Productive Use of Energy

Experiences from Energy 4 Impact in East Africa

July 2019
Contents

1. Energy 4 Impact: Overview & Snapshot of Activities with PUE in Africa

2. Productive Use of Electricity (PUE) Business Models

3. PUE Standalone

4. PUE Mini-Grids

5. PUE Grid Extension

6. Impact on Electricity Providers
1. Energy 4 Impact

Our Approach

**Productive Rural Communities Hub**

**Appliance financing**
- Scale up PUE financing (grant)
- Launch Challenge fund rounds to tackle specific PUE bottlenecks
- Calls for funding to all innovative partnerships
- Collaborate with investors to de-risk

**Advisory services**
- Contextualisation
- Demand stimulation strategy
- Product market entry, payment and end-user finance
- Improve the viability and maximise the social impact of electrification programmes

**Micro business incubators**
- Business, PUE, finance, sales, route-to-market mentoring
- Informal economy
- Focus on strategic value chains
- Improve livelihoods

**Learning, demonstrating, scaling**
- Solid M&E&L system
- Research with academics and businesses
- Partnerships
- Disseminate knowledge about technologies, business models, financing schemes
- Advocacy
1. Energy 4 Impact

Mapping Our PUE Interventions

PRODUCTIVE USE OF ENERGY: Across Africa, E4I helps to power off-grid areas to enable businesses and boost productivity to improve livelihoods.

**Off-Grid**
- 20+ MGs advised on PUE, Grid Extension
- PUE strategy, demand assessment stimulation, data mgmt
- Standalone Systems (milling, cooling, irrigation)

**Businesses**
- 700 Businesses in on- and off-grid villages in Tz
- 4,000 businesses supported globally
- 10,000 Jobs created

**Tools**
- Financial instruments & Appliance Financing
- PUE Toolkit & PUE Value Chain Mapping
- Testing PUE appliances
1. Energy 4 Impact

PUE Portfolio at a Glance

Funders

Programs total Value of $ 9.4 Million (current)

- Mini-grid support
- Grid extension
- PUE Action Research
- Hypotheses Testing & Implementation
- PUE Mapping in 15 African countries
- Appliance Financing
- Appliance Field Testing
- Market Development for solar irrigation
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Productive Use of Electricity

Why PUE?

- Increase **uptake of electricity**
- Reach critical level of sales to secure **financial viability** to electricity providers
- PUs enhance the **economic & social development impacts** (sustainable electricity consumption)
- **Matching electricity demand – supply**: shift demand from times of lower renewable resource availability to times of higher availability through DSM
## 2. PUE Business Models

<table>
<thead>
<tr>
<th>Business Model</th>
<th>Power Provider</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Sales (kWh)/ Consumption Based</td>
<td>Revenue ($/kWh)</td>
<td>CAPEX + electricity cost</td>
</tr>
<tr>
<td>Anchor Clients</td>
<td>E.g. 30% from anchor client ($/kWh)</td>
<td></td>
</tr>
<tr>
<td>Leasing and Financing of Appliances</td>
<td>Electricity ($/kWh) + Financial Income</td>
<td>Op CF needs to support asset repayments</td>
</tr>
<tr>
<td>Electricity as a Service</td>
<td>Revenue ($/unit) for product/service</td>
<td>No CAPEX, electricity cost</td>
</tr>
<tr>
<td>Energy Hubs/Centers</td>
<td>Revenue = rent (incl. electricity cost)</td>
<td>No CAPEX, electricity cost + rental cost</td>
</tr>
<tr>
<td>Franchise Model</td>
<td>Franchise fee</td>
<td></td>
</tr>
<tr>
<td>Stand-alone systems</td>
<td>Product sales PAYGO</td>
<td>High CAPEX, no/ low OPEX</td>
</tr>
</tbody>
</table>
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1. Energy 4 Impact: Overview & Snapshot of Activities with PUE in Africa

2. Productive Use of Electricity (PUE) Business Models

3. PUE Standalone
   - Phone Charging
   - Micro EPs (salons, TV show, etc.)
   - Refrigeration
   - Milling
   - Irrigation
   - Social Institutions

4. PUE Mini-Grids

5. PUE Grid Extension

6. Impact on Electricity Providers
PUE Standalone

Phone Charging
Micro EPs
Refrigeration
Milling
Irrigation
Social Institutions
### 3. PUE Standalone

**Phone Charging**

<table>
<thead>
<tr>
<th><strong>Business Model</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Charge up to 50-60 phones/ day (each charge takes 2 to 3 hours)</td>
</tr>
<tr>
<td>Revenues of USD 0.3-0.6/ charge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Technology</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Early tech: panels, battery, charge controller and other components separately, which needed technical expertise for assembly and installation</td>
</tr>
<tr>
<td>Current tech: solar charging kits</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Market</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers tend to charge their phones 2 times per week</td>
</tr>
<tr>
<td>Enterprises worked with: 556 in Tanzania</td>
</tr>
</tbody>
</table>
### 3. PUE Standalone

#### Micro Businesses

Many micro and small businesses conduct several income generating activities simultaneously.

<table>
<thead>
<tr>
<th>PUE Activity</th>
<th>PUE Equipment</th>
<th>Power Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail Shop</td>
<td>Light</td>
<td>&lt; 10W</td>
</tr>
<tr>
<td>Entertainment</td>
<td>Radio</td>
<td>&lt; 100W</td>
</tr>
<tr>
<td></td>
<td>Music system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TV</td>
<td></td>
</tr>
<tr>
<td>Refrigeration</td>
<td>Fridge</td>
<td>150 – 200W</td>
</tr>
<tr>
<td></td>
<td>Freezer</td>
<td></td>
</tr>
<tr>
<td>Salon</td>
<td>Hair cutter</td>
<td>20W</td>
</tr>
<tr>
<td></td>
<td>Hair dryer</td>
<td></td>
</tr>
</tbody>
</table>
3. PUE Standalone

Refrigeration

<table>
<thead>
<tr>
<th>Business Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Household refrigeration for food storage</td>
</tr>
<tr>
<td>2. Small commercial refrigeration for retail (cold drinks, dairy)</td>
</tr>
<tr>
<td>3. Small commercial ice-makers for agricultural or other</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>• AC (incl. inverter) vs. DC</td>
</tr>
<tr>
<td>Cost:</td>
</tr>
<tr>
<td>• AC on average USD 250</td>
</tr>
<tr>
<td>• DC at USD 600 – 1,000 and above</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Market is nascent: on-grid testing conducted; Prize Award for innovations (OG DC fridges/ freezers)</td>
</tr>
<tr>
<td>• Affordability: financing solutions needed for HH and business (PAYGO)</td>
</tr>
</tbody>
</table>
3. PUE Standalone

Milling

| Business Model | • Increase farmer revenue  
|               | • Promote food security  
|               | • Ability and willingness to pay for milling services and milled produce |
| Technology    | • Hammer, plate and stone mills  
|               | Energy Source:  
|               | • Electricity, incl. mini-grid (AC) (10 kWp+)  
|               | • Diesel engine  
|               | • Standalone solar (DC) (1,200 W)  
|               | Cost:  
|               | • Electric motor USD 500  
|               | • Electric mill approx. USD 2,000 |
| Market        | • Maize  
|               | • Millet  
|               | • Sorghum  
|               | • Milling revenues: main-grid USD 0.02-0.03; mini-grid USD 0.11-0.13; diesel USD 0.04 – 0.06 |
3. PUE Standalone

Irrigation

| Business Model | • Develop ecosystem for solar powered irrigation  
|                | • Not enough data to prove the business model  
|                | • Savings on diesel cost                       |

| Technology     | • Pumps: Ennos Sunlight (surface water), Future Pump (submersible)  
|                | • Plug ‘n Play  
|                | Power need:  
|                | • 375 Wp pump (Ennos)  
|                | • 700 Wp pump (Future pump)  
|                | Cost:  
|                | • Up to USD 5,000 |

| Market         | • Smallholder farmers (1-2 ha)  
|                | • Low farmers’ awareness  
|                | • Maize and horticulture (different payback periods)  
|                | • 10 demo sites in Rwanda  
|                | • Distributors are key in market access (manufacturers don’t distribute) |
### 3. PUE Standalone

#### Social Institutions

<table>
<thead>
<tr>
<th>Business Model</th>
<th>Technology</th>
<th>Market</th>
</tr>
</thead>
</table>
| • Improve quality of education in remote schools  
• Incorporate ICT | • 800W, 400AmH Batteries, 1000W Inverters, Wiring | • Equipment like: tablets/ computer laboratories, printers, staff laptops, mobile phones  
• Lighting: evening classes; security lighting in boarding facilities  
• Increase teachers morale |
| | | • Prolong night-time service provision;  
• Provide faster emergency response;  
• Power essential medical equipment; cold chain for vaccines, blood and medicines;  
• Attract and retain skilled health workers; |
| | | • Availability and quality of essential health care access to life-saving interventions  
• Reduce child and mother mortality |
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## 4. PUE Mini-Grids

### Value Chain Analysis and Business Case Assessment

<table>
<thead>
<tr>
<th>Categories</th>
<th>Role of Electricity</th>
<th>VC Analysis at Village Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Primary industries (agriculture, fishing, etc.),</td>
<td>• <strong>Enabler</strong> of a product/service (e.g. ice making),</td>
<td>• Local production, processing and marketing and assess value-addition opportunities for electrification</td>
</tr>
<tr>
<td>• Light manufacturing (carpentry, welding, ice making),</td>
<td>• <strong>Catalyst</strong> that improves a product (e.g. electric milling)</td>
<td>• Techno-economic considerations</td>
</tr>
<tr>
<td>• Commercial and retail enterprises (phone charging, groceries, hair salons, etc.)</td>
<td>• <strong>Differentiator</strong> that changes the customer experience (e.g. cold drinks)</td>
<td></td>
</tr>
</tbody>
</table>

*Note: This analysis is based on the experience of Energy 4 Impact based on the TA work provided and a PU mapping exercise.*
## 4. PUE Mini-Grids

### Other Demand Stimulation Activities

<table>
<thead>
<tr>
<th>Enterprise Development Training</th>
<th>Equipment Financing</th>
<th>Developer Operated PUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mentoring is necessary to build the commercial and technical skills of local entrepreneurs</td>
<td>• Energy access ≠ energy usage due to lack of electrical equipment</td>
<td>• Some mini-grid developers chose to establish their own PU business that relies on electricity from the mini-grid</td>
</tr>
<tr>
<td>• Identify local PUE champions to recruit and inspire others</td>
<td>• Capital cost of equipment and appliances may be high compared to financials of the enterprise</td>
<td>• This gives control over demand for electricity</td>
</tr>
<tr>
<td>• Training on electricity and appliance usage, entrepreneurship as well as health &amp; safety</td>
<td>• Challenges in access to finance due to remote locations</td>
<td>• Potentially higher margin on PU business sales than electricity sales</td>
</tr>
<tr>
<td>• Mentoring can bridge the access to finance gap (group mobilisation, access to mobile money, etc.)</td>
<td>• Microfinancing schemes by MG developers/ Lease-to-own model</td>
<td>• Reduced regulatory risk, since sale of services, e.g. milling is less regulated than electricity sales</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Diversification of funding streams</td>
</tr>
</tbody>
</table>

**Note:** This analysis is based on the experience of Energy 4 Impact based on the TA work provided and a PU mapping exercise.
4. PUE Mini-Grids: Case Study

JUMEME: Key Maker Model

- Jumeme is a PPP in the lake region of Northern Tanzania with financial assistance from EEP “Energy And Environment Partnership Programme With Southern And East Africa Phase II” and 10th EDF “European Development Fund”.
- 1 mini-grid of 90kWp in Ukerewe island
- Jumeme is connecting households (approx. 200) and businesses (approx. 50) and also extends end-user finance for electrical appliances
- Testing the Key Maker Model: milling imported maize to produce flour for sale to the local community, and using freezers to make ice for preservation of fish, both for local fishermen and to support their own tilapia fishing business
4. PUE Mini-Grids: Case Study

Devergy: Pico-Grids (DC)

- DC-based pico-grid in rural Tanzania
- Operational since 2012 and now has 14 operational sites
- Technology: solar PV/ battery storage for 2kWp systems
- Selling energy services as well as lease-to-own for electrical appliances (TV, stereo, radio, fans, fridges)
- Energy 4 Impact provided support to Devergy on defining productive use business models, in particular the cold storage activities around cold drinks and ice making
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PUE Grid Densification

REDP Introduction

• Program to stimulate local economic activity and strengthen development effects from the electrification

• Skills development and access to finance in 59 villages in Tanga and Pwani

• Pilot to test out a time- and cost effective implementation model (12 months)

• Results monitoring to map effects and gain experience

• Lessons learned can guide future PUE efforts in Tanzania and elsewhere
# PUE Grid Densification

## REDP Selected Results

<table>
<thead>
<tr>
<th>Goal</th>
<th>Indicator</th>
<th>Achieved as of end Q1 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Increased PUE awareness and knowledge</strong></td>
<td>At least 2,500 attendants at PUE Clinics</td>
<td>4,218 attended PUE Clinics (2,703 male/ 1,519 female)</td>
</tr>
<tr>
<td></td>
<td>74 PUE champions</td>
<td>59 PUE Champions recruited</td>
</tr>
<tr>
<td><strong>Enhanced business acumen in selected villages</strong></td>
<td>At least 1,000 business owners trained</td>
<td>1,040 business owners have been trained.</td>
</tr>
<tr>
<td></td>
<td>Increase of profit by 15% of 300 enterprises supported</td>
<td>Aggregate profit increase of 87% from baseline to March 2019.</td>
</tr>
<tr>
<td><strong>New Market Linkages created</strong></td>
<td>At least 5 new stakeholder collaborations established</td>
<td>Collaboration with stakeholders such as PASS, VFT, CRDB, NMB &amp; TEMSO Engineering</td>
</tr>
<tr>
<td><strong>Access to finance</strong></td>
<td>At least 120 loans facilitated through program</td>
<td>121 entrepreneurs have acquired formal loans (64 are female borrowers while 57 are male borrowers).</td>
</tr>
<tr>
<td><strong>Enhanced uptake of Power</strong></td>
<td>kWh consumption/ month</td>
<td>Monthly consumption of electricity averaged per enterprise 42 kWh in July 2018 to 75 kWh in March 2019. 80% increase.</td>
</tr>
</tbody>
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Increased Grid Utilisation

<table>
<thead>
<tr>
<th>Capacity Utilisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• PUE loads help increase the utilisation of the available production in kWh</td>
</tr>
<tr>
<td>• The revenues generated and the amount of power consumed by small business users (in both kWp and kWh terms) is equivalent to nearly 10 - 12 households</td>
</tr>
<tr>
<td>• Should be &gt; 70% to ensure that 70% of electricity demand translates into revenues for the developers</td>
</tr>
<tr>
<td>• Increased capacity utilisation decreases levelised cost of electricity (LCOE)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Return on Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The IRRs of mini-grids vary significantly from one developer to another, depending on the size, business model, technology, location of the plant, and types of customers.</td>
</tr>
<tr>
<td>• The IRR for the project increases significantly as more PUs are added to the load mix.</td>
</tr>
<tr>
<td>• Assuming the fixed costs of connection are similar, this implies the connection costs of a business are roughly 10 times cheaper per unit of energy compared to households.</td>
</tr>
</tbody>
</table>
6. Impact on Electricity Providers

Increased Grid Utilisation

![Bar chart showing increased grid utilisation for HHs, SEs, PUs, and All Loads.](chart_image)

![Line chart showing IRR for HHs, SEs, PUs, and All Loads.](chart_image)
6. Impact on Electricity Providers

Social Impact

- Sustainable Rural Businesses
- Job Creation
- Social Impact
- Environmental Benefits
- Enhanced Gender Equality
6. Impact on Electricity Providers

Social Impact – Sustainable Rural Businesses

<table>
<thead>
<tr>
<th>Energy service</th>
<th>Potential value creation through reliable and clean power source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agro-processing</strong></td>
<td>Value add to existing products; increased productivity; increased savings; enhanced access to additional products within the community</td>
</tr>
<tr>
<td><strong>Manufacturing</strong></td>
<td>Reduced transport for the service; increased efficiency.</td>
</tr>
<tr>
<td><strong>Drying</strong></td>
<td>Preservation of products; access to new markets; reduced wastage</td>
</tr>
<tr>
<td><strong>Refrigeration</strong></td>
<td>Enhanced longevity of products; chilling in hot weather; enhancing sales and value of the product</td>
</tr>
<tr>
<td><strong>Electronics (internet, tv, printing)</strong></td>
<td>Entertainment; education; access to information and markets; news.</td>
</tr>
</tbody>
</table>
6. Impact on Electricity Providers

Social Impact

Job Creation
- Create jobs from existing, expanding businesses as well as new businesses
- ‘Multiplier Effect’: workers spend most of their income within the local economy
- Help the local economy progress from traditional economic activities (retail/services) to more value-added ones (processing/manufacturing)

Environmental Benefits
- Mitigate climate change through clean energy
- Reduce usage of fossil fuels and thus reduce CO2 emissions

Gender
- Empower women through more local employment
- However, female participation in PUE activities is still relatively low in Africa
Contact Us

Diana Kollanyi
Regional Head of Programmes
Senior PUE Expert
Energy 4 Impact

diana.kollanyi@energy4impact.org
Tel: +254 (0) 722 508 789