

# Productive Use of Energy

## Experiences from Energy 4 Impact in East Africa



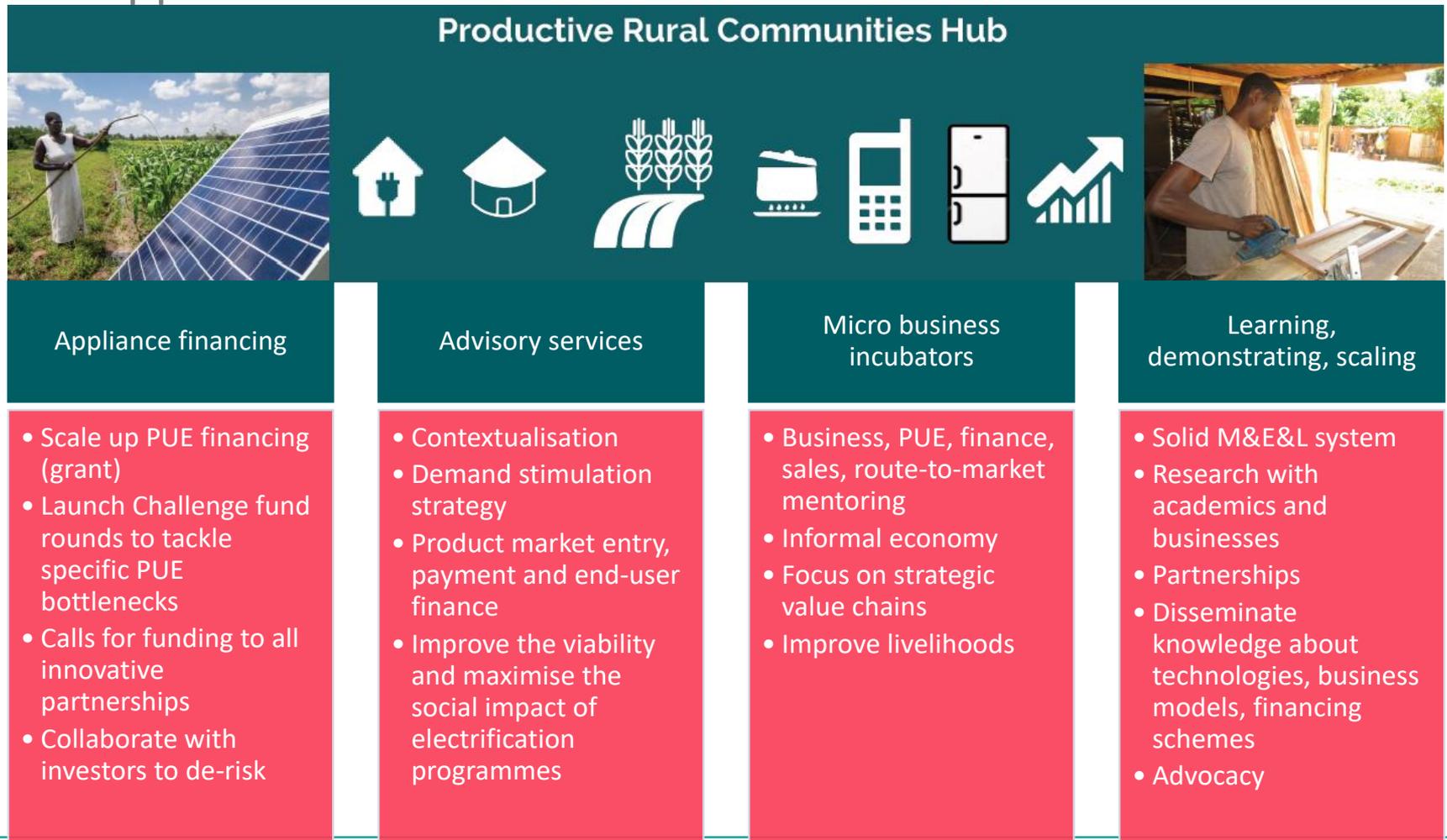
July 2019

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- 1. Energy 4 Impact: Overview & Snapshot of Activities with PUE in Africa**
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- 3. PUE Standalone**
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- 6. Impact on Electricity Providers**

# 1. Energy 4 Impact

## Our Approach



# 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 mngt

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  
instrument  
s &  
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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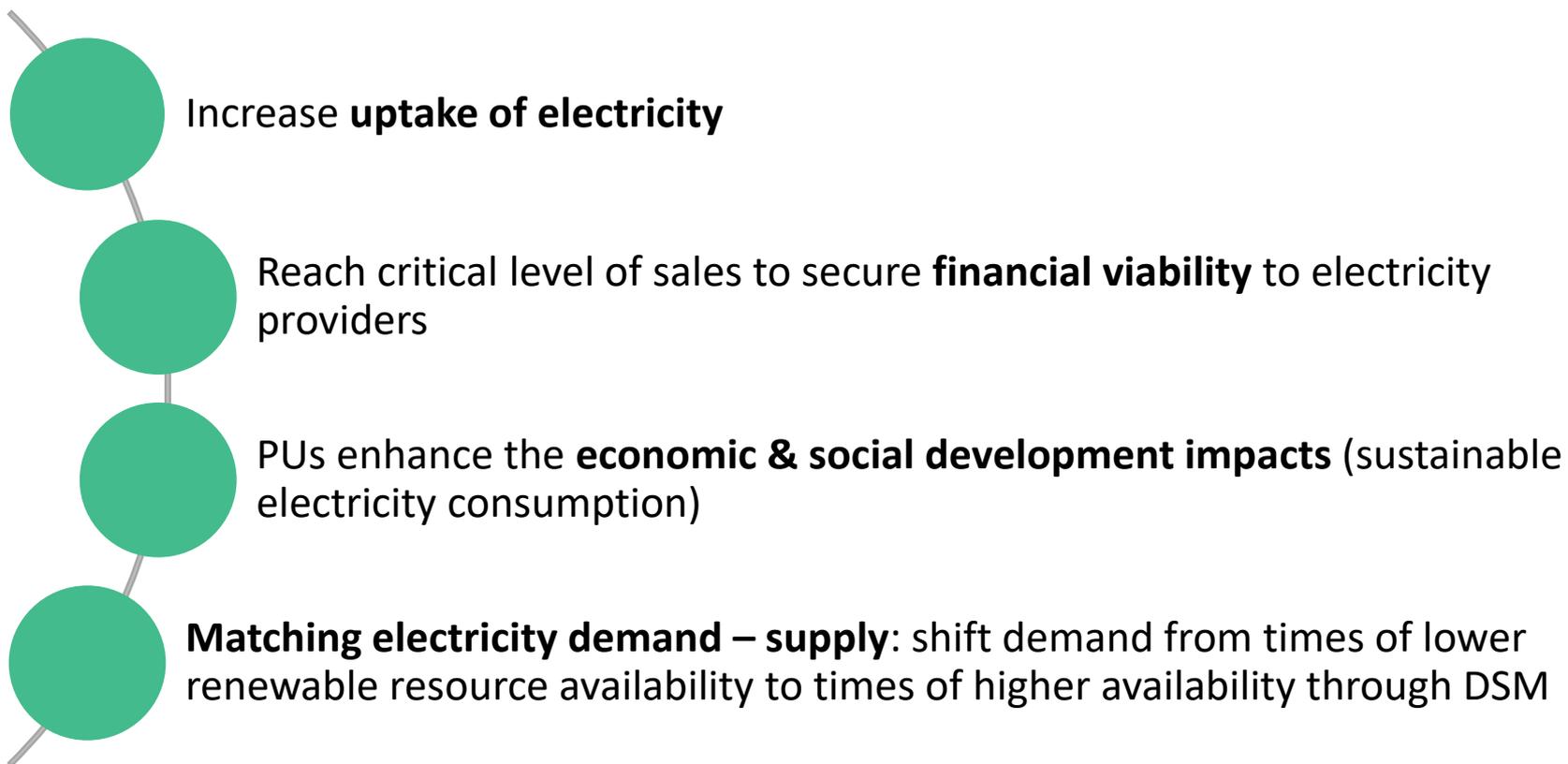
4. PUE Mini-Grids

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# Productive Use of Electricity

## Why PUE?



## 2. PUE Business Models

	<b>Revenue Models Power Provider</b>	<b>Revenue Models Operator</b>
▶ Unit Sales (kWh)/ Consumption Based	<i>Revenue (\$/kWh)</i>	<i>CAPEX + electricity cost</i>
▶ Anchor Clients	<i>E.g. 30% from anchor client (\$/kWh)</i>	
▶ Leasing and Financing of Appliances	<i>Electricity (\$/kWh) + Financial Income</i>	<i>Op CF needs to support asset repayments</i>
▶ Electricity as a Service	<i>Revenue (\$/unit) for product/ service</i>	<i>No CAPEX, electricity cost</i>
▶ Energy Hubs/Centers	<i>Revenue = rent (incl. electricity cost)</i>	<i>No CAPEX, electricity cost + rental cost</i>
▶ Franchise Model	<i>Franchise fee</i>	
▶ Stand-alone systems	<i>Product sales PAYGO</i>	<i>High CAPEX, no/ low OPEX</i>

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

Phone Charging

Micro EPs

Refrigeration

Milling

Irrigation

Social Institutions

# 3. PUE Standalone

## Phone Charging

<b>Business Model</b>	<ul style="list-style-type: none"><li>• Charge up to 50-60 phones/ day (each charge takes 2 to 3 hours)</li><li>• Revenues of USD 0.3-0.6/ charge</li></ul>
<b>Technology</b>	<ul style="list-style-type: none"><li>• Early tech: panels, battery, charge controller and other components separately, which needed technical expertise for assembly and installation</li><li>• Current tech: solar charging kits</li></ul>
<b>Market</b>	<ul style="list-style-type: none"><li>• Customers tend to charge their phones 2 times per week</li><li>• Enterprises worked with: 556 in Tanzania</li></ul>

# 3. PUE Standalone

## Micro Businesses

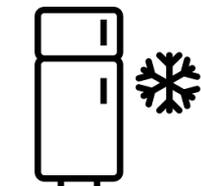
Many micro and small businesses conduct several income generating activities simultaneously



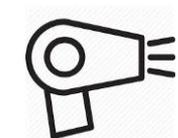
<b>PUE Activity</b>	<b>PUE Equipment</b>	<b>Power Rating</b>
<b>Retail Shop</b>	Light	< 10W



<b>Entertainment</b>	Radio Music system TV	< 100W
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<b>Refrigeration</b>	Fridge Freezer	150 – 200W
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<b>Salon</b>	Hair cutter Hair dryer	20W
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# 3. PUE Standalone

## Refrigeration

<b>Business Model</b>	<ol style="list-style-type: none"><li>1. Household refrigeration for food storage</li><li>2. Small commercial refrigeration for retail (cold drinks, dairy)</li><li>3. Small commercial ice-makers for agricultural or other</li></ol>
<b>Technology</b>	<ul style="list-style-type: none"><li>• AC (incl. inverter) vs. DC</li></ul> <p>Cost:</p> <ul style="list-style-type: none"><li>• AC on average USD 250</li><li>• DC at USD 600 – 1,000 and above</li></ul>
<b>Market</b>	<ul style="list-style-type: none"><li>• Market is nascent: on-grid testing conducted; Prize Award for innovations (OG DC fridges/ freezers)</li><li>• Affordability: financing solutions needed for HH and business (PAYGO)</li></ul>

# 3. PUE Standalone

## Milling

<b>Business Model</b>	<ul style="list-style-type: none"><li>• Increase farmer revenue</li><li>• Promote food security</li><li>• Ability and willingness to pay for milling services and milled produce</li></ul>
<b>Technology</b>	<ul style="list-style-type: none"><li>• Hammer, plate and stone mills</li></ul> <p>Energy Source:</p> <ul style="list-style-type: none"><li>• Electricity, incl. mini-grid (AC) (10 kWp+)</li><li>• Diesel engine</li><li>• Standalone solar (DC) (1,200 W)</li></ul> <p>Cost:</p> <ul style="list-style-type: none"><li>• Electric motor USD 500</li><li>• Electric mill approx. USD 2,000</li></ul>
<b>Market</b>	<ul style="list-style-type: none"><li>• Maize</li><li>• Millet</li><li>• Sorghum</li><li>• Milling revenues: main-grid USD 0.02-0.03; mini-grid USD 0.11-0.13; diesel USD 0.04 – 0.06</li></ul>

# 3. PUE Standalone

## Irrigation

<b>Business Model</b>	<ul style="list-style-type: none"><li>• Develop ecosystem for solar powered irrigation</li><li>• Not enough data to prove the business model</li><li>• Savings on diesel cost</li></ul>
<b>Technology</b>	<ul style="list-style-type: none"><li>• Pumps: Ennos Sunlight (surface water), Future Pump (submersible)</li><li>• Plug 'n Play</li></ul> <p>Power need:</p> <ul style="list-style-type: none"><li>• 375 Wp pump (Ennos)</li><li>• 700 Wp pump (Future pump)</li></ul> <p>Cost:</p> <ul style="list-style-type: none"><li>• Up to USD 5,000</li></ul>
<b>Market</b>	<ul style="list-style-type: none"><li>• Smallholder farmers (1-2 ha)</li><li>• Low farmers' awareness</li><li>• Maize and horticulture (different payback periods)</li><li>• 10 demo sites in Rwanda</li><li>• Distributors are key in market access (manufacturers don't distribute)</li></ul>

# 3. PUE Standalone

## Social Institutions



Business Model	<ul style="list-style-type: none"> <li>• Improve quality of education in remote schools</li> <li>• Incorporate ICT</li> </ul>	<ul style="list-style-type: none"> <li>• Availability and quality of essential health care access to life-saving interventions</li> <li>• Reduce child and mother mortality</li> </ul>
Technology	<ul style="list-style-type: none"> <li>• 800W, 400AmH Batteries, 1000W Inverters, Wiring</li> </ul>	<ul style="list-style-type: none"> <li>• 800W, 400AmH Batteries, 1000W Inverters, Wiring</li> </ul>
Market	<ul style="list-style-type: none"> <li>• Equipment like: tablets/ computer laboratories, printers, staff laptops, mobile phones</li> <li>• Lighting: evening classes; security lighting in boarding facilities</li> <li>• Increase teachers morale</li> </ul>	<ul style="list-style-type: none"> <li>• Prolong night-time service provision;</li> <li>• Provide faster emergency response;</li> <li>• Power essential medical equipment; cold chain for vaccines, blood and medicines;</li> <li>• Attract and retain skilled health workers;</li> </ul>

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# 4. PUE Mini-Grids

## Value Chain Analysis and Business Case Assessment

Categories	Role of Electricity	VC Analysis at Village Level
<ul style="list-style-type: none"><li>• <b>Primary industries</b> (agriculture, fishing, etc.),</li><li>• <b>Light manufacturing</b> (carpentry, welding, ice making),</li><li>• <b>Commercial and retail enterprises</b> (phone charging, groceries, hair salons, etc.)</li></ul>	<ul style="list-style-type: none"><li>• <b>Enabler</b> of a product/ service (e.g. ice making),</li><li>• <b>Catalyst</b> that improves a product (e.g. electric milling)</li><li>• <b>Differentiator</b> that changes the customer experience (e.g. cold drinks)</li></ul>	<ul style="list-style-type: none"><li>• Local production, processing and marketing and assess value-addition opportunities for electrification</li><li>• Techno-economic considerations</li></ul>

*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

### Enterprise Development Training

- Mentoring is necessary to build the commercial and technical skills of local entrepreneurs
- Identify local PUE champions to recruit and inspire others
- Training on electricity and appliance usage, entrepreneurship as well as health & safety
- Mentoring can bridge the access to finance gap (group mobilisation, access to mobile money, etc.)

### Equipment Financing

- Energy access  $\neq$  energy usage due to lack of electrical equipment
- Capital cost of equipment and appliances may be high compared to financials of the enterprise
- Challenges in access to finance due to remote locations
- Microfinancing schemes by MG developers/ Lease-to-own model

### Developer Operated PUs

- Some mini-grid developers chose to establish their own PU business that relies on electricity from the mini-grid
- This gives control over demand for electricity
- Potentially higher margin on PU business sales than electricity sales
- Reduced regulatory risk, since sale of services, e.g. milling is less regulated than electricity sales
- Diversification of funding streams

*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



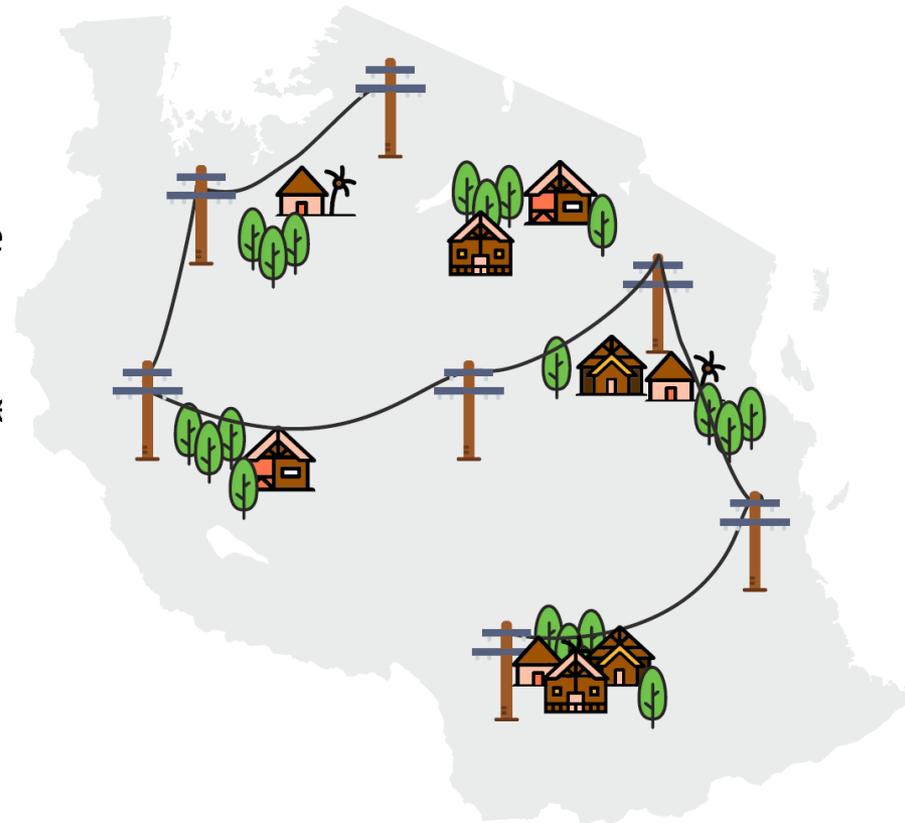
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# PUE Grid Densification

## 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

Goal	Indicator	Achieved as of end Q1 2019
<b>Increased PUE awareness and knowledge</b>	At least 2,500 attendants at PUE Clinics	4,218 attended PUE Clinics (2,703 male/ 1,519 female)
	74 PUE champions	59 PUE Champions recruited
<b>Enhanced business acumen in selected villages</b>	At least 1,000 business owners trained	1,040 business owners have been trained.
	Increase of profit by 15% of 300 enterprises supported	Aggregate profit increase of 87% from baseline to March 2019. 349 entrepreneurs supported.
<b>New Market Linkages created</b>	At least 5 new stakeholder collaborations established	Collaboration with stakeholders such as PASS, VFT, CRDB, NMB & TEMSO Engineering
<b>Access to finance</b>	At least 120 loans facilitated through program	121 entrepreneurs have acquired formal loans (64 are female borrowers while 57 are male borrowers).
<b>Enhanced uptake of Power</b>	kWh consumption/ month	Monthly consumption of electricity averaged per enterprise 42 kWh in July 2018 to 75 kWh in March 2019. 80% increase.

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# 6. Impact on Electricity Providers

## Increased Grid Utilisation

### Capacity Utilisation

- PUE loads help increase the utilisation of the available production in kWh
- 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
- Should be > 70% to ensure that 70% of electricity demand translates into revenues for the developers
- Increased capacity utilisation decreases levelised cost of electricity (LCOE)

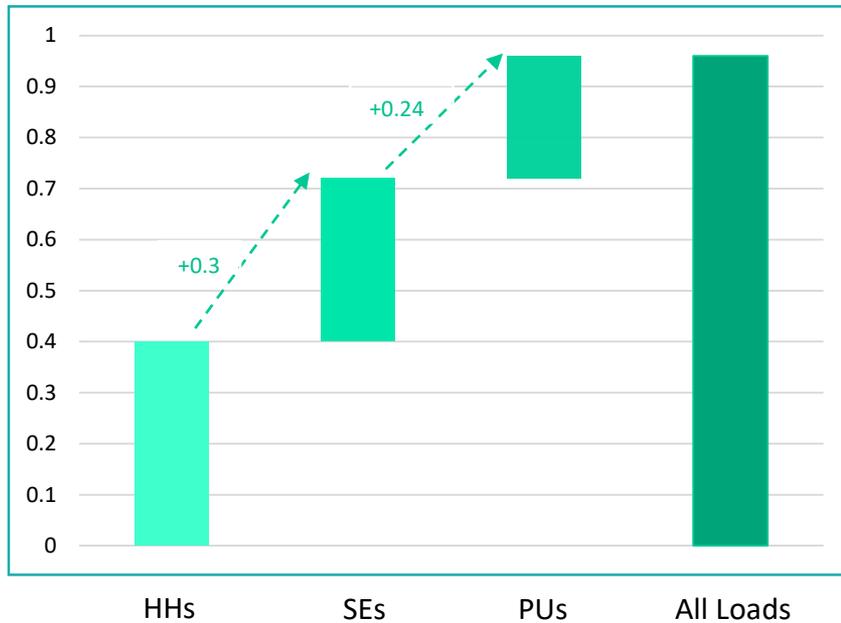
### Return on Investment

- 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.
- The IRR for the project increases significantly as more PUs are added to the load mix.
- 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.

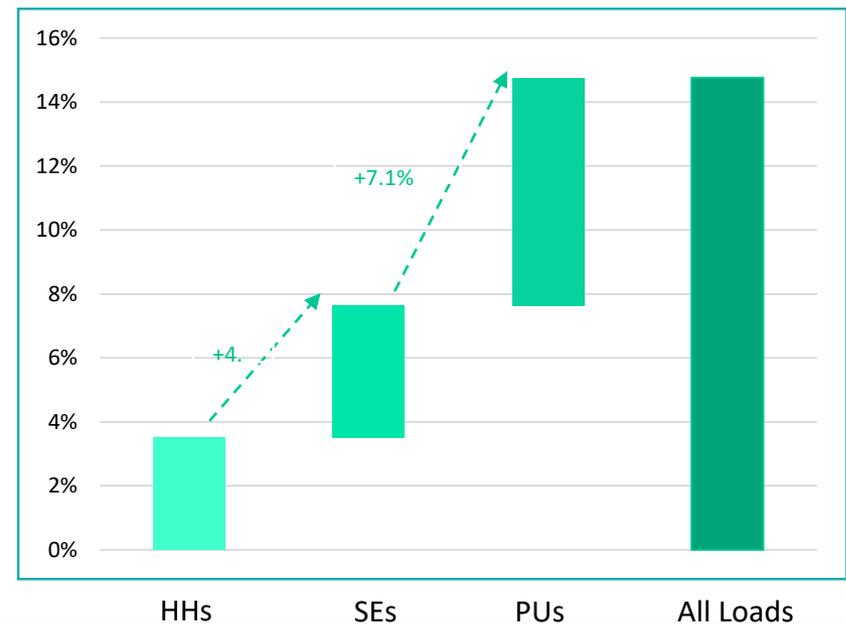
# 6. Impact on Electricity Providers

## Increased Grid Utilisation

Utilisation

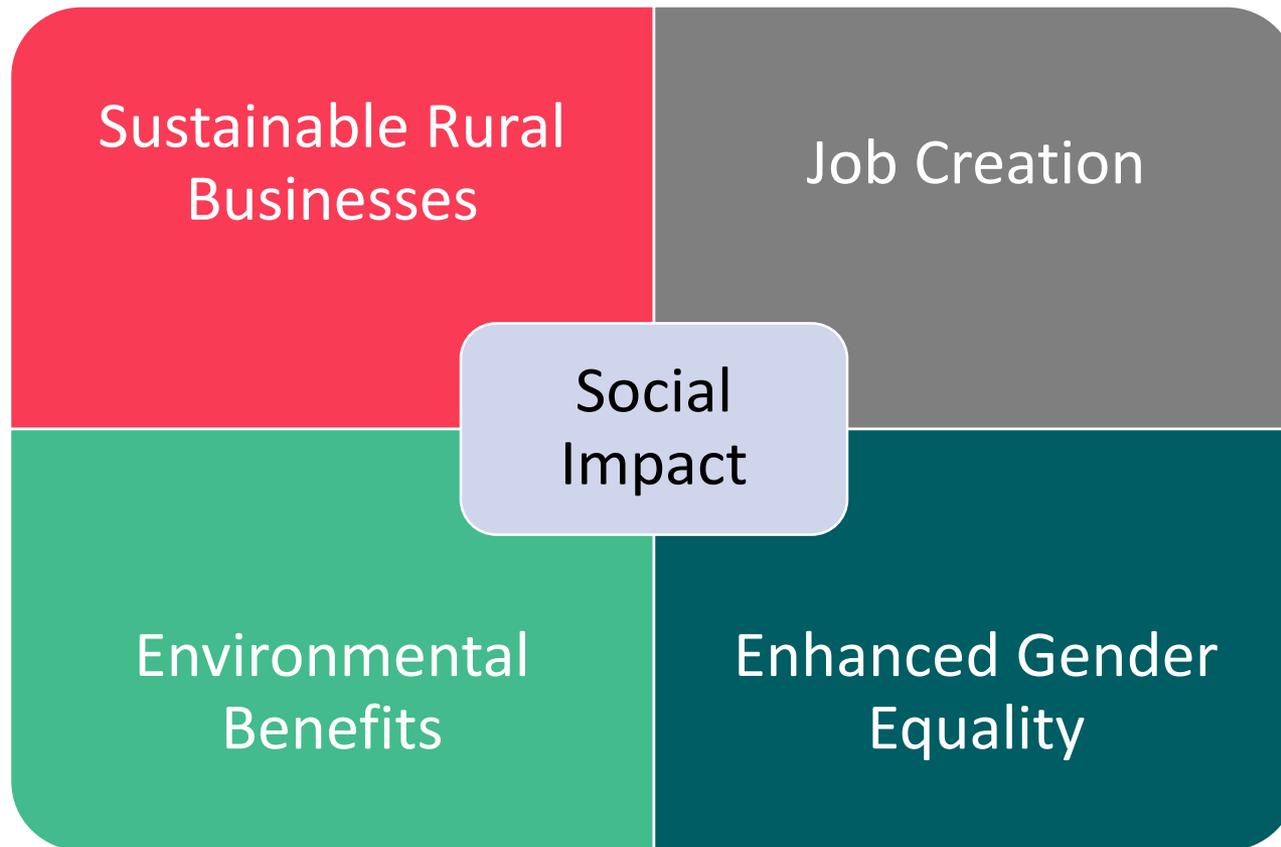


IRR



# 6. Impact on Electricity Providers

## Social Impact



# 6. Impact on Electricity Providers

## Social Impact – Sustainable Rural Businesses

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

# 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](mailto:diana.kollanyi@energy4impact.org)

Tel: +254 (0) 722 508 789