ESRES
ENERGY SECURITY AND RESOURCE EFFICIENCY IN SOMALILAND

Using Hybrid Mini-grids to Improve Energy Access in Somaliland:

Lessons Learned Implementing the Energy Security and Resource Efficiency in Somaliland Programme

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Somaliland

- Former British protectorate declared independence from Somalia in 1991—not internationally recognized as independent country.
- Population of 3.5–4.5 million, mostly rural and some nomadic.
- GDP of $2 billion, primarily from remittances, livestock, and agriculture.
- Per capita GDP about $500.
- Generally avoided the security and terrorism issues of Somalia.
- All electricity provided by private ESPs generally running old, inefficient diesel generators.
- Semi-official national tariff of $0.79/kWh.
- Energy access 60–80%.

Somaliland Operating Environment

Issues	Challenges	Opportunities
Unrecognized country	• Lack of access to international finance • Unenforceable contracts • Reluctance of suppliers to engage • Constrains import of affordable power	• Provides incentive for RE to increase energy security and independence
Low-level conflicts (FCAS) • Clan/sub-clan conflicts • Territorial dispute w/ Puntland	• Inability to fully engage in contested areas • Motivation for Government to demonstrate/extend remit	• Increases need for energy security and resiliency provided by RE
No formal legal & regulatory framework for electricity sector • Somaliland Electrical Energy Act (SEEA) still not passed • Regulation is limited and informal	• Highest electricity tariff in the world • Uncertainty stifles long-term investment • Overlapping ESPs • Constrains import of affordable power	• Entrepreneurial opportunity for RE

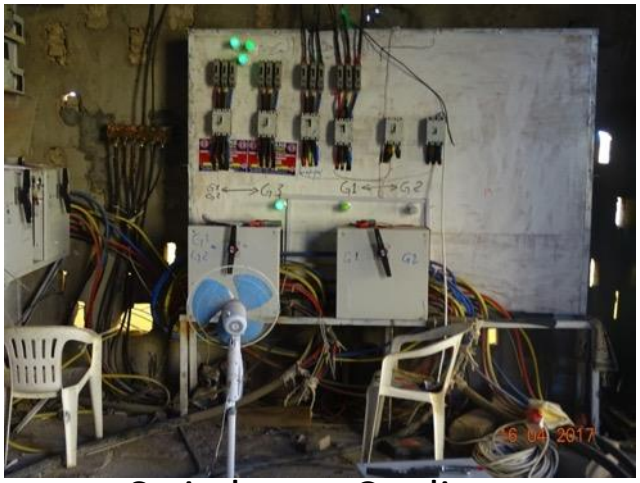
Somaliland Operating Environment (Cont.)

Issues	Challenges	Opportunities
No national grid • No transmission system • Very limited intra-city use of 33 kV • Larger systems distribute at 11 kV • Most systems distribute at line voltage	• Limited opportunities for large-scale generation • All generation linked to integrated local provider	• Attractive environment for hybrid mini-girds
Extremely low energy density • Low population density • Low per capita usage	• High distribution/customer connection costs (e.g., customer buys meter) • Need to encourage productive usage	• Small systems will meet current needs of most towns and have large marginal impact
Virtually no greenfield sites • All but the smallest clusters of houses generally have some incumbent power provider	• Incumbent operator has vested interest in preserving current system • Local partner likely has extremely limited capacity	• Somaliland has a high rate of access to electricity • Operators have local legitimacy

Existing Systems Highlight Somalilander's Resourcefulness

Fuel Management System

Vibration Suppression


Switchgear Cooling

Improvised Cross Arms

Average Annual Operating Cost*

= $42

= $288

= $69

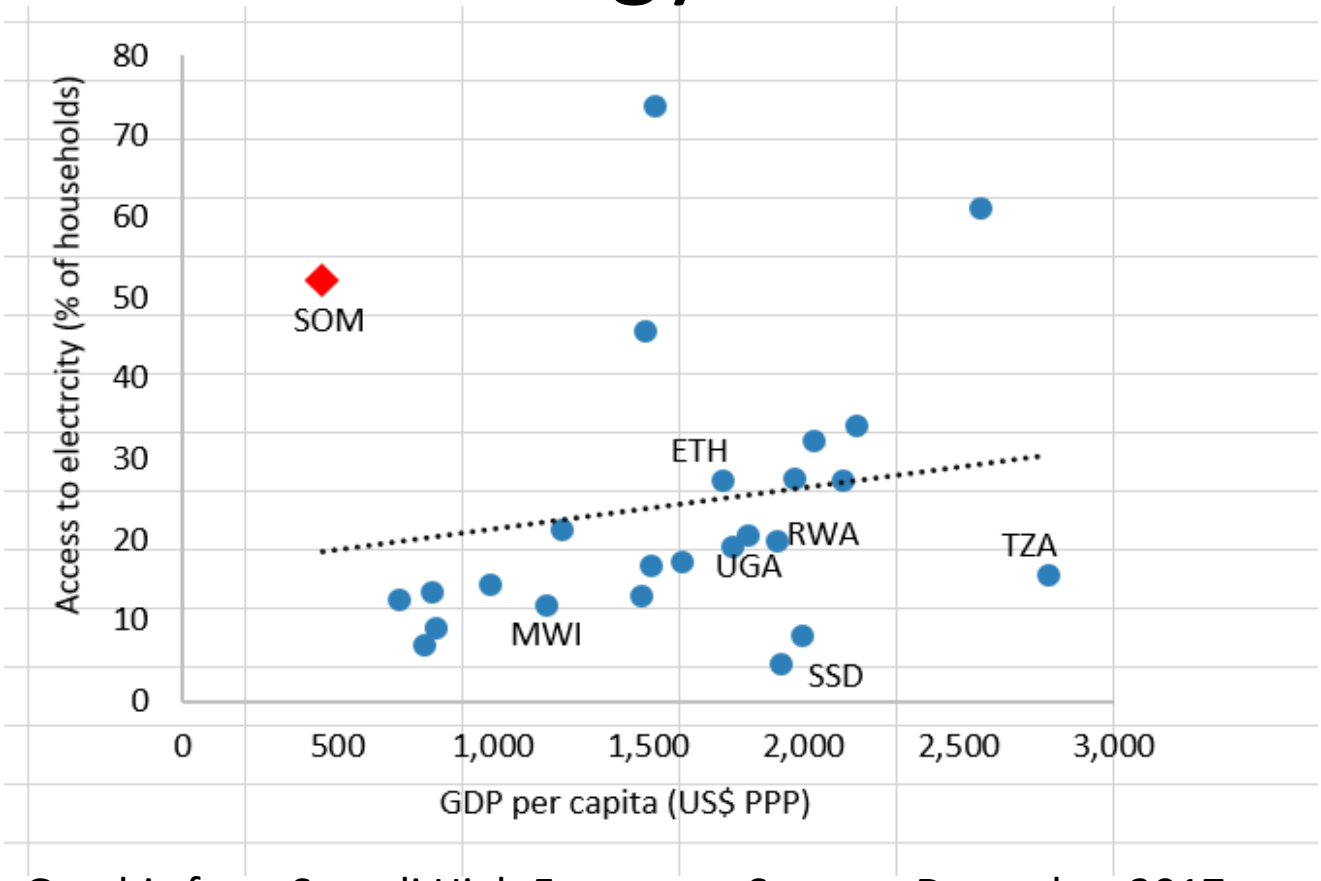
= $346

= $103

= $606

*Based on tariff of $0.79/kWh and typical operating times.
Refrigerator assumed to be on 24 hrs/day (8 hr. cycle time).

Somaliland Has Surprisingly High Rate of Energy Access



Graphic from Somali High Frequency Survey - December 2017

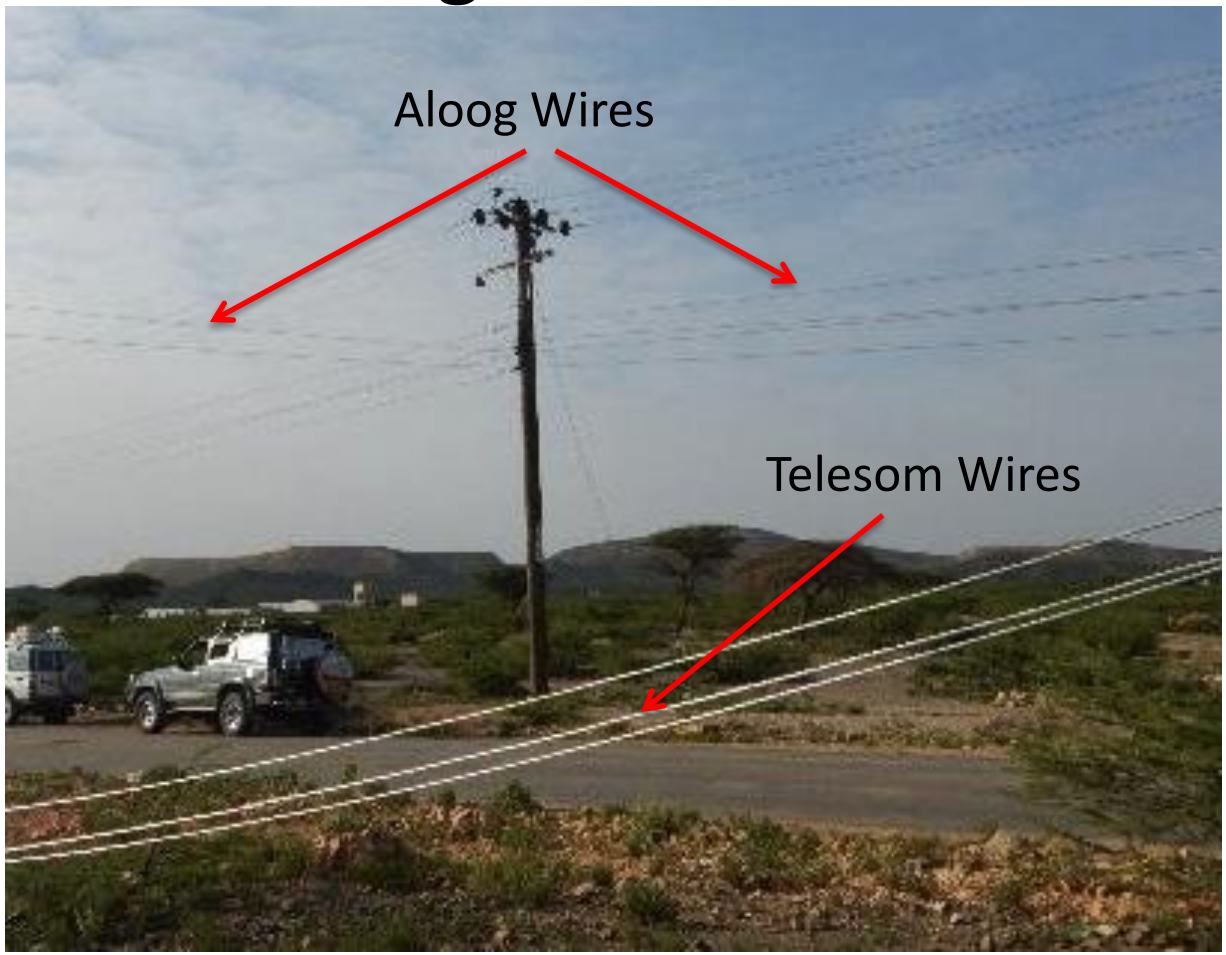
Somaliland Has Extremely Low "Electricity Density"

Population Density and Per Capita Electricity Consumption in Selected African Countries

Country	Population Density (Pop/km^2)	Per Capita Electricity Consumption (kWh)	Electricity Density (kWh/km^2)
Rwanda	456	38	17,328
Zambia	22	709	15,598
Angola	23	401	9,223
Sudan	22	269	5,918
Congo (DRC)	36	114	4,104
Sierra Leone	99	33	3,267
Liberia	45	69	3,105
Niger	18	64	1,152
Somaliland	22	27	583

Average electricity density in Somaliland equates to 2-4 households using ten 20 W light bulbs per km^2.

Lack of Regulation Results in Getting Wires Crossed



Distribution in Borama (June 2017)

ESRES Programme Overview

Objective

To promote green growth and poverty reduction in Somaliland through increased access to more affordable and reliable renewable energy services.

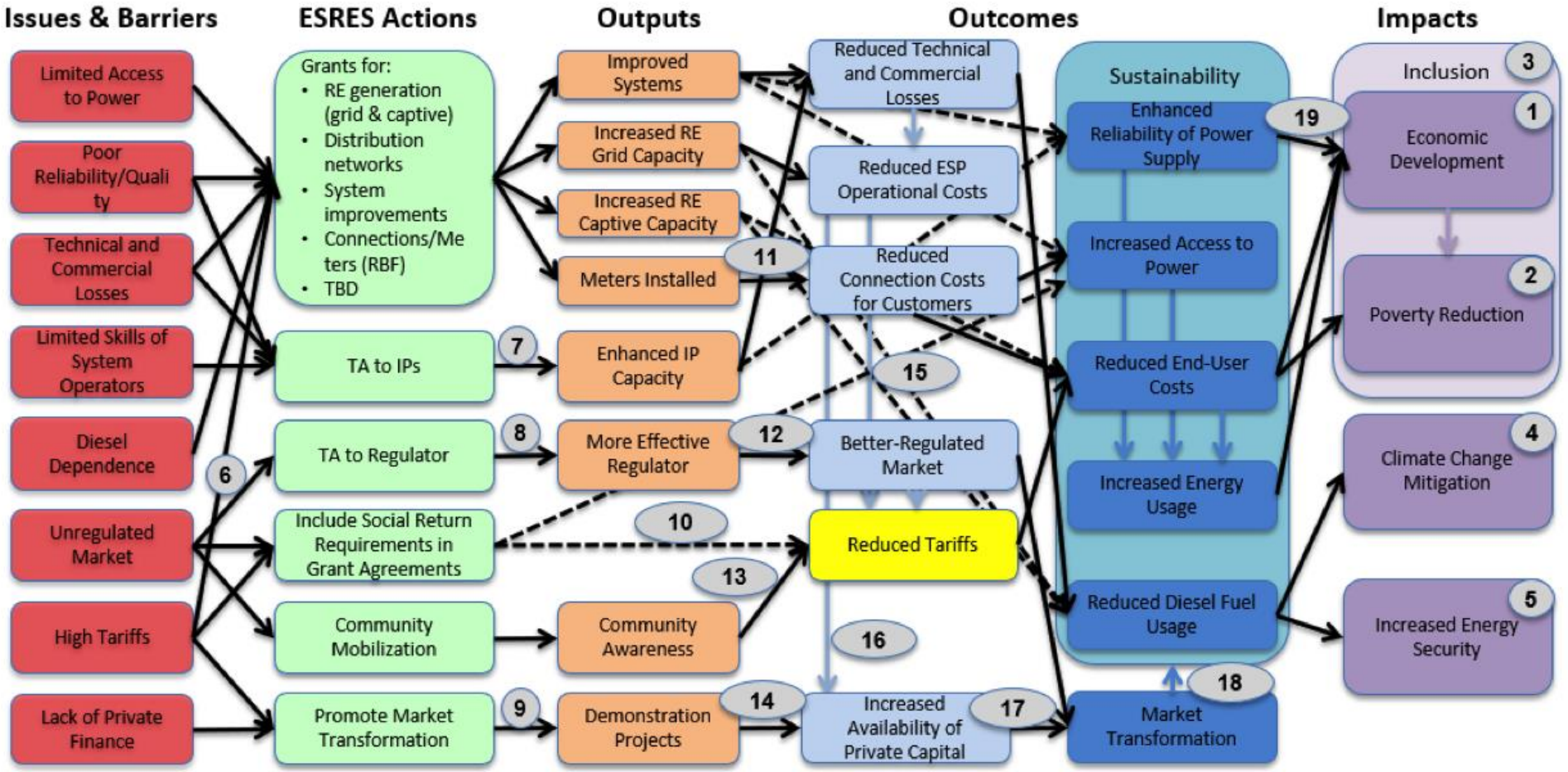
Phases

- ESRES1 (36 months): pilot-phase
- ESRES2 (36 months): expansion-phase

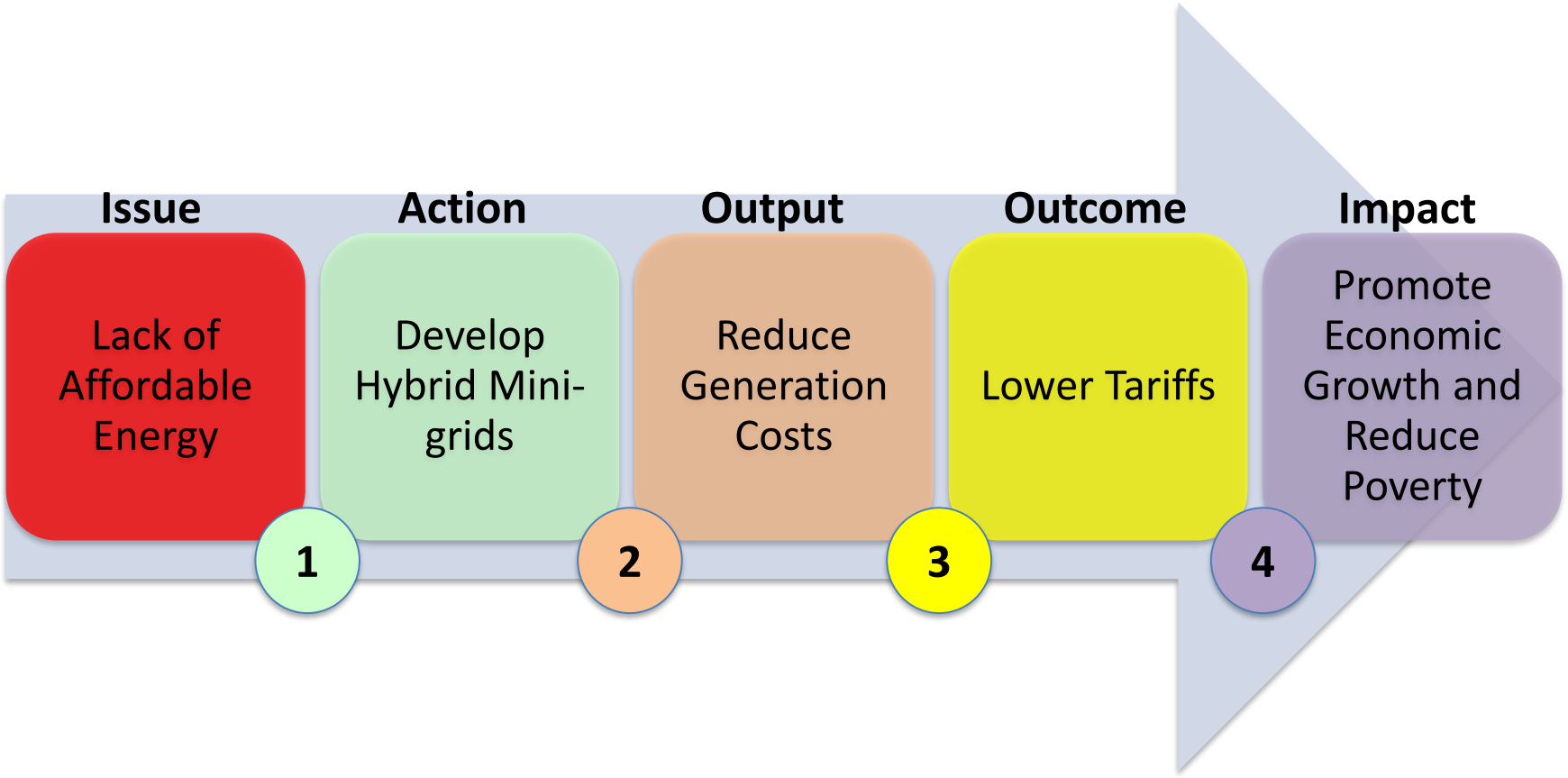
Funding and Implementation

- UKAid through FCDO Somalia
- GBP 20 million from International Climate Fund
- Coordination with Ministry of Energy and Minerals
- Mott MacDonald is the Programme Manager

ESRES Theory of Change



Simplified ESRES Programme Logic



Questions ESRES Sought to Answer

1. Is it feasible to build hybrid mini-grids in a fragile, post-conflict environment?
2. Can a hybrid mini-grid reduce generation costs?
3. Does reducing generation costs lead to reduced electricity tariffs?
4. Does reducing the price of electricity promote economic growth and reduce poverty?

ESRES1 Project Sites

Borama (Aloog)

Gabiley (Sompower)

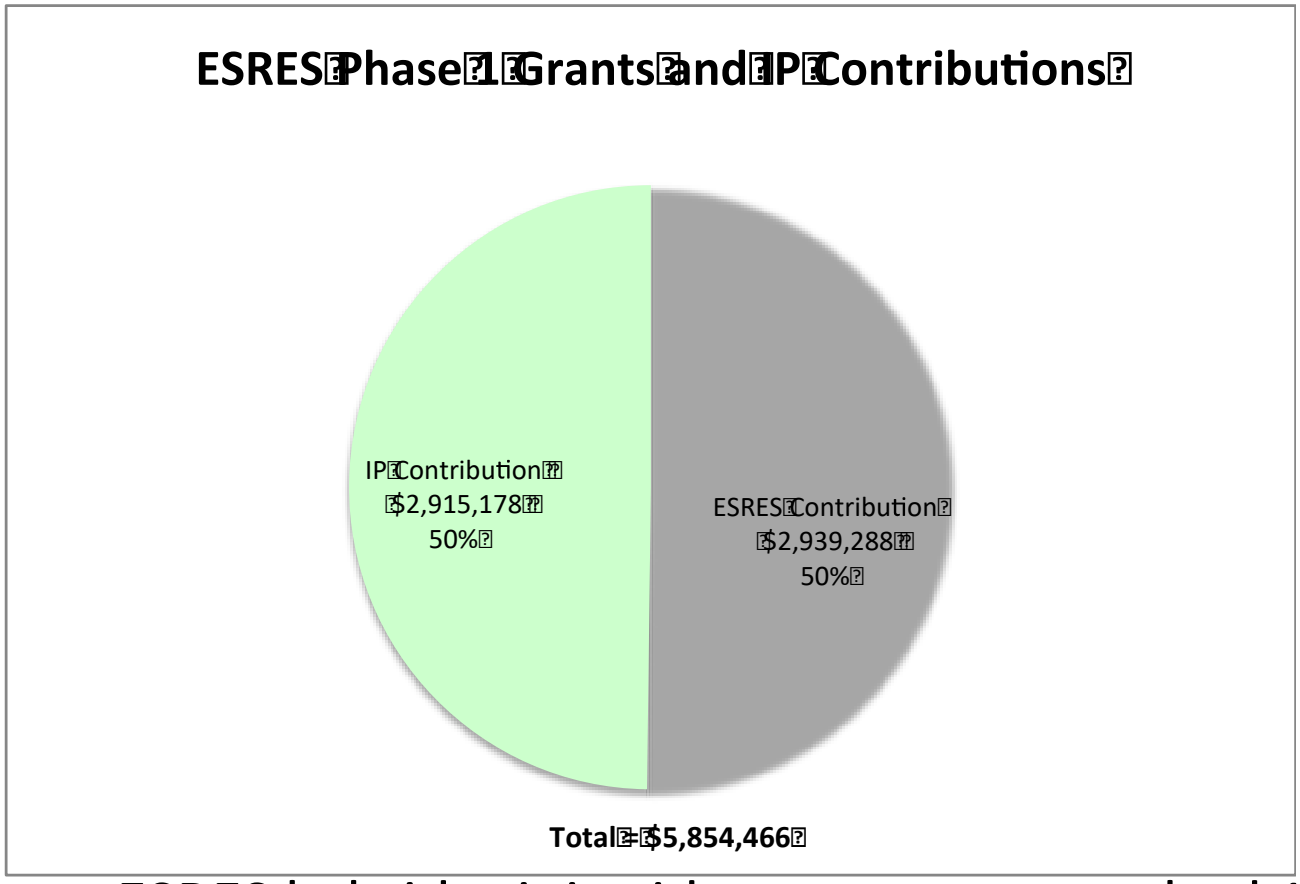
Sheikh (Beder)

Burao (HECO)

Buhoodle (Telesom)

Badhan (Badhan Electricity)

Local Partners Made Significant Contribution to Hybrid Mini-Grid Projects



In aggregate, ESRES hybrid mini-grid grants were matched 100% by IPs.

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1 Is it feasible to build hybrid mini-grids in a fragile, post-conflict environment?

Answer: Yes. ESRES supported developing nine hybrid mini-grids with 8 MWp PV capacity throughout Somaliland.

Lessons Learned:

- Success required co-financing from implementing partners—ensuring buy in and engagement.
- Implementation required EPC contractors willing to take risk and collaborate with local client.
- ESRES played key role as catalyst: Financing, project management support, and technical oversight.
- Demonstration effect: Since ESRES, private sector invested in hybrid mini-grids with over 6 MWp of PV capacity.

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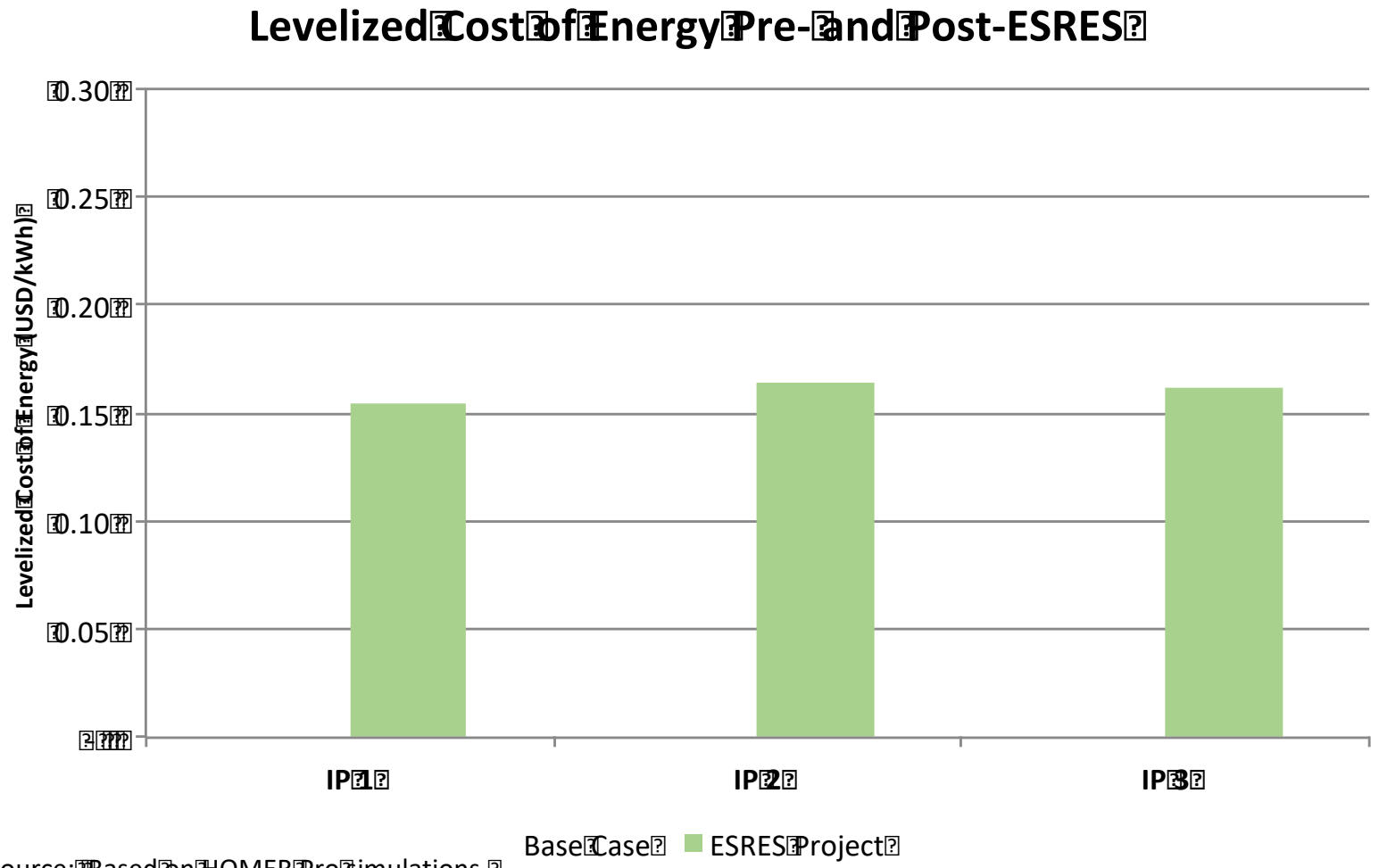
ESRES Hybrid Mini-grids Reduce Generation Costs



Source: Based on HOMER Pro simulations.

HOMER Training Key Success Factor in Hybrid Mini-grid System Design

HOMER training in Hargeisa, Somaliland, August 26-29, 2019

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2 Can a hybrid mini-grid reduce generation costs?

Answer: Yes. The three current ESRES projects reduced the LCOE by an average of 30%.

Lessons Learned:

- Need reliable tool to analyze proposed systems—and know how to use it.
- System design requires good baseline data.
- Need to assess system-wide impact, including distribution, metering, and changing usage patters (e.g., time-of-use and price elasticity).

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Pressure on Prices

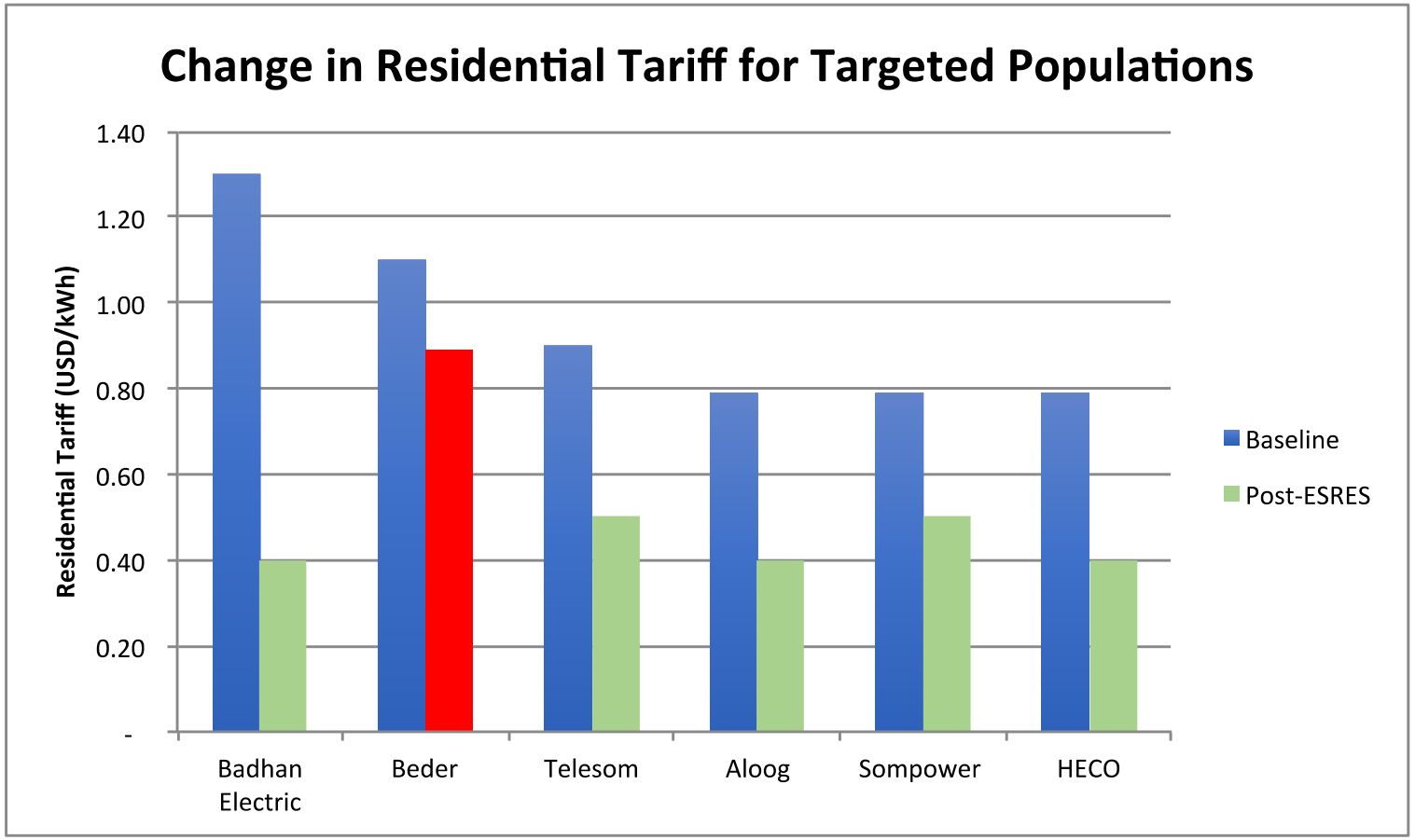
Pulling Prices Down

- Government regulation
- Contractual terms
- Community pressure
- Verified baseline costs and tariff

Pushing Prices Up

- Increased availability of power (better service)
- IP seeking return on investment
- Increase in diesel cost
- Unverified baseline costs and tariff

Most IPs Significantly Reduced Their Tariff



Average tariff reduction of over 40%.

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3 Does reducing generation costs lead to reduced electricity tariffs?

Answer: Yes, it can—ESRES achieved over 40% tariff reduction for targeted beneficiaries.

Lessons Learned:

- Ideally requires effective legal and regulatory framework.
- Much more challenging but still possible absent regulation.
- Other effective enforcement tools include grant agreement terms, bank guarantees, relationship with implementation partner, and community engagement/social pressure.

Questions ESRES Sought to Answer

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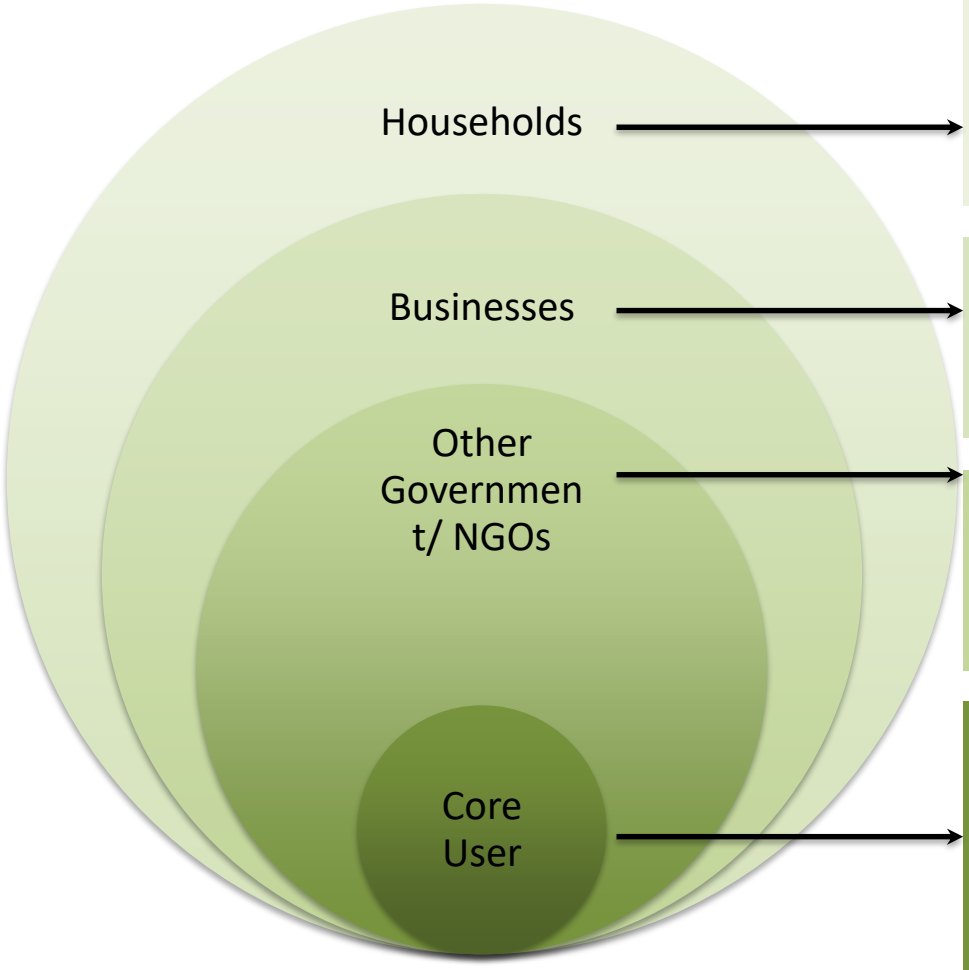
How Does the User Mix Affect Economic Viability?



- Usage improves quality of life but does not generate revenue
- Usage supported by local income
- Usage may either displace or promote other consumption
- 75% of users with 30-35% of load (Evening)

- Usage generates revenue
- Usage supported by local income
- Usage promotes other consumption
- 20% of users with 20-25% of load (Mixed)

- Other large users with strong need and ability to pay
- Usage supported by outside resources
- 5% of users with 20-25% of load (Daytime)

- Largest user with significant need and guaranteed ability to pay
- Vested interest in system
- Usage supported by outside resources
- Usage may explicitly subsidize other customer classes
- 1 user with 15-20% of load (Depends)

What Does it Take to Power Economic Development?

Item	Power (W)	Business/Benefit
CFL Light Bulbs	50	• Extend shop hours • Restaurant/café • Night classes/studying • Security
Sewing Machine	100	• Dress-maker/tailor
TV & Satellite Dish	250	• Restaurant/café
Computer (2-3) & Printer (1)	250-500	• Education • Internet access • …
Refrigerator/Freezer	500 – 1,500	• Drink vendor • Restaurant/café • Grocery shop • Health clinic
Power Tools	500 – 2,000	• Construction • Furniture-making
Air Compressor (2 HP)	2,000 – 2,500 (10 Amp Three-Phase)	• Tire/auto repair • Construction • Small manufacturing
Water Pump	2,000 – 5,000 (10 – 15 Amp Three-Phase)	• Reduce water-gathering time • Crop irrigation • Livestock

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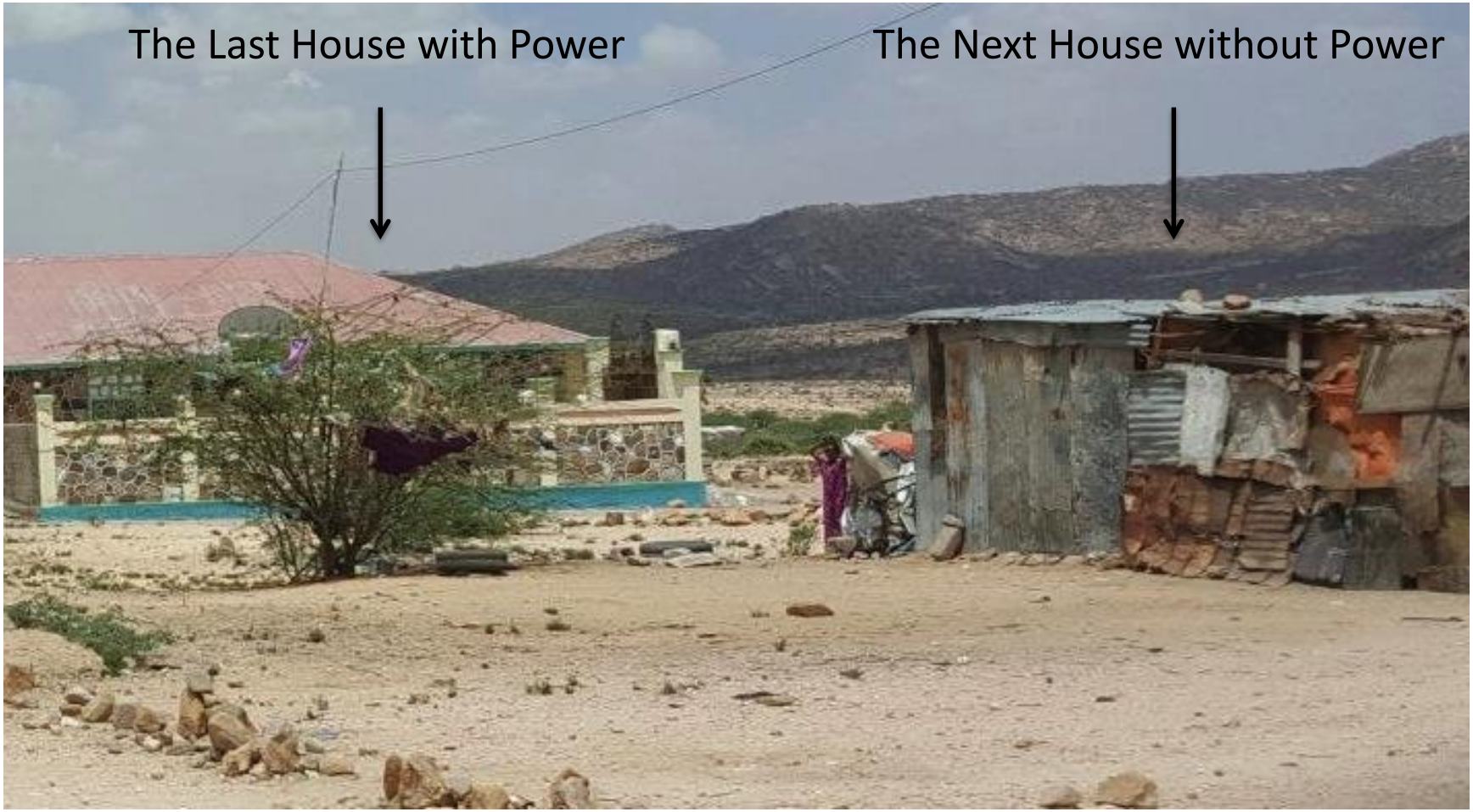
The Next House Problem



4 Does reducing the price of electricity promote economic growth and reduce poverty?

Answer: Probably, but too soon to assess impact of ESRES Programme.

Lessons Learned:

- User mix a factor but not basis for implementation model.
- System should have sufficient capacity to allow for productive use.
- Assess importance of availability and reliability in supporting expected usage.
- Can't connect everyone—sometimes uncomfortable short-term trade off between helping poor and promoting productive use.
- Design appropriate tariff structure.
- Be aware of gender-specific impacts and potential for labor substitution/displacement.

Summary

No.	Question	Answer	Lessons Learned
1	Is it feasible to build hybrid mini-grids in a fragile, post-conflict environment?	Yes	• Success supported by co-financing, strong suppliers, and technical assistance.
2	Can a hybrid mini-grid reduce generation costs?	Yes	• Requires good tools and data to properly design systems.
3	Does reducing generation costs lead to reduced electricity tariffs?	It can	• Absent regulation, need alternative mechanisms such as contracts, bank guarantees, social pressure, and ultimately goodwill.
4	Does reducing the price of electricity promote economic growth and reduce poverty?	Probably, but un-confirmed	• Ensure system allows for productive use. • Design appropriate tariff structure. • Need to gather baseline data and conduct longitudinal study.