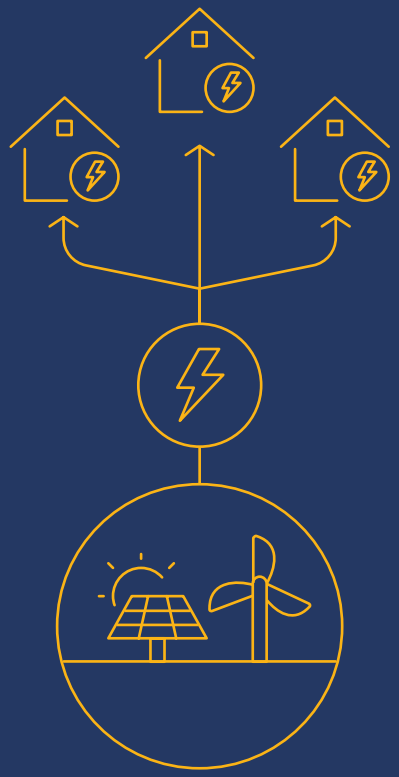
CROSSBOUNDARY

Mini-Grid Innovation Lab

Innovation Insight

Reducing tariff leads to large and sustained increases in demand on mini-grids

September 2022



About the CrossBoundary Mini-Grid Innovation Lab

CrossBoundary's Mini-Grid Innovation Lab, part of CrossBoundary Group, is Africa's first R&D fund exclusively focused on testing new business model innovations for mini-grids, designed to close the gap on the 618 million Africans who do not have power. The Mini-Grid Innovation Lab works with developers across the continent to test innovations to make mini-grids a more reliable and commercially viable solution. For additional information, visit **www.crossboundary.com/labs**.

Mini-grids can deliver lower tariffs to rural customers with significantly less subsidies than the main grid

The Lab has been running the Tariff[1] Reduction prototype from 2018 to 2022, cutting tariffs across five sites in Tanzania between 50-75% to on average $0.48/kWh.The findings of this study uncover two key take-aways that **strongly support the case for developing tariff reduction programs at scale**:

1. **Lower tariffs significantly increase consumption, and these high consumption levels are sustained over time.** Customers increased their consumption by 1.5-3x baseline levels after two years, and have maintained that level of consumption until today.

2. **The lowest consuming users (the poorest) benefit the most from reduced tariffs**, increasing their consumption ~19X compared to the highest consuming customers who increased consumption by 1.2X.

Findings from the study also have implications for program design:

- The higher the percentage reduction in tariff, the greater the increase in consumption– regardless of absolute tariff value. 75% reduction to 59c/kWh increased consumption by 3x, while 66% reduction to 47c/kWh increased consumption by 1.6x.
- Mini-grids can deliver lower tariffs to rural customers with significantly less subsidies than the main grid. Assuming what has been seen in Tanzania could be expected in a country like Sierra Leone, we estimate moving main grid subsidies to mini-grids could provide up to 80% saving on subsidy outlay, assuming customers respond similarly to seen in Tanzania

Based on this strong evidence base, the Lab is working with AMDA and GEAPP to **launch a tariff reduction pilot in Sierra Leone in Q4 2022** that will gather data on the optimal subsidy amount for a national scale-up.

1. Any charge, fee, price or rate for the purchase of electricity. See here for more information on tariff structuring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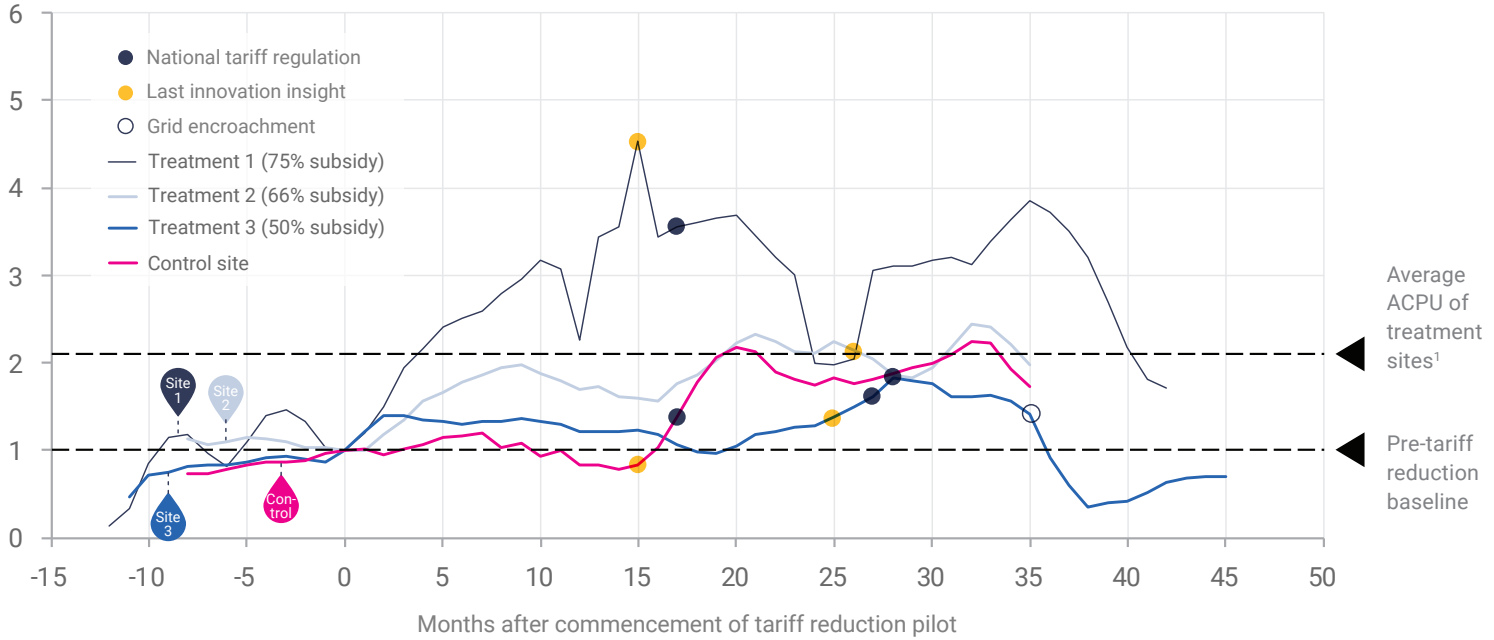
Cutting tariffs by
50-75%
to $0.48/kWh on average
Running from
2018-2022
Across 5 sites
in Tanzania

Mini-grids customers have maintained ~1.5-3x their baseline consumption 3+ years after tariff reduction



About the Tariff Reduction Prototype

- Running since 2018, initially cutting tariffs across five sites in Tanzania between 50-75% to on average $0.48/kWh
- In July 2020, tariffs were further reduced to $0.04/kWh due to national regulations (operations remained under private developers)
- Sites are located in northern Tanzania
- 825 initial treatment connections, and 589 control connections

What we're seeing

- The treatment sites have maintained between 1.5-3x the pre-tariff reduction baseline consumption levels – the exception is treatment site 1, where consumption declined drastically following grid encroachment
- The control site has also experienced consumption uptick to between 1.5x to 2x from ~0.8x baseline levels due to regulation that enforced the tariff to reduce to ~4c/kWh across mini-grids in Tanzania
- Site capacity has not been able to keep up with demand – developers report implementing load shedding across sites to protect installed equipment

What it means

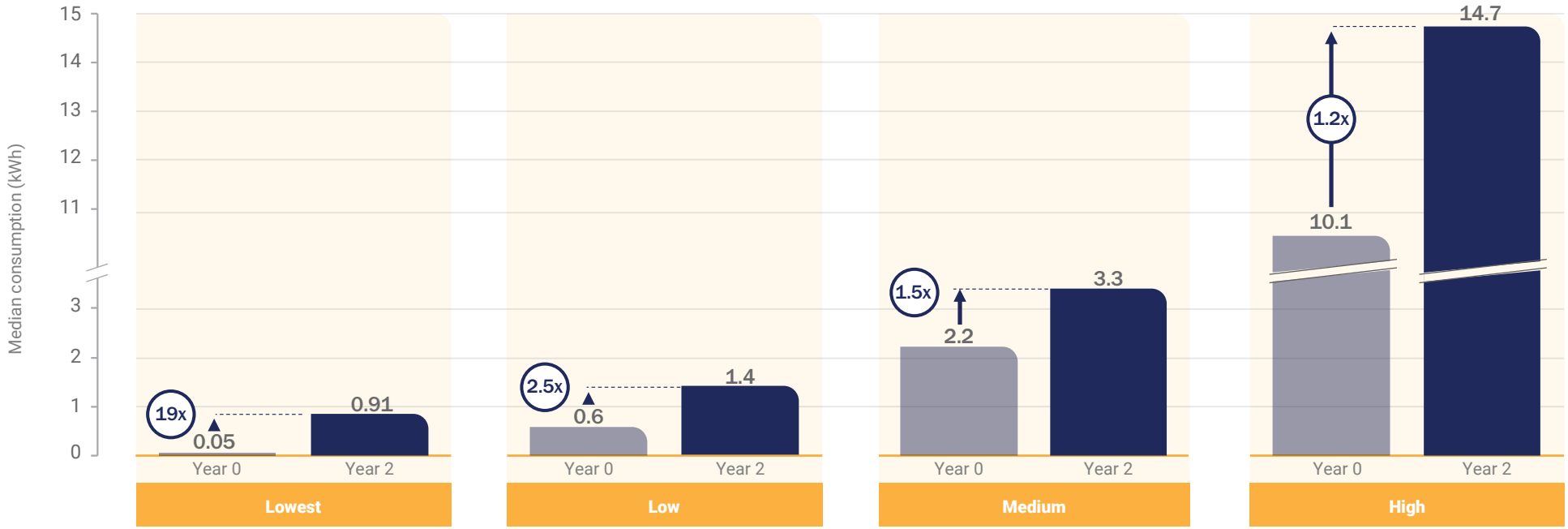
- Consumption growth observed as a result of tariff reduction is maintained 3+ years following reduction of tariffs
- Planning for capacity expansion is crucial for maintaining high service levels for customers following tariff reduction

Note: ACPU index is calculated by indexing actual consumption values immediately prior to tariff reduction indexed to 1.

1. Excludes grid encroached treatment sites 2. Sharp consumption decline following grid encroachment reflects some customers switchingto grid – partially owing to reduced service levels from mini-grid

The social impact of tariff reduction is clear – the lowest consuming users benefit the most from reduced tariffs

Consumption across different customer segments after tariff reduction (in kWh/month)



What we're seeing

- The observed effect of tariff reduction in increasing median consumption is inversely proportional to customer's baseline consumption
- The "lowest" consumer category increased median consumption by 19x, while the "high" consumer segment only had a 1.2x increase –these are commercial users who are likely closer to their demand saturation

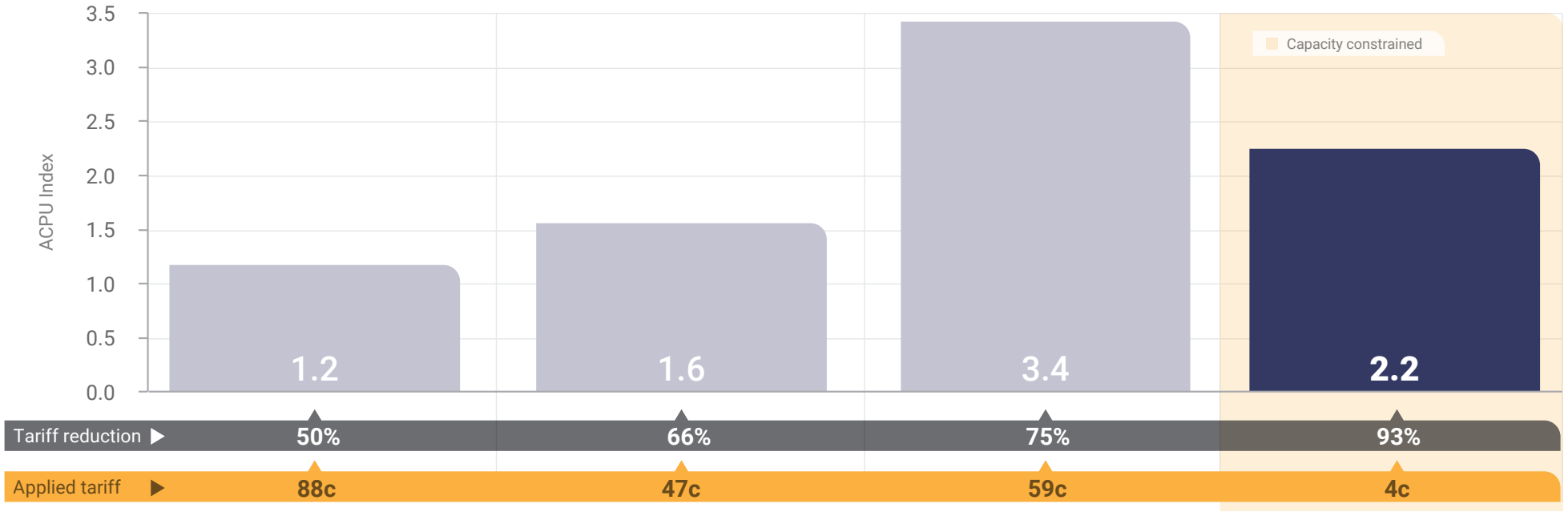
What it means

- This reinforces our assertion from the previous ***Innovation Insight*** that tariff subsidies benefit all categories of mini-grid customers, but the greatest impact is felt by the lowest-using, and likely lowest-income, customers – highlighting the social impact that results from tariff reduction

Note: The customer segments/bands have been determined using the normal distribution of the average consumption per user in the 12 months preceding the start of the tariff reduction prototype. This data shows a right-skewed (positive skewed) distribution of consumption where the mode < median < mean. To create clear boundaries, we've taken the log of this consumption, divided the log data into the bottom/top 0-25%, 25-50%, 50-75% and 75-100%, and removed outlier data. This then gave us the following boundaries in the normal space: [0.14, 0.90, 5.98] in kWh. These make up the boundaries of Lowest, Low, Medium and High.

The higher the percentage reduction in tariff, the greater the increase in consumption

Average Consumption Per User Index across different rates of tariff reduction



What we're seeing

- As the proportion of tariff subsidized increases from 50-75%, the consumption rise as a result of tariff reduction increases as well. Above 75%, increasing the proportion of tariff subsidized does not translate into higher consumption – contrary to expectation
- Furthermore, there does not seem to be a clear relationship between the absolute value of the subsidized tariff level and the factor of consumption increase observed

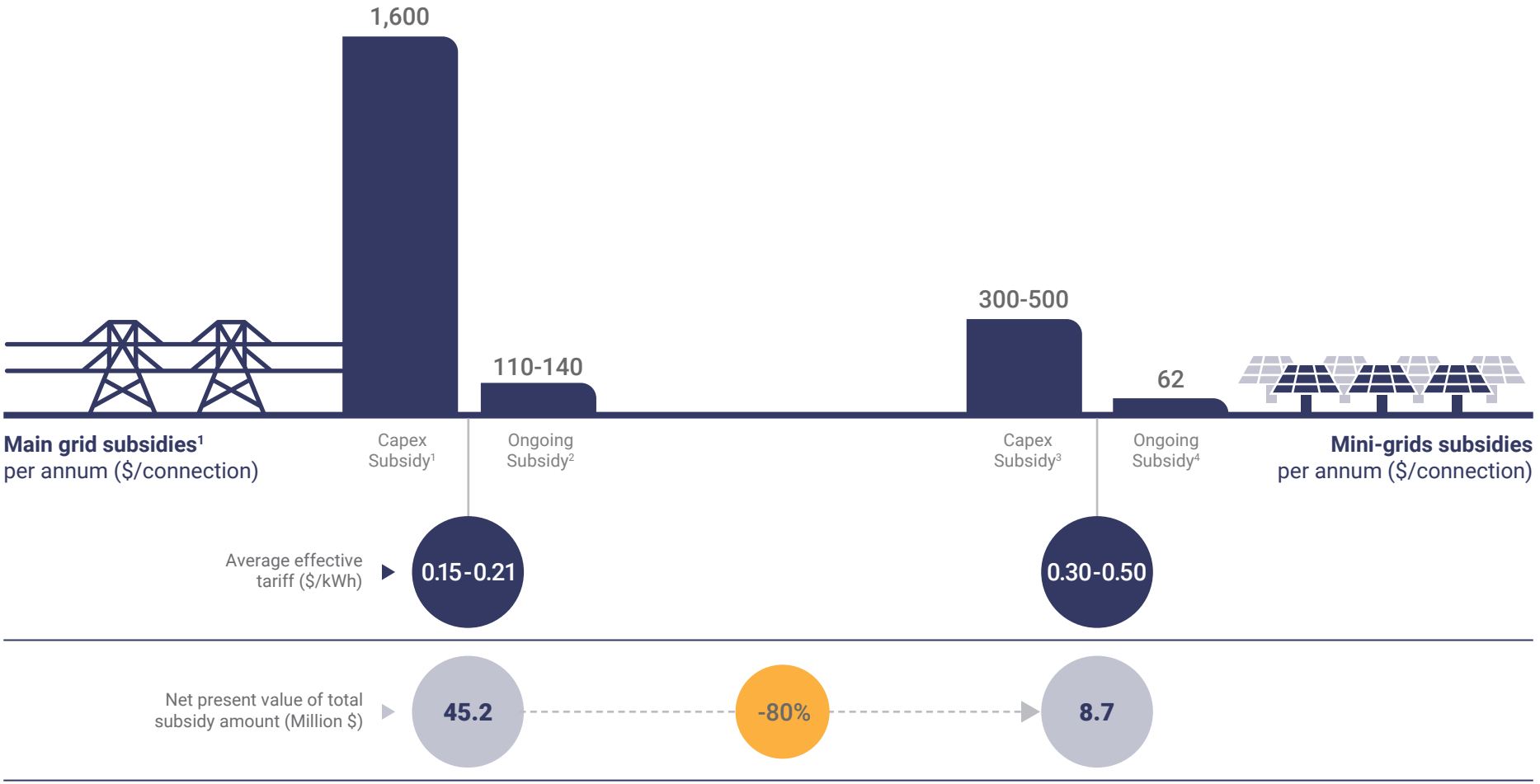
What it means

- It appears customer's consumption increase following tariff reduction is driven primarily by the proportion of tariff that is subsidized and not the absolute amount of subsidy charged
- Saturation of demand occurs after 75% tariff reduction, but cannot be fully estimated as declining service levels at sites where consumptions exceeded available capacity means customers cannot truly fulfil their demand

Note: Actual values immediately prior to tariff reduction indexed to 1

1. Government imposed in July 2020
2. There are 2 treatment sites with this tariff profile – both have been combined here
3. The relationship between percentage reduction of tariff and consumption increase appears to directional, rather than governed by a clear proportionality. It is also not clear the extent to which the consumption increase is driven by site characteristics.

Subsidizing mini-grids is cheaper than subsidizing expansion of the main grid – for example, the government of Sierra Leone could save up to 80% in subsidy outlay



1. Estimated using a minimum spanning MV network to connect mini-grid sites to the main grid
2. Estimated using revenue shortfalls and subsidy actuals in World bank grants report
3. FCDO capex grants administered by UNOPS.
4. Paid annually over 5 years

Source: E-Guide analytics, ECOWAS GIS data, World bank report on enhancing energy access in Sierra leone 2021, Lab internal data, developers

Next steps

These findings support the case for developing tariff reduction programs at scale – the Lab is working with partners to launch a country-wide program in Sierra Leone, starting with a regional pilot of 8 mini-grid sites in Q4 2022

The Lab is working with Global Energy Alliance for People and Planet (GEAPP), African Minigrid Developers' Association (AMDA) and other sector partners to deploy **tariff reduction at scale across Sierra Leone**

We will start with a **1-year regional pilot of 8 mini-grid sites, launching in Q4 2022** to obtain Sierra Leone-specific data points including consumption increase levels at set tariffs, informing the subsidy requirement and duration for national scale-up

The eventual program scale-up is aimed at all 101 existing mini-grids in Sierra Leone, and is expected to **cost ~$8-25M**, with subsidy being phased out after year 5 at the subsidized tariff level

Program partners

Global Energy Alliance for People and Planet
energicity
WINCH ENERGY
PowerGen
Ministry of Energy Sierra Leone
SLEWRC
ManoCap Advisory
ODYSSEY
UNOPS
AMDA
Foreign, Commonwealth & Development Office
THE WORLD BANK
INENSUS

Disclaimer and acknowledgements

The Lab is supported by the University of Massachusetts Amherst, Rochester Institute of Technology, and Duke University, who support experiment design and analysis of results. The Lab's work and the results presented here are strongly endorsed by the Africa Minigrid Developers Association (AMDA).

The Lab's Innovation Insight series provides ongoing, early insights on the prototypes so mini-grid developers, governments, and funders can act on the results as they emerge. All results and analysis in these series is therefore shared as actionable business intelligence rather than scientific evidence.

While these series are not intended to meet the standards of an academic paper, the Lab will publish more complete reports at the end of each prototype, and has partnered with University of Massachusetts Amherst, Rochester Institute of Technology, and Duke University to publish academic papers on certain prototypes.

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CrossBoundary's Mini-Grid Innovation Lab's work is made possible by the following funders:

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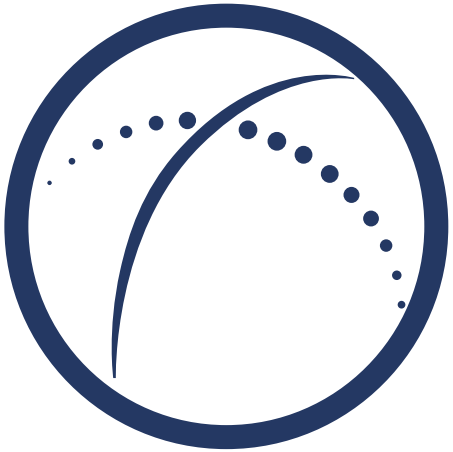

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