

Productive Use of Energy

Experiences from Energy 4 Impact in East Africa



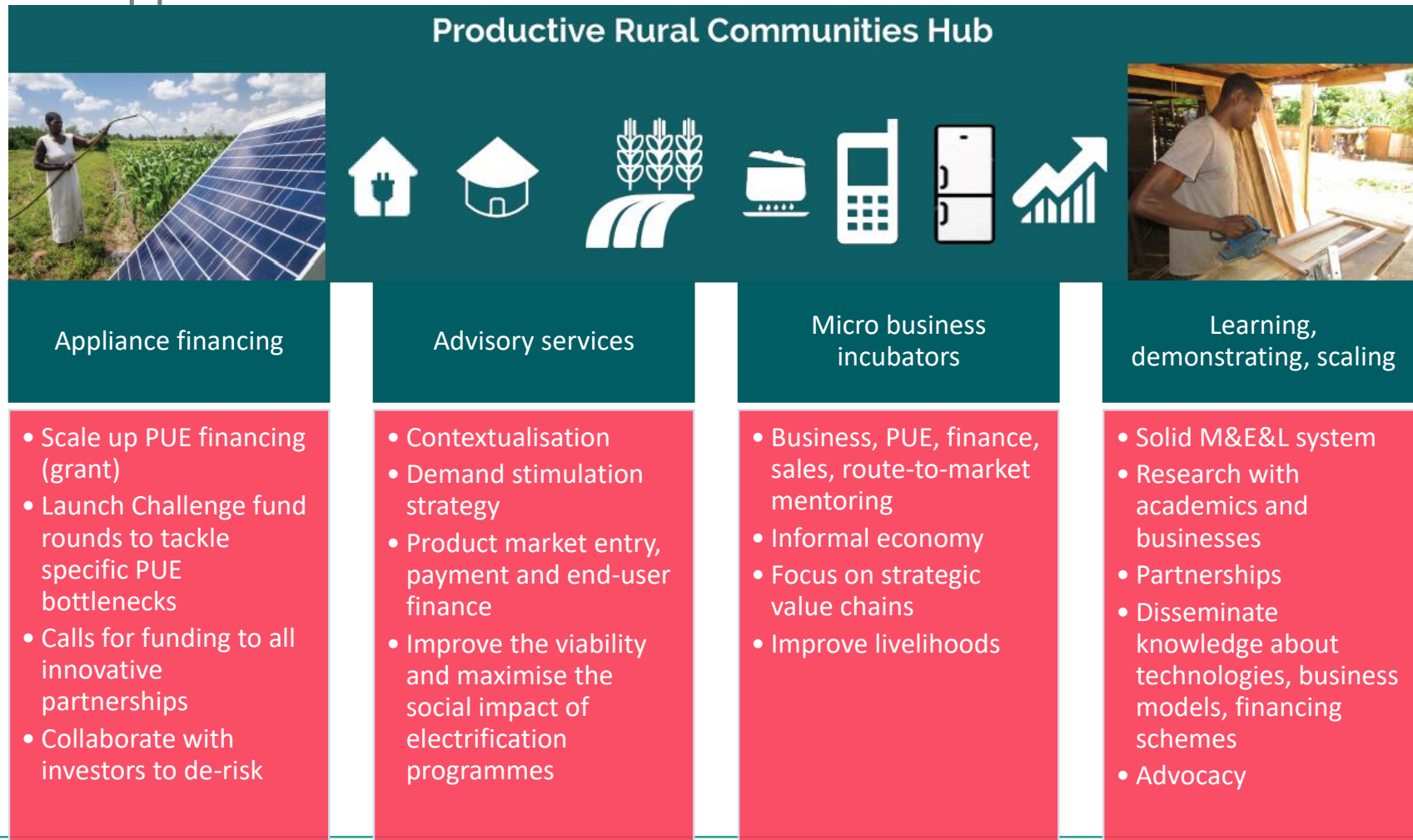
July 2019

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



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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3. PUE Standalone

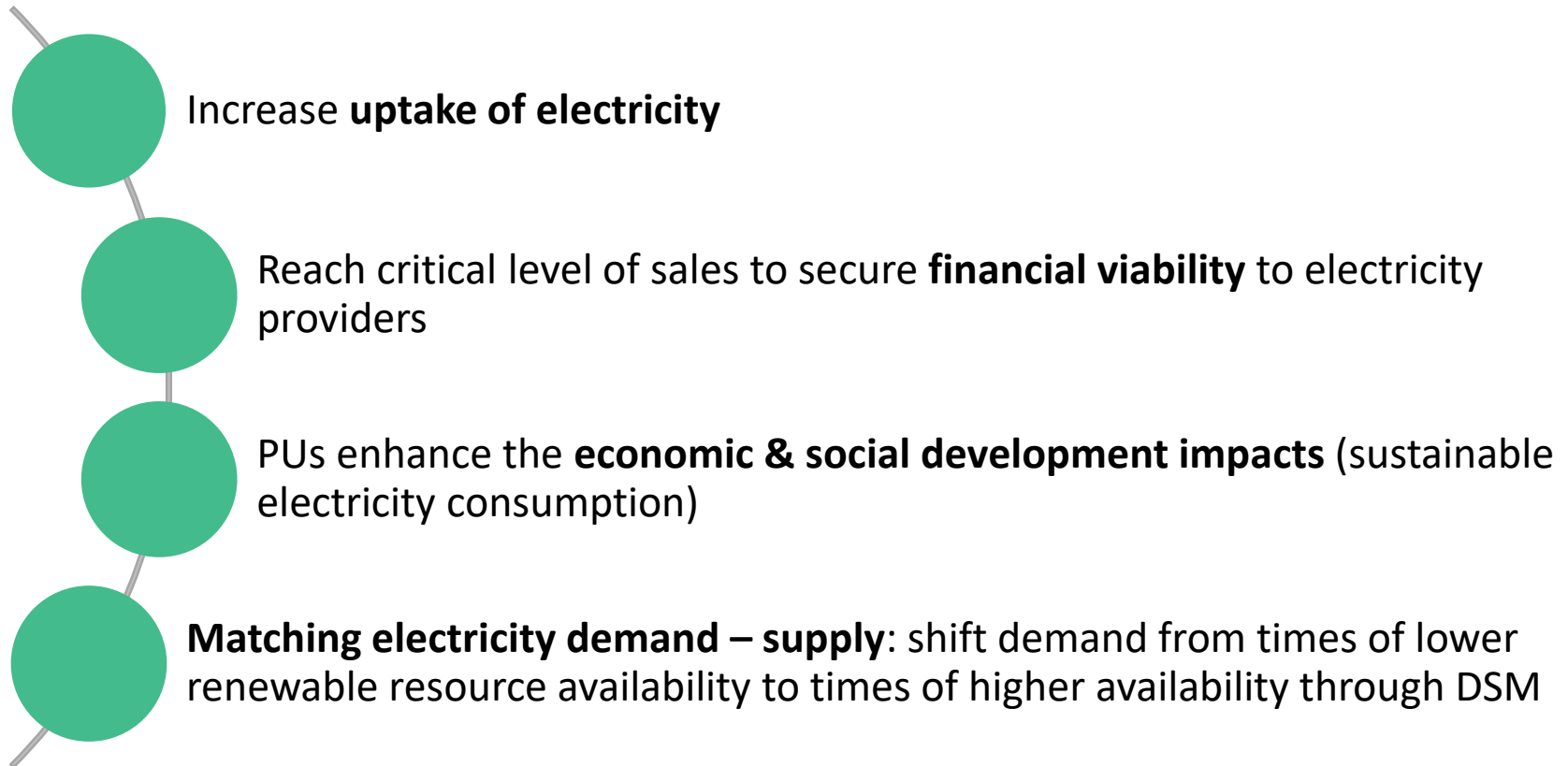
4. PUE Mini-Grids

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6. Impact on Electricity Providers

Productive Use of Electricity

Why PUE?



2. PUE Business Models

	Revenue Models Power Provider	Revenue Models Operator
▶ 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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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
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PUE Standalone

Phone Charging

Micro EPs

Refrigeration

Milling

Irrigation

Social Institutions

3. PUE Standalone



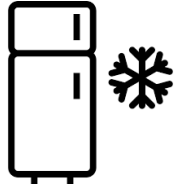
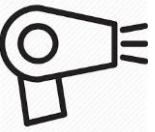
Phone Charging

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

3. PUE Standalone

Micro Businesses

Many micro and small businesses conduct several income generating activities simultaneously

	PUE Activity	PUE Equipment	Power Rating
	Retail Shop	Light	< 10W
	Entertainment	Radio Music system TV	< 100W
	Refrigeration	Fridge Freezer	150 – 200W
	Salon	Hair cutter Hair dryer	20W

3. PUE Standalone

Refrigeration

Business Model	<ol style="list-style-type: none">1. Household refrigeration for food storage2. Small commercial refrigeration for retail (cold drinks, dairy)3. Small commercial ice-makers for agricultural or other
Technology	<ul style="list-style-type: none">• AC (incl. inverter) vs. DC <p>Cost:</p> <ul style="list-style-type: none">• AC on average USD 250• DC at USD 600 – 1,000 and above
Market	<ul style="list-style-type: none">• Market is nascent: on-grid testing conducted; Prize Award for innovations (OG DC fridges/ freezers)• Affordability: financing solutions needed for HH and business (PAYGO)

3. PUE Standalone

Milling

Business Model	<ul style="list-style-type: none">• Increase farmer revenue• Promote food security• Ability and willingness to pay for milling services and milled produce
Technology	<ul style="list-style-type: none">• Hammer, plate and stone mills <p>Energy Source:</p> <ul style="list-style-type: none">• Electricity, incl. mini-grid (AC) (10 kWp+)• Diesel engine• Standalone solar (DC) (1,200 W) <p>Cost:</p> <ul style="list-style-type: none">• Electric motor USD 500• Electric mill approx. USD 2,000
Market	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none">• Develop ecosystem for solar powered irrigation• Not enough data to prove the business model• Savings on diesel cost
Technology	<ul style="list-style-type: none">• Pumps: Ennos Sunlight (surface water), Future Pump (submersible)• Plug 'n Play <p>Power need:</p> <ul style="list-style-type: none">• 375 Wp pump (Ennos)• 700 Wp pump (Future pump) <p>Cost:</p> <ul style="list-style-type: none">• Up to USD 5,000
Market	<ul style="list-style-type: none">• 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



Business Model	<ul style="list-style-type: none"> • Improve quality of education in remote schools • Incorporate ICT 	<ul style="list-style-type: none"> • Availability and quality of essential health care access to life-saving interventions • Reduce child and mother mortality
Technology	<ul style="list-style-type: none"> • 800W, 400AmH Batteries, 1000W Inverters, Wiring 	<ul style="list-style-type: none"> • 800W, 400AmH Batteries, 1000W Inverters, Wiring
Market	<ul style="list-style-type: none"> • Equipment like: tablets/ computer laboratories, printers, staff laptops, mobile phones • Lighting: evening classes; security lighting in boarding facilities • Increase teachers morale 	<ul style="list-style-type: none"> • 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;

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

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



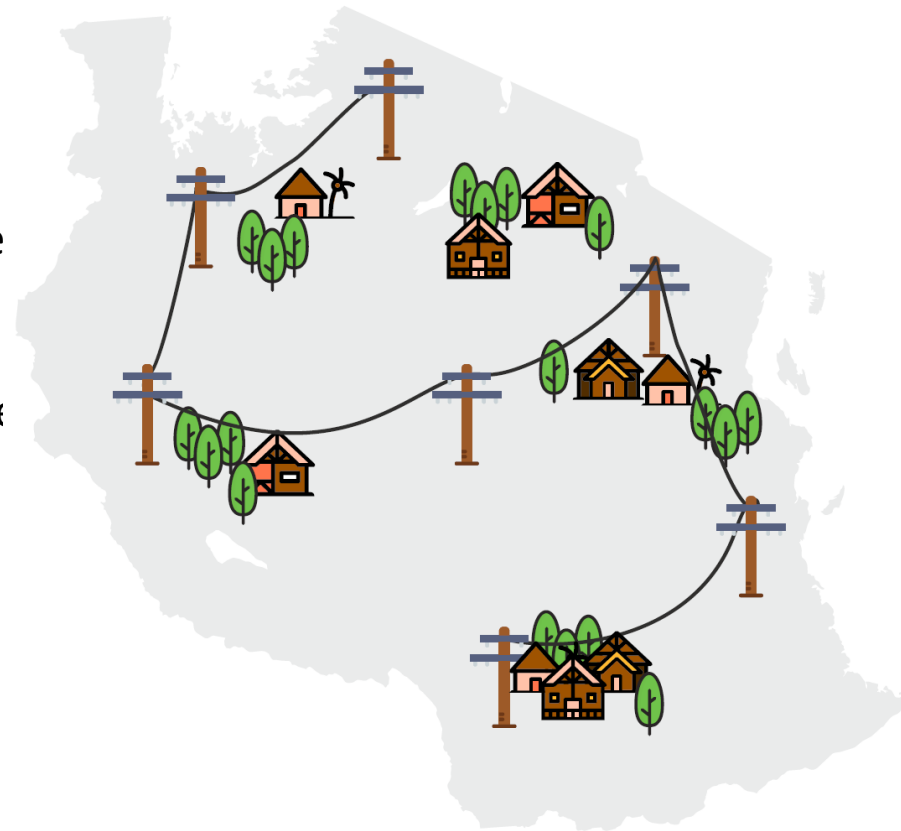
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PUE Grid Densification

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
Increased PUE awareness and knowledge	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
Enhanced business acumen in selected villages	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.
New Market Linkages created	At least 5 new stakeholder collaborations established	Collaboration with stakeholders such as PASS, VFT, CRDB, NMB & TEMSO Engineering
Access to finance	At least 120 loans facilitated through program	121 entrepreneurs have acquired formal loans (64 are female borrowers while 57 are male borrowers).
Enhanced uptake of Power	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)

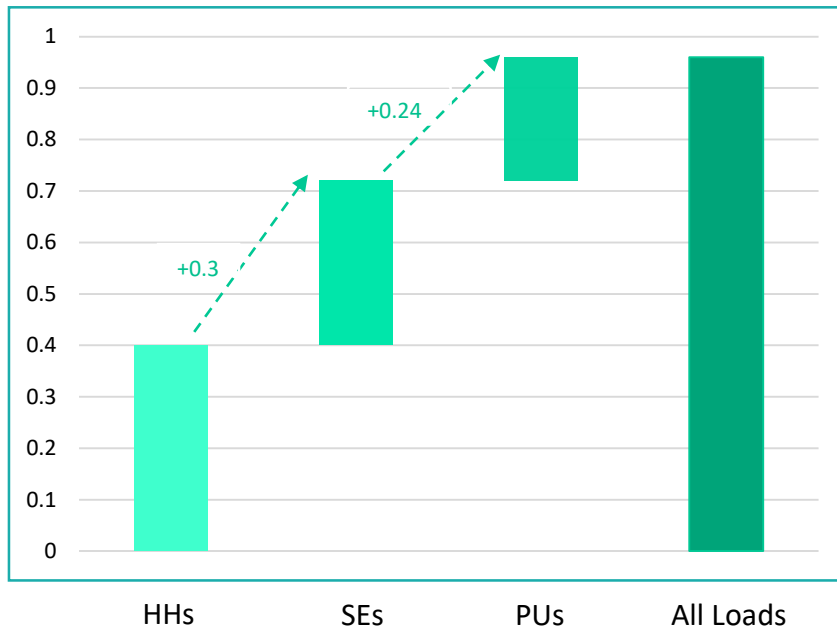
Return on Investment

- 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.

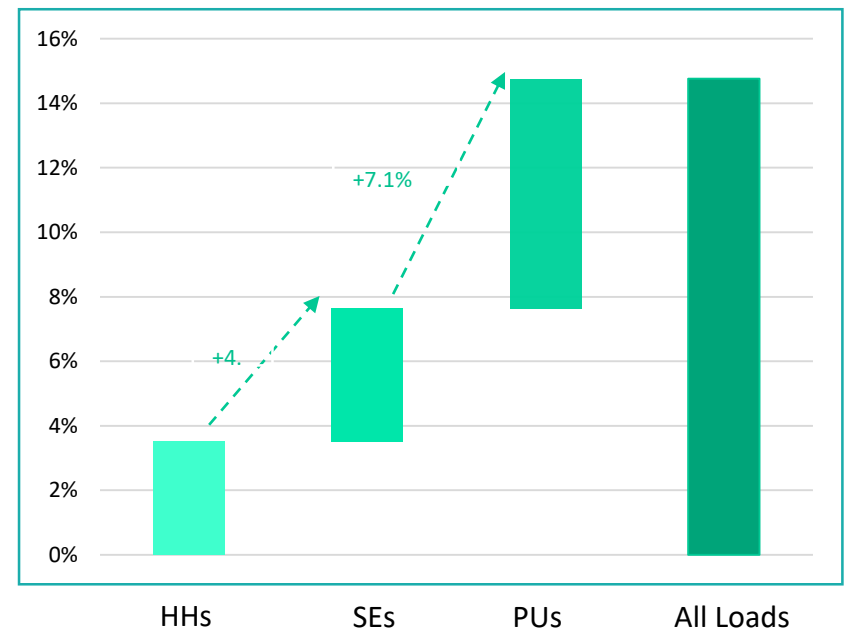
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Increased Grid Utilisation

Utilisation

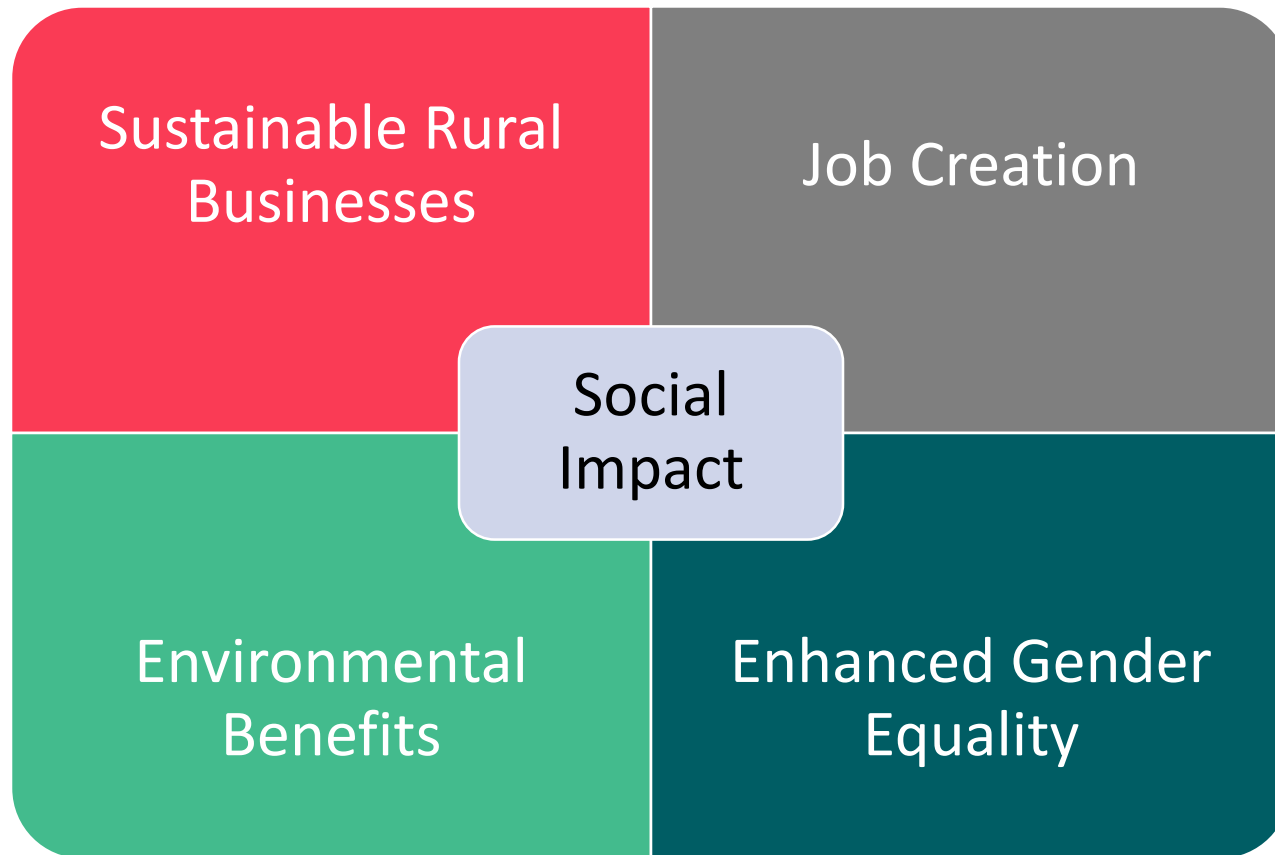


IRR



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

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