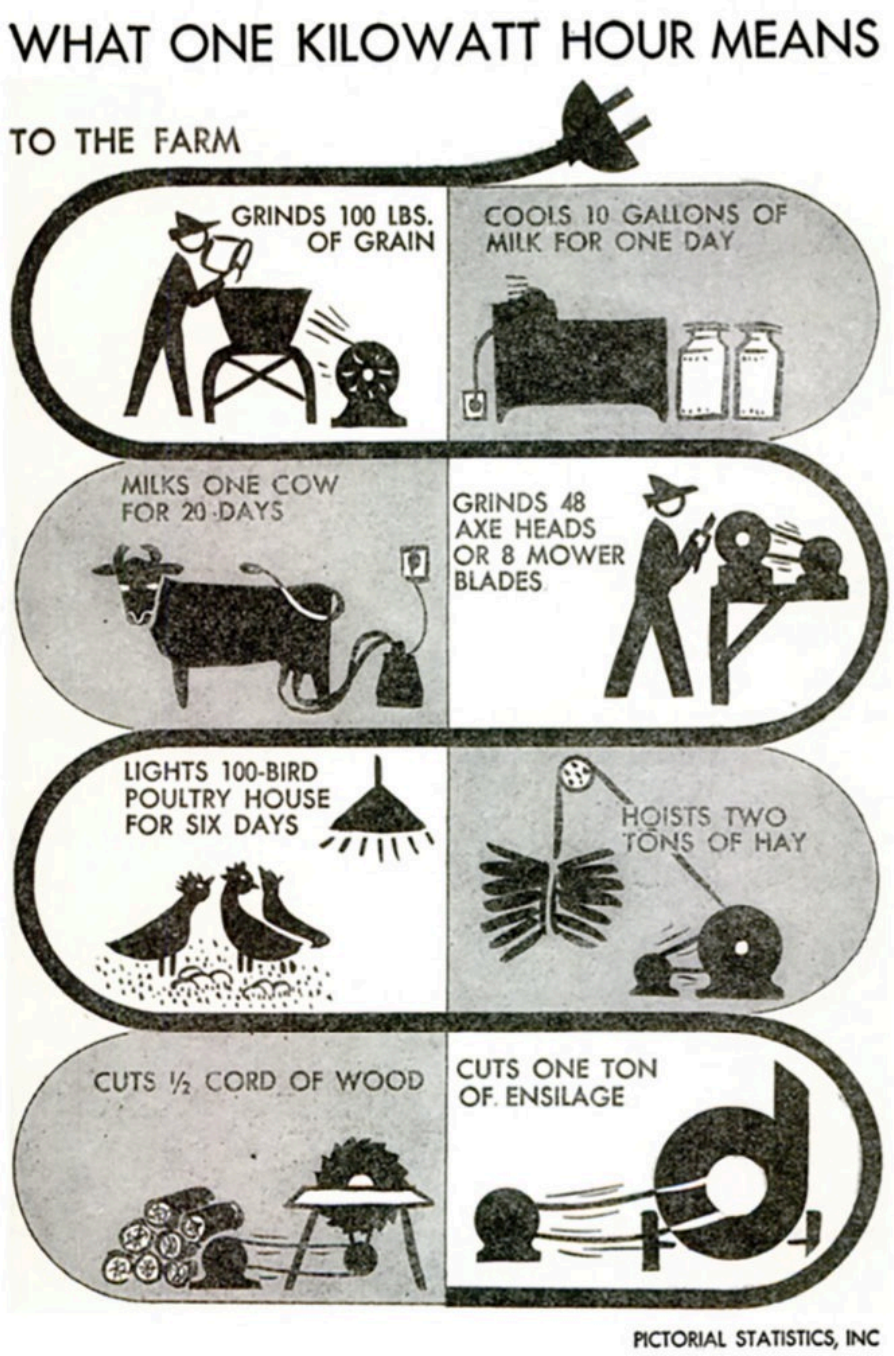
**Takeaway:** Mill #2, which has a more active daily use profile, is far more interesting as an IGA customer for a minigrid than Mill #1. Additionally, the appliance owner of Mill #1 likely doesn't have much incentive to switch energy sources because they don't use the machine as frequently as Mill #2.

<table>
<tr><th colspan="2">Inputs</th><th colspan="5">Electricity Retailer Perspective</th><th colspan="4">Appliance Owner Perspective</th></tr>
<tr><th>Minigrid System Type</th><th>Load Profile</th><th>New appliance load (kwh)</th><th>Net Profit from appliance (USD)</th><th>Original Unmet Load (kWh)</th><th>Add'l Unmet Load (kWh)</th><th>Total Annual Unmet Load (%)</th><th>Grain Milled/ Hulled (kgs)</th><th>Income (USD)</th><th>Net Revenue (USD)</th><th>Simple Payback (months)</th></tr>
<tr><td>Baseline System</td><td>Mill #1</td><td>192</td><td>$ 74</td><td>489</td><td>40</td><td>7.0%</td><td>26,351</td><td>$ 567</td><td>$ 480</td><td>12.5</td></tr>
<tr><td>Baseline System</td><td>Rice Huller</td><td>1034</td><td>$ 448</td><td>489</td><td>55</td><td>7.1%</td><td>141,610</td><td>$ 3,045</td><td>$ 2,579</td><td>2.3</td></tr>
<tr><td>Baseline System</td><td>Mill #2</td><td>2560</td><td>$ 1,127</td><td>489</td><td>77</td><td>7.2%</td><td rowspan="3">350,511</td><td rowspan="3">$ 7,536</td><td rowspan="3">$ 6,384</td><td rowspan="3">0.9</td></tr>
<tr><td>Oversized System</td><td>Mill #2</td><td>2560</td><td>$ 1,140</td><td>129</td><td>36</td><td>2.7%</td></tr>
<tr><td>Undersized System</td><td>Mill #2</td><td>2560</td><td>$ 1,088</td><td>1173</td><td>199</td><td>14.8%</td></tr>
</table>

# Contact us for beta testing!



FACTOR[e] VENTURES




# This has been done before

US electric appliance campaigns in the 1930-50

# Thank You

FACTOR[e] VENTURES