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Energy and Economic Growth
Applied Research Programme

UKaid
from the British people

UTILITIES 2.0: BETTER SERVICES, BETTER CONNECTIONS

LESSONS FROM UGANDA AND NIGERIA

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3 June 2020, 6pm EAT

Photo Credit: FRES

Utilities 2.0:
Better Services, Better Connections
Lessons from Uganda and Nigeria

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June 3, 2020

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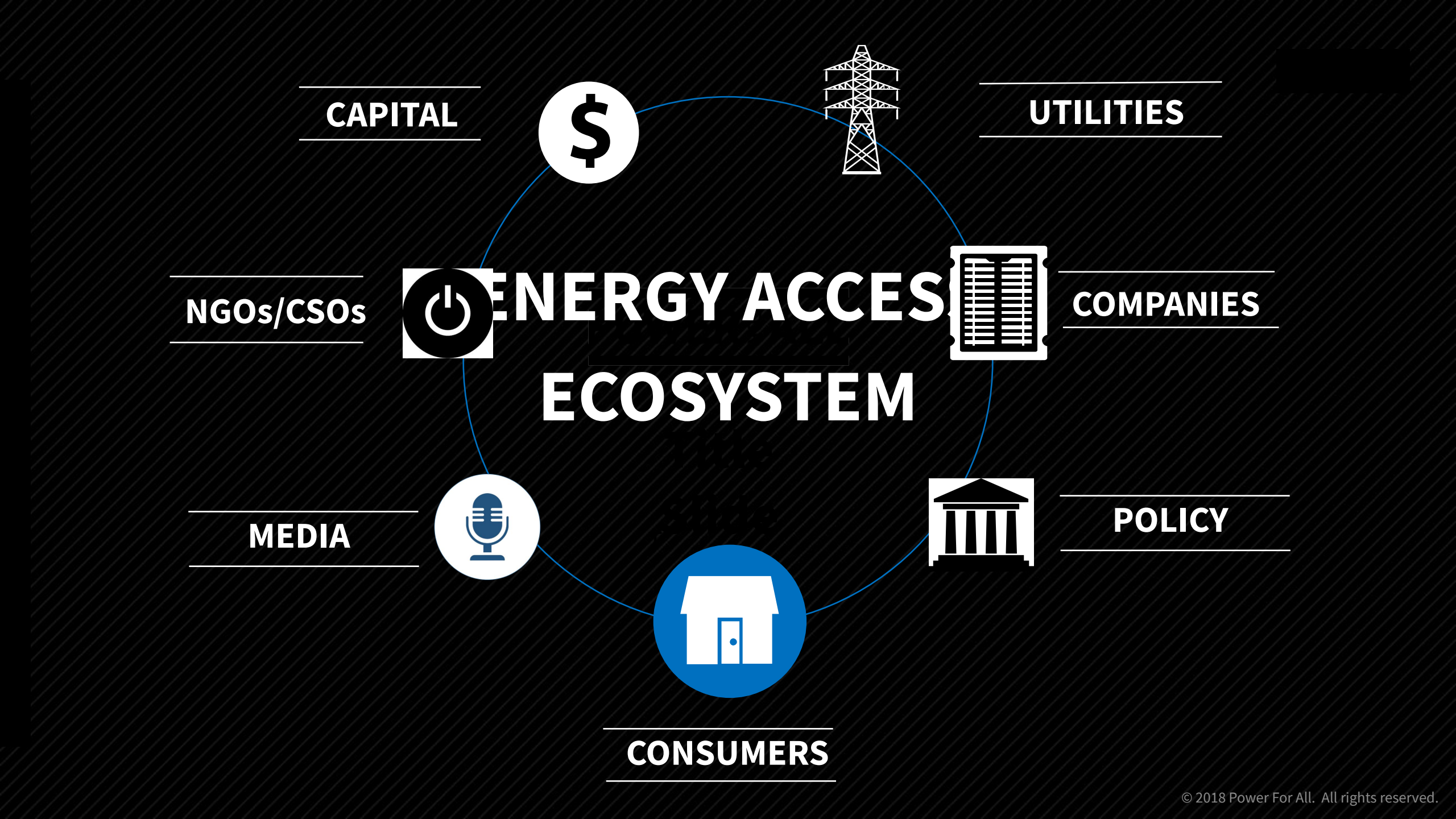

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UTILITY 1.0

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Utility 1.0: SDG7 by 2030?

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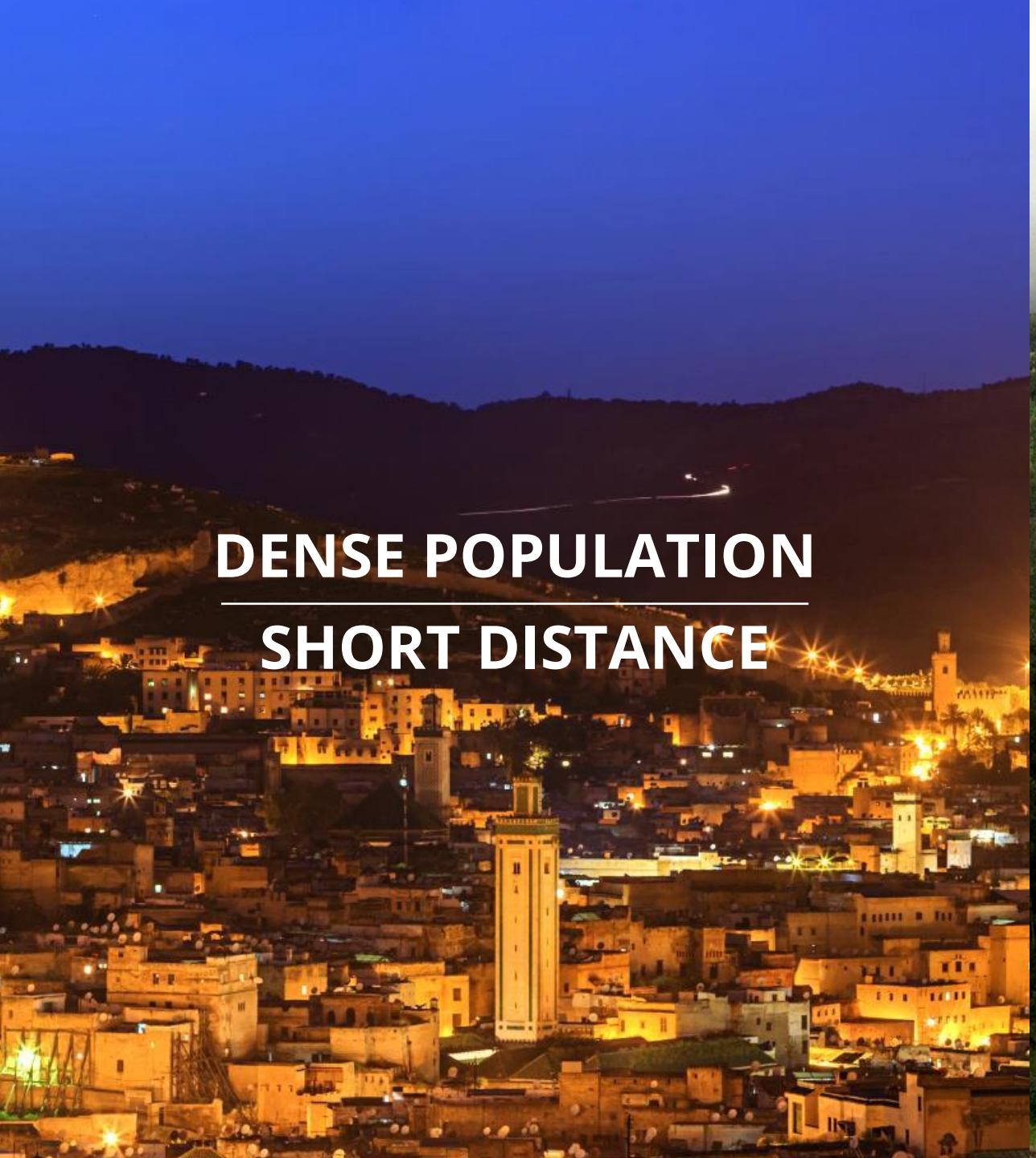
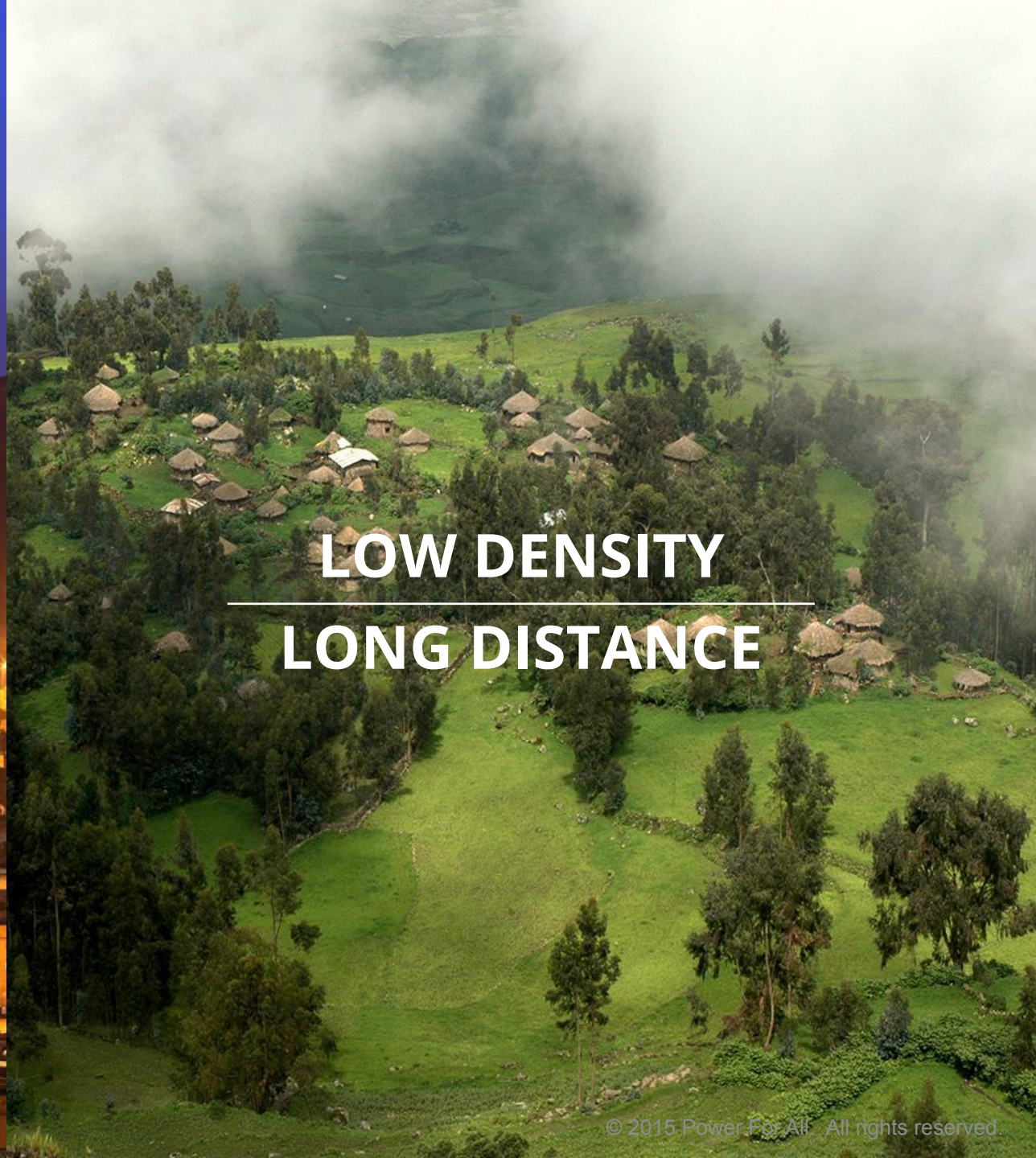
- **SDG7 gets a "D"** (ODI)
- Central grid has been connection of choice for development dollars
- Global investment in power sector increased 2.5x over 15 years
- But energy poor only decreased 1.1 BN to **850,000** since 2010 (ESMAP)
- 100 M+ people per year (20 M connections) to achieve 2030 target

Utility 1.0: Limits in LEA* Countries

- Annual per capita consumption is 400 kWh v. 8,000 kWh in OECD
- Connections up to $2000—more than the annual income of the unconnected
- New energy customers often don’t know how to use energy
- 85 percent of the energy impoverished live in rural areas

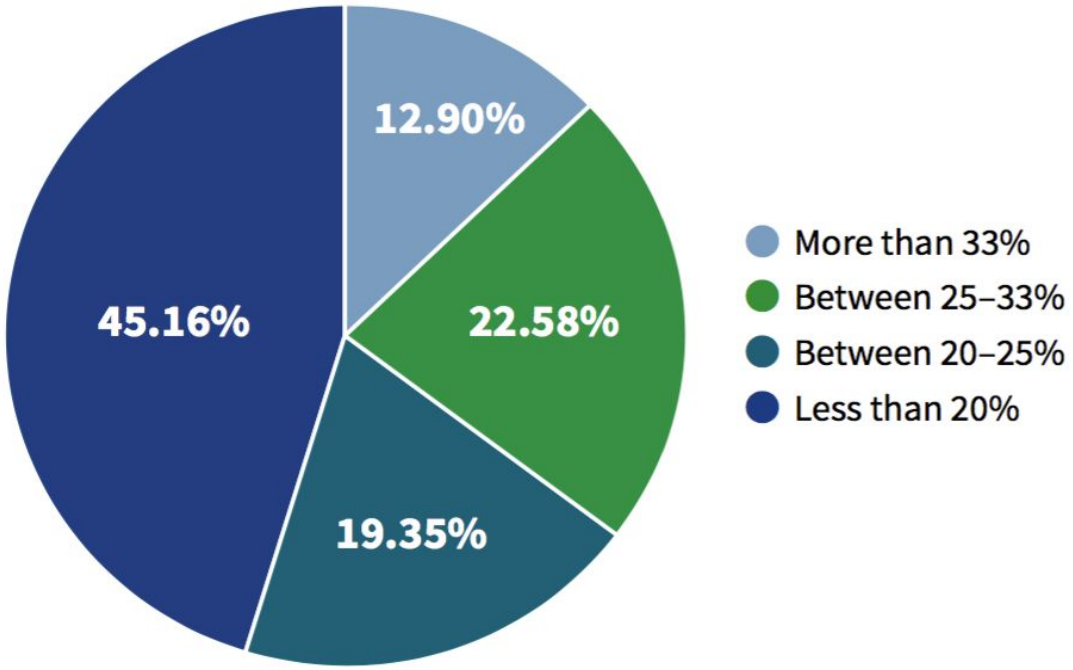
* In low energy access countries (LEAs) less than half of the population is electrified





Utility 1.0: The 1.0 Challenge

FIGURE 1: SSA T&D UTILITY LOSSES 2011–2015[17]



- There are only 2 profitable utilities in all of Sub Saharan Africa
- T&D losses in LEA countries are 5x to 10x developed world counterparts
- Most countries suffer over 500 hours per year of service interruptions
- Average utility deficit US$ 0.10 per kWh and up to 2 % of a country's GDP

Utility 1.0: The 2.0 Opportunity

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Centralized Strengths	Decentralized Strengths
Infrastructure	Modularity
Incumbency	Competition
Scale	Agility
Low-cost, long-term debt	Range of investors, options
Significant customer base	Customer-centric brands
Billing and collection	Ancillary services + products
Capacity + “deep bench”	Innovation

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UTILITIES 2.0

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Utilities 2.0: Vision

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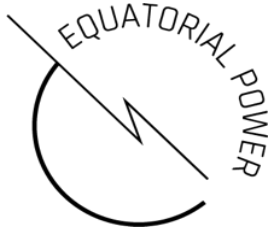
Utilities 2.0 is designed to combine centralized and decentralized technology into an integrated, intelligent, and interactive energy network that can deliver customer-centric, clean energy solutions to end energy poverty at the lowest cost, in the fastest time.

Utilities 2.0: Vision

First-of-kind demonstration of **benefits of integrating centralized and decentralized** energy in the developing world to test:

- Integrated planning and innovative finance can **reduce connection cost, accelerate pace, and improve affordability**
- Smart, integrated technologies can **improve reliability** of connections and reduce grid losses
- Data and finance innovations can **drive demand stimulation** for all energy companies' bottom lines and customer benefit.

Utilities 2.0: Process



Pilot Design: Research

Thesis:

Grid-integrated decentralized renewable tech (PV, storage, mini-grids)

(a) Can reduce the distribution and generation costs of new customer connections

(b) Can provide higher service reliability and at a faster rate of deployment.

Sample Research Questions:

- What connection components can DRE help reduce, and by what margin?
- What infrastructure or operations improve reliability, reduce losses? What margin?
- Can DRE provide connections faster? What is the optimal mix for speed?
- What business models interests work?

Utilities 2.0:
Better Services, Better Connections
Lessons from Uganda and Nigeria

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Moderator:
Dr. Rebekah Shirley
Chief Research Officer, Power for All

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Florence Nsubuga
Chief Operations Officer, Umeme Ltd

James Sherwood
Principal, Rocky Mountain Institute

Pradeep Pursnani
Chief Executive Officer, Konexa

Jonathan Phillips
Energy Access Program, Duke University

Dr. Rebekah Shirley (moderator)
Chief Research Officer, Power for All

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Challenges

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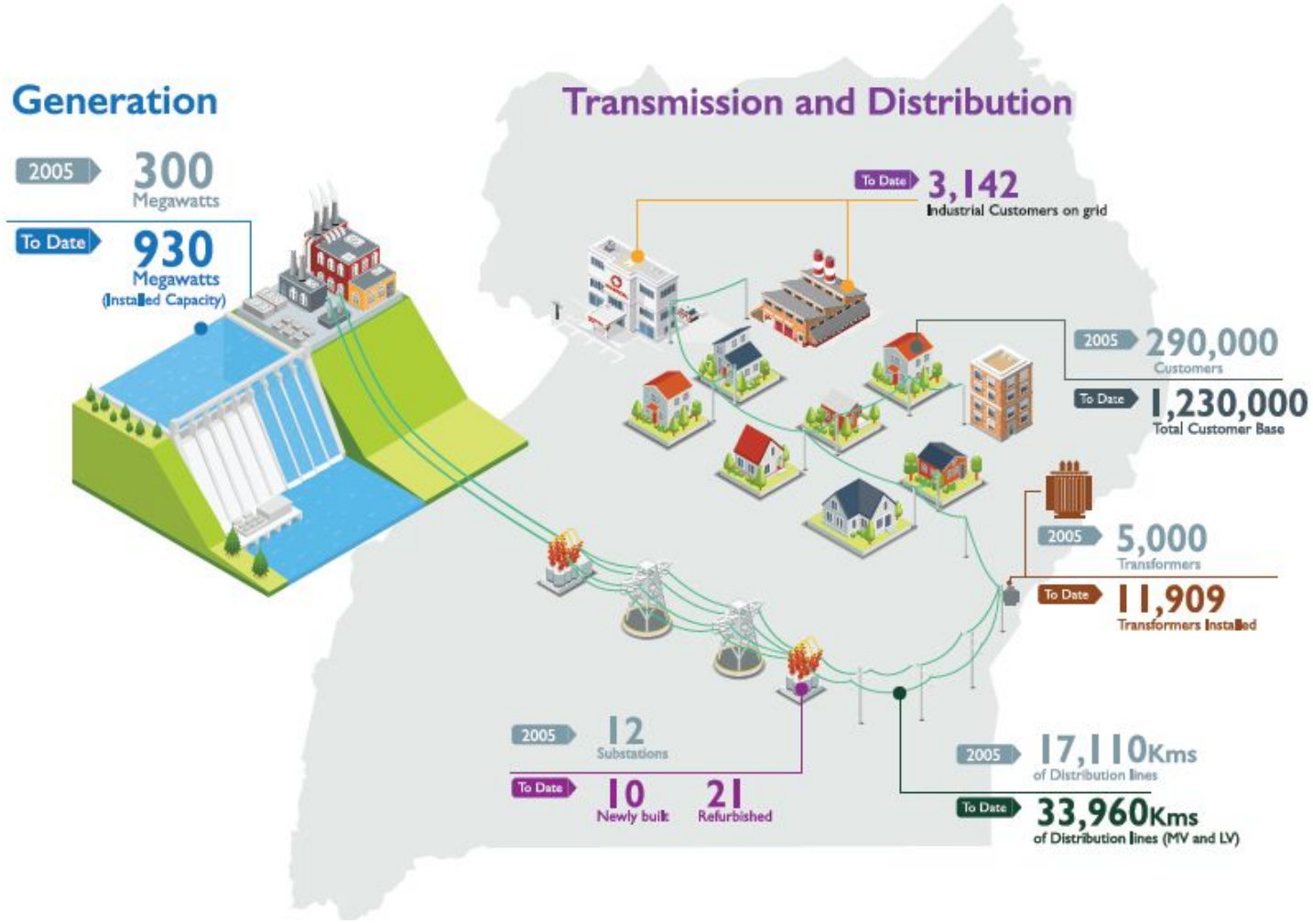
Who We Are

- Distribution Power company in Uganda distributing 97% of the electricity up to 33kV
- Operate a 20 year Concession via a single-buyer model (2005-2025)
- Regulated Company (ERA, USE)
- Hold 2 licenses to distribute and supply low voltage electricity up to 33kV
- Cross-listed on Uganda Securities Exchange (USE) and Nairobi Stock Exchange (NSE)

Our Contribution to the Sector



Closing the Gaps

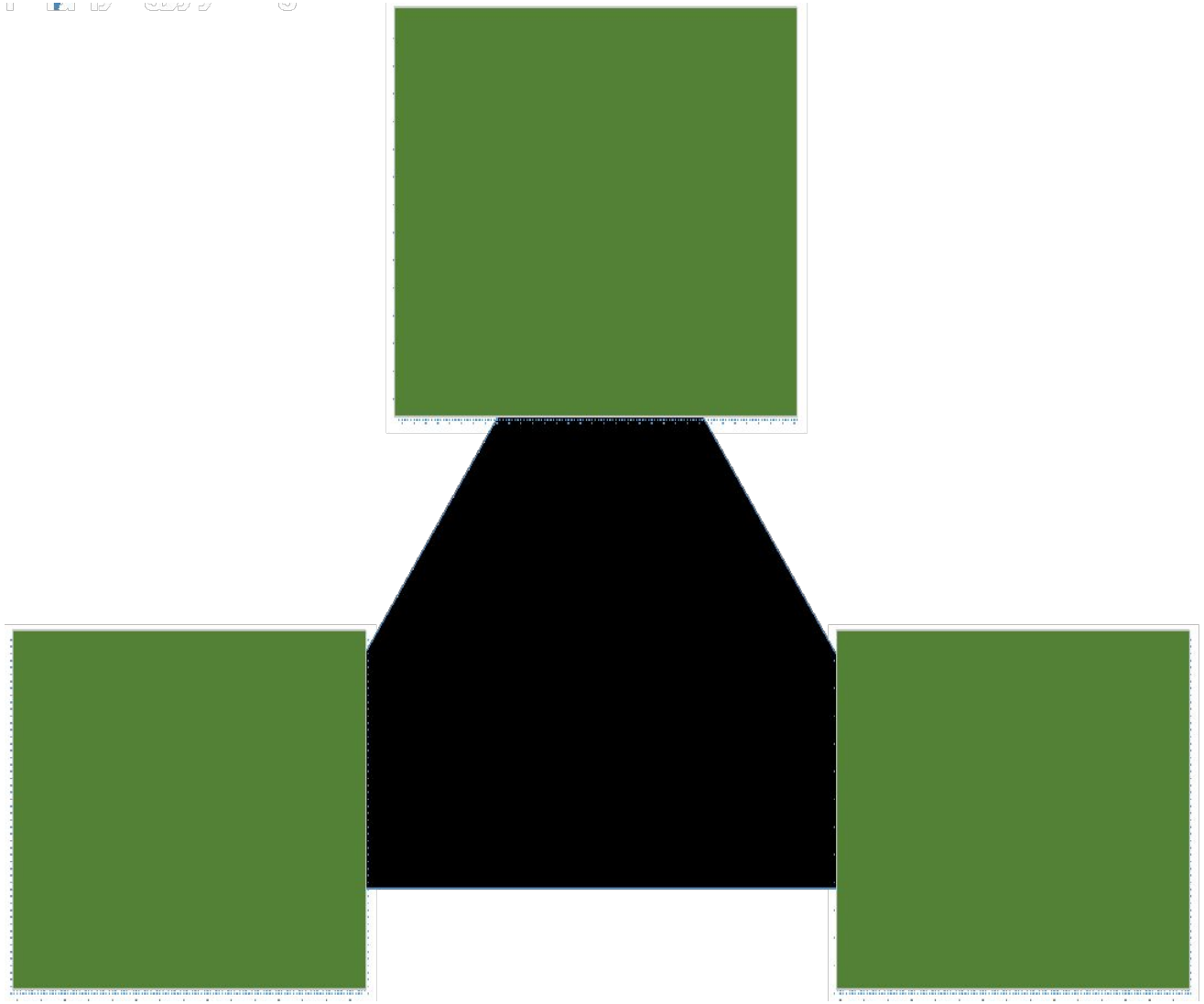
Umeme powers over 2000 schools in Uganda and is seeking for solutions to power more.

Challenges of service delivery

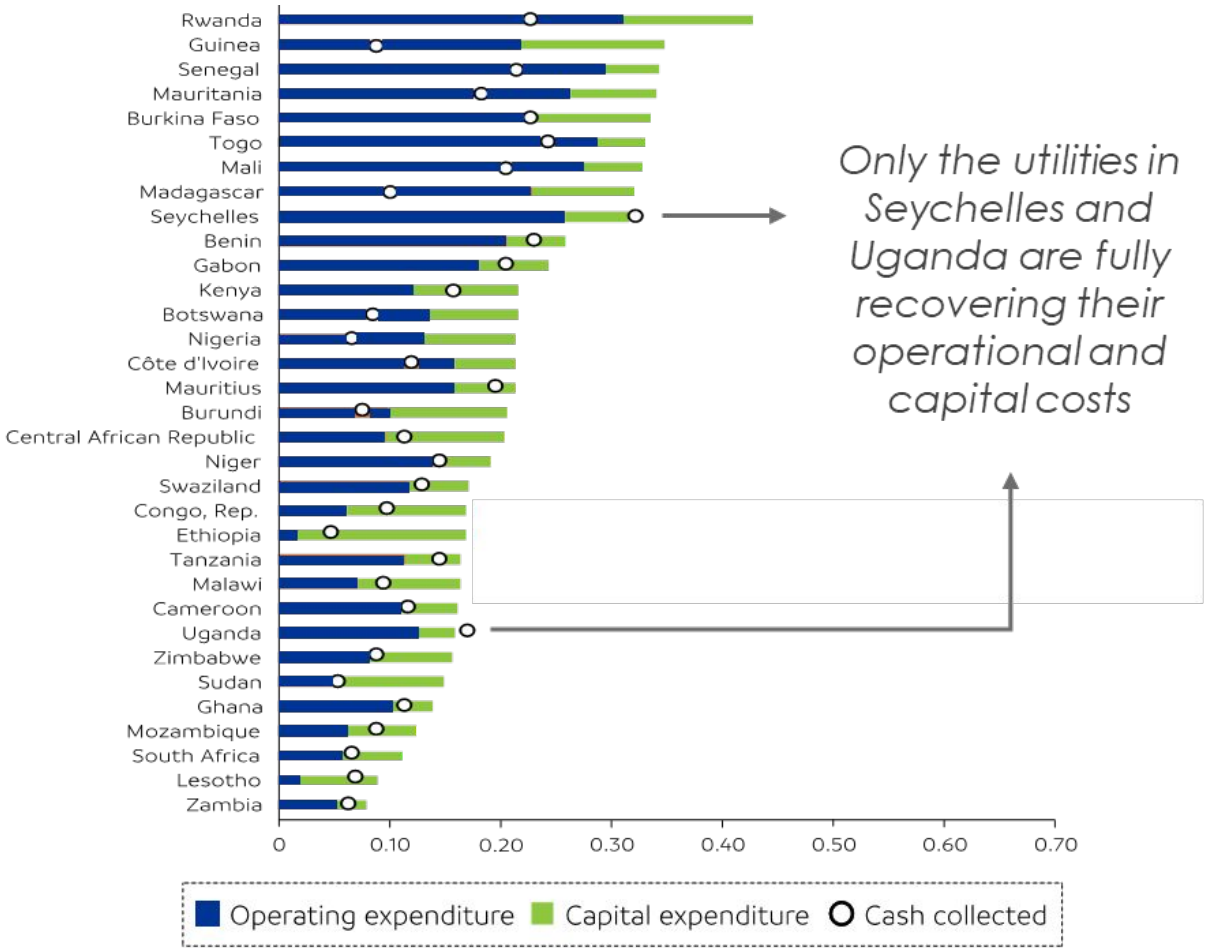
- Over 5m additional connections for universal access. 3x current pace
- Over USD10bn required if Business as Usual

YET

- Low demand for grid edge customers (monthly average of 17kwh vs 45kwh for the existing on grid domestic customers, increasing the cost to serve.
- 629 MW peak domestic demand Vs 1,852 MW installed capacity (including Karuma by end of 2020).



Utilities across Sub-Saharan Africa (SSA) are failing to deliver on their mandates in terms of quality, reach, and cost of service



The reasons for this are manifold and vary by country and utility, but they **all share two common themes:**

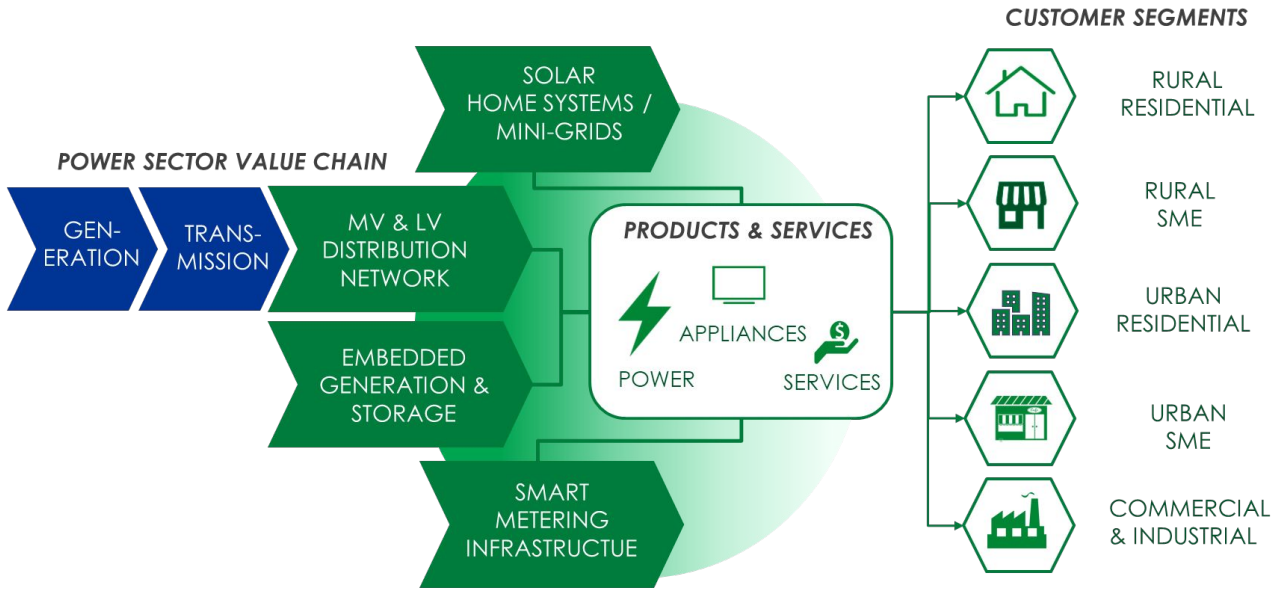
1. **Inability to access affordable capital** to invest in infrastructure upgrades
2. **Low revenue collection rates** due to a combination of theft, estimated billing practices, and non-payment

Source: World Bank (2016) Making Power Affordable for Africa and Viable for its Utilities

Konexa is the Energy Company of the Future

We are the first integrated utility deploying long-term capital to 1) make grid investments, 2) deploy off-grid technologies, 3) install embedded generation & storage capacity, and 4) leverage cutting edge smart metering infrastructure.

INTEGRATED UTILITY MODEL



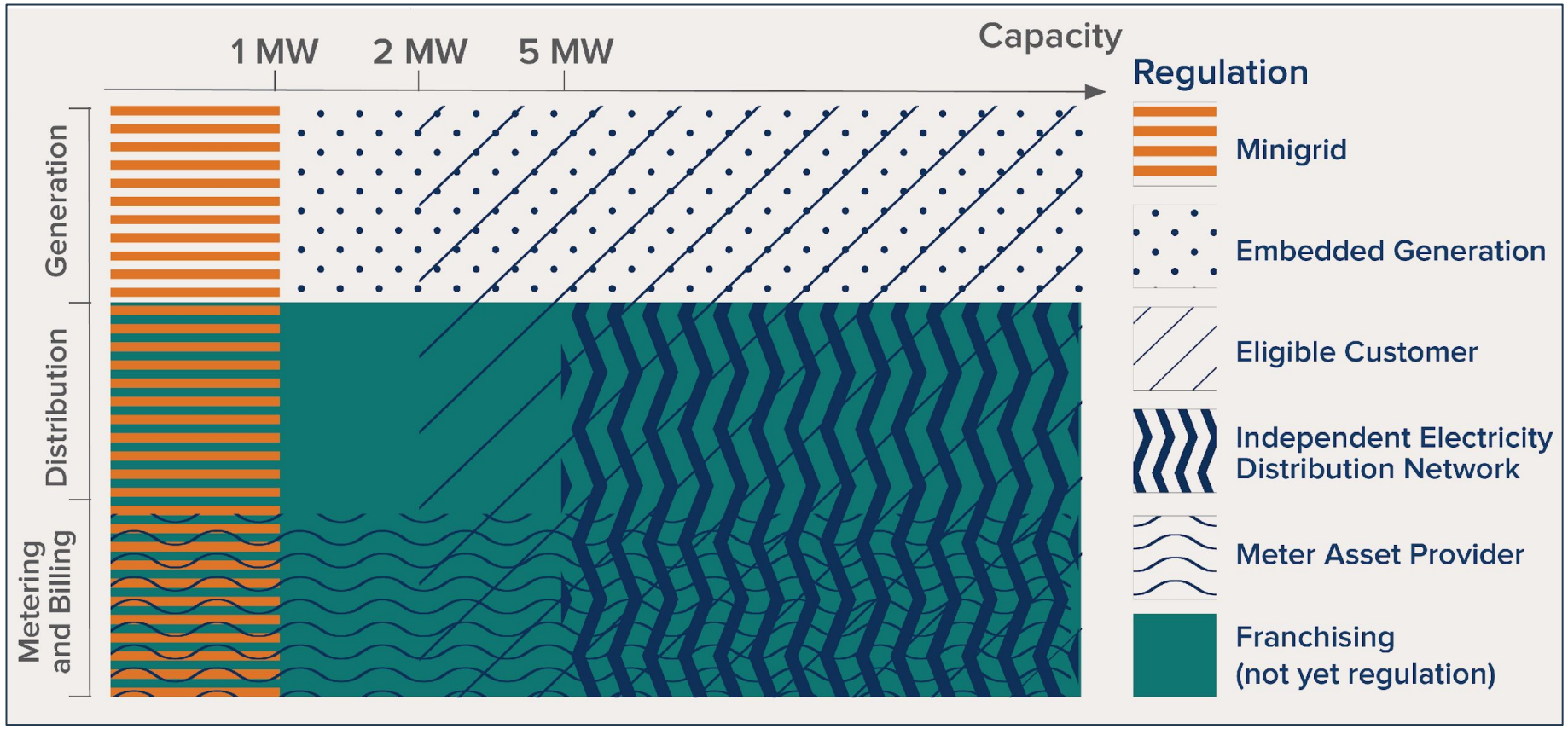
Components of Konexa's business model

Outside of Konexa's business model. Konexa will opportunistically invest in transmission if required to ensure reliable and high quality power supply to its customers

KONEXA VALUE DRIVERS

1. Access to larger, more patient capital pools
2. Operational efficiencies across electrification modes
3. Dynamic, long-term customer relationships

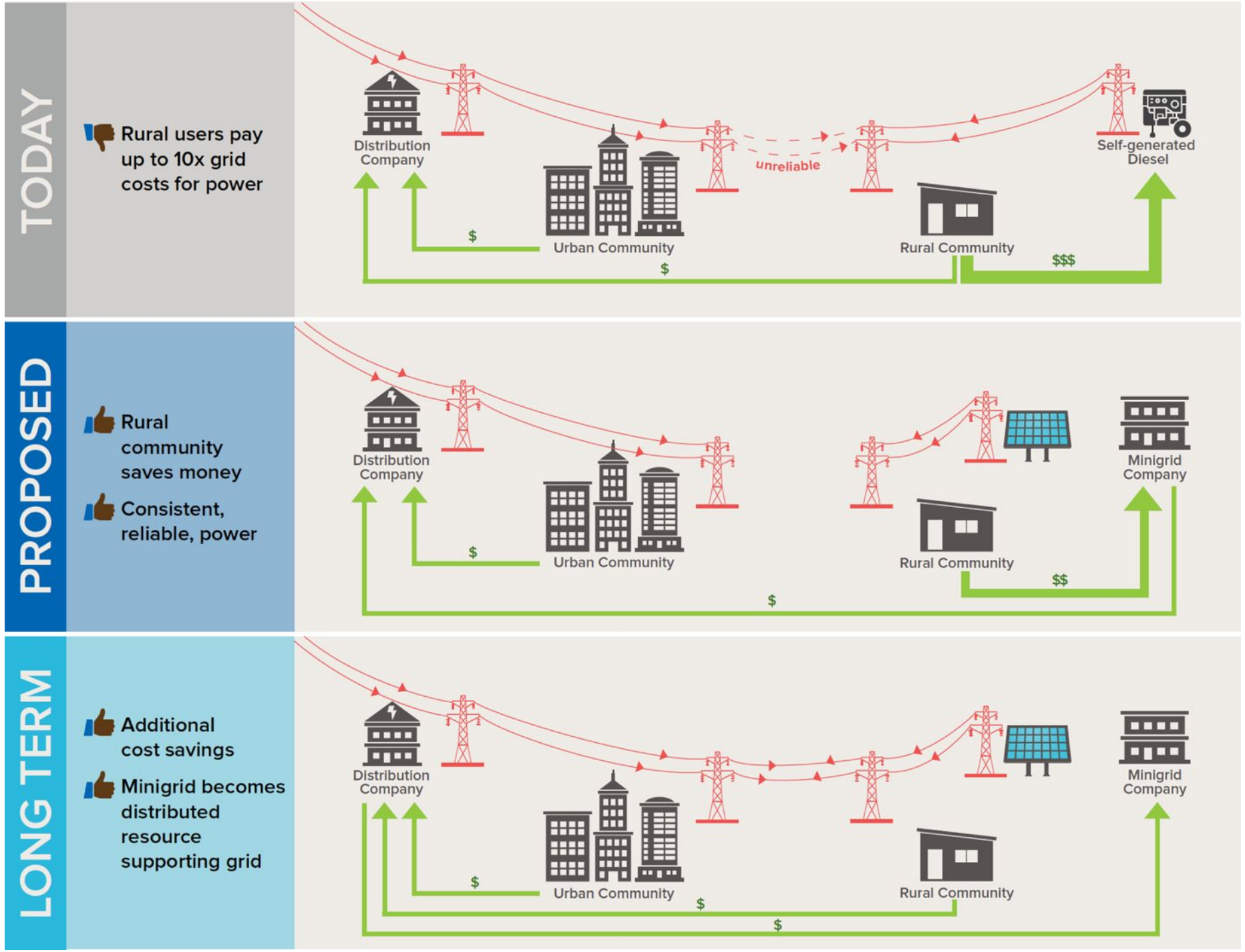
Nigeria has several alternative regulations available that enable DERs



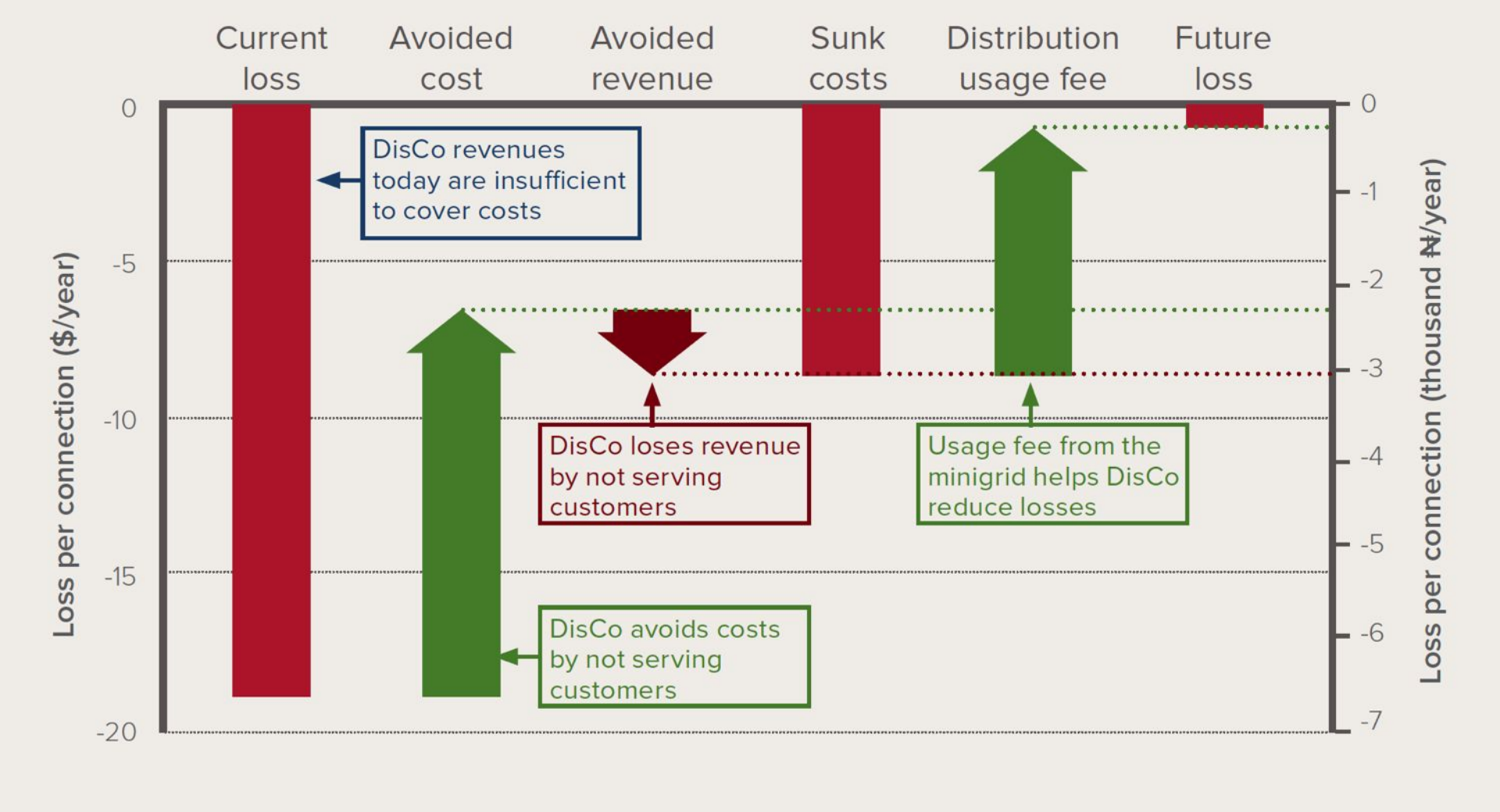
Minigrid Definition:

- **Self-contained power generation system serving multiple customers** through a distribution network
- Up to **1 MW** capacity
- **High reliability**, at least 95%

Source: *Electrifying the Underserved.* RMI, Cleantech Hub, All On, EMRC. *rmi.org/insight/undergrid-business-models*


TODAY
Rural users pay up to 10x grid costs for power
Distribution Company
unreliable
Self-generated Diesel
$
Urban Community
Rural Community
$
$$$
PROPOSED
Rural community saves money
Consistent, reliable, power
Distribution Company
Minigrid Company
$
Urban Community
Rural Community
$$
$
LONG TERM
Additional cost savings
Minigrid becomes distributed resource supporting grid
Distribution Company
Minigrid Company
$
Urban Community
Rural Community
$
$

Transitioning service to an undergrid minigrid can reduce DisCo financial losses by 60–100% in a rural community



Source: *Under the Grid*, rmi.org/insight/under-the-grid/

Rural electrification programs have historically been costly. Public financing has been essential for raising capital

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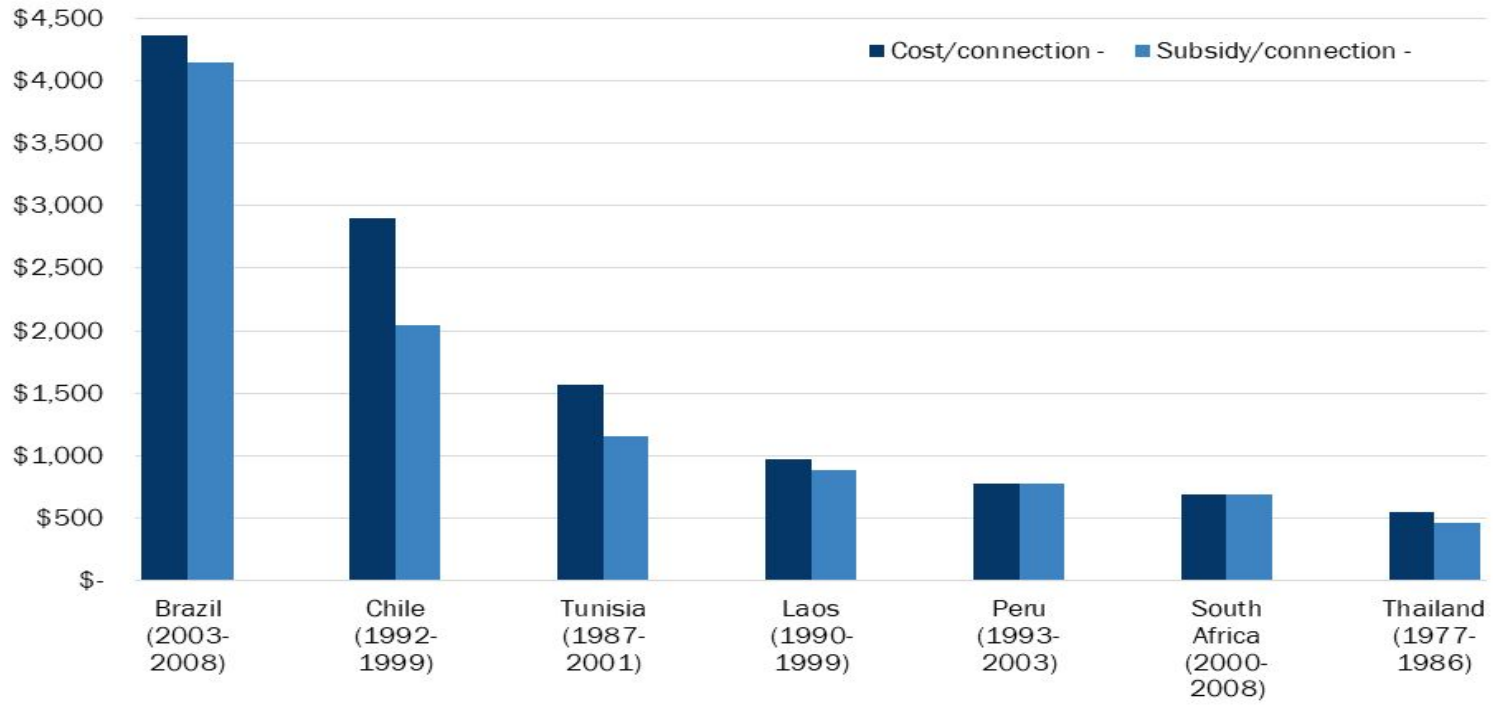
Figure 1. Cost and subsidy per new electricity connection



Source: "Lessons for Modernizing Energy Access Finance, Part 1: What the Electrification Experiences of Seven Countries Tell Us about the Future of Connection Costs, Subsidies, and Integrated Planning." NI Policy Brief 20-02. Durham, NC: Duke University.

BROOKINGS

- Connection costs > $1,500 per household/business, on average
- Customers paid an average of $210/connection, or 14 percent of total connection costs.
- Connection subsidies ranged between 70 and 100%
- Regions, communities, and projects prioritized based on social value and productivity considerations

Density and incomes drive cost and subsidy considerations

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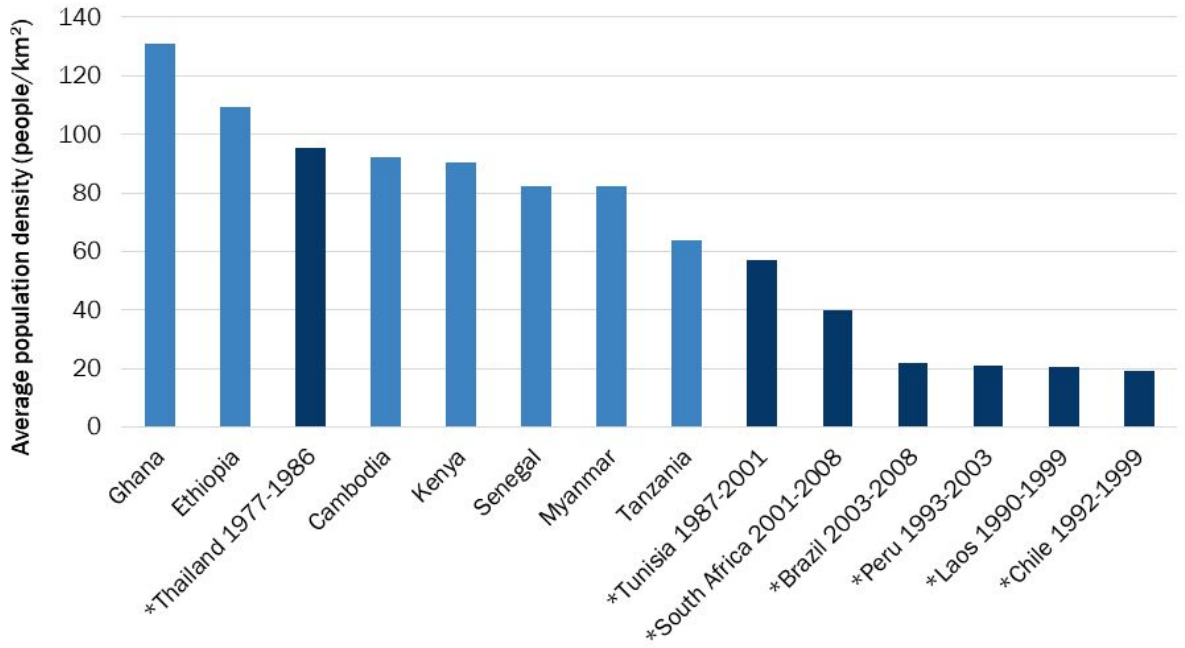
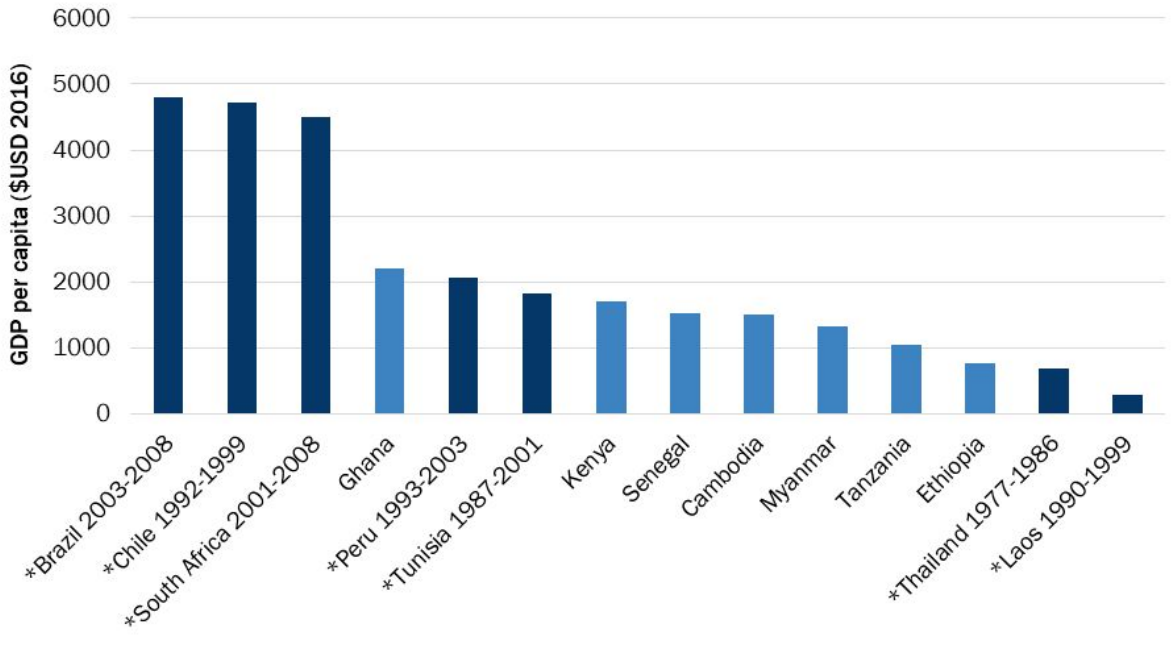
Figure 2. Density in case countries and those facing rural electrification gaps today



Source: World Bank. 2019b; World Bank 2019c.
Note: Countries with an asterisk (*) are case countries, and their data is from the focus period for each case. Other countries are 2018 data from countries where rural electrification is a priority issue at present.

BROOKINGS

Figure 3. Income in case countries and those facing rural electrification gaps today



Source: World Bank. 2019b; World Bank 2019c.
Note: Countries with an asterisk (*) are case countries, and their data is from the focus period for each case. Other countries are 2018 data from countries where rural electrification is a priority issue at present.

BROOKINGS

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Business Innovations

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Our integrated model is based on partnerships with existing utilities, cutting edge technology, and a customer value proposition for 24/7 reliable power

Intelligent Network Planning

Network design based on enumeration, load surveys, and connected network models

Technical Loss Reduction

Targeted investments to upgrade or replace key distribution infrastructure

Commercial Loss Reduction

Theft reduction and switch from estimated to consumption-based billing through next generation metering

Commercial & Industrial Customers

100% reliable power provision to commercial and industrial customers with load sensitive operations

Energy Access for All

Electrification of rural populations through off-grid technologies like mini grids and solar home systems

Customer Centricity

Domestic and productive use appliances based on in-depth understanding of customer needs

Complementary Generation

Balancing of grid shortages through installation and operation of embedded generation assets

Proprietary Technology

Integrated utility systems architecture to harmonize operations across assets

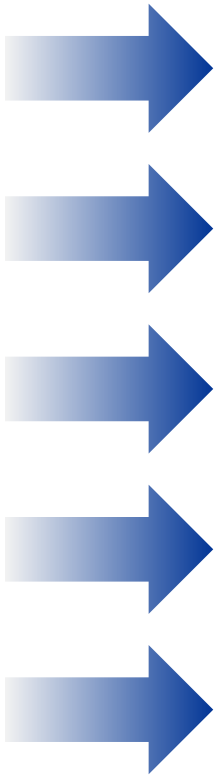
Government Support

Compliance with regulation and alignment with Government priorities and objectives

The integrated distribution model can break the vicious cycle that African utilities face today and restore health to energy systems

CURRENT UTILITY MODEL

- Significant operational losses due to **non-cost reflective tariffs**
- **High ATC&C* losses** due to inefficient distribution and low revenue collection rates
- **Low electrification rates** due to expensive, one-size-fits all grid extension solution
- **Single product offering** in the form of sales of kWh
- **Non-transparent estimated billing processes** with minimal customer engagement



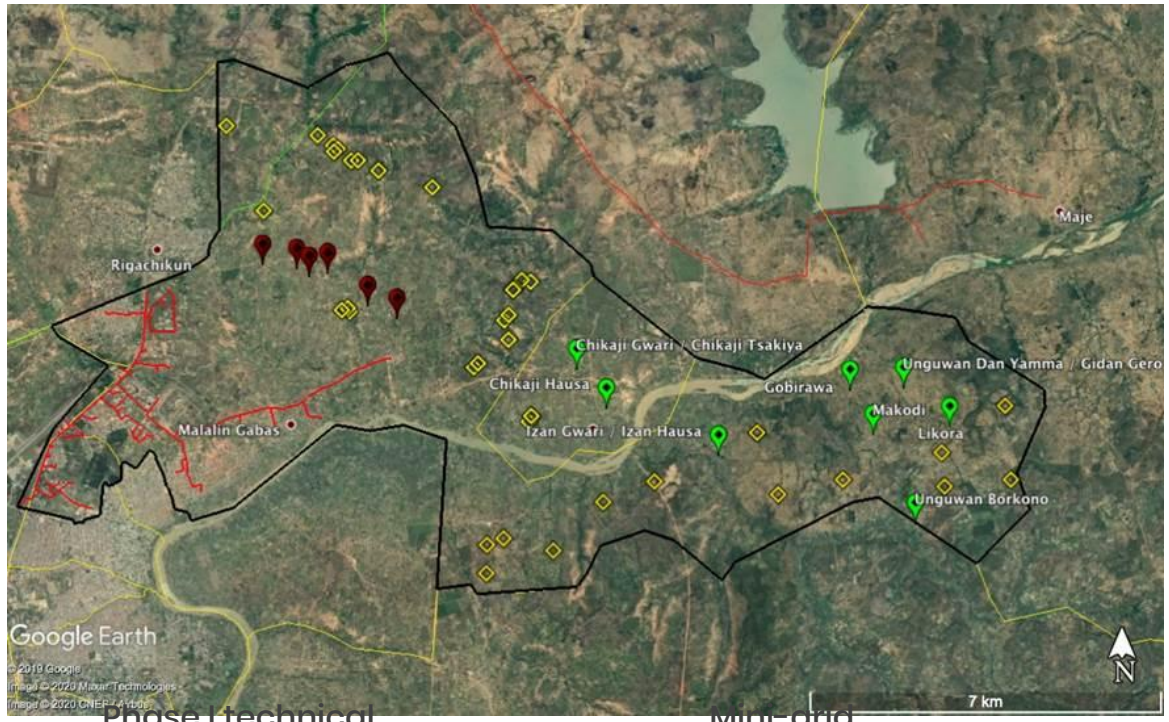
KONEXA'S INTEGRATED MODEL

- De-risking by targeting large value pools of **C&I customers on a willing buyer, willing seller basis**
- **Loss reduction** through **infrastructure investments** and **comprehensive metering**
- **Increased viability for low demand customers** due to provision of mini grids and SHS
- Increasing kWh / viability of demand through **appliances and financing**
- **Accurate billing** and **extensive customer engagement**

** Aggregate technical, commercial, and collection losses*

Phase I will focus on the Zaria Road area and select maximum demand (MD) customers in the Kudenda area; It is estimated to cost ~$45 million

ZARIA ROAD AREA



Phase I technical boundary
11 kV feeder
33kVfeeder
Mini-grid site
SHS cluster
Grid extension site

KEY PHASE I ACTIVITIES *[NON-EXHAUSTIVE]*

- Grid network upgrades
  - Consumer connection upgrades
  - LV line and pillar upgrades
  - DT protections / replacements / additions
  - Sectionalisors & Auto Reclosers
  - Fault path indicators
  - MV line rehabilitations
- Construction of mini grids
- Roll out of solar home systems
- Comprehensive meter rollout
- Development of 2.5MW solar PV plant
- Development and implementation of systems architecture
- Acquisition of a 40% stake in a hydro power plant

Konexa has received catalytic seed-stage support to date from key energy access donors

Electrifying the Underserved identifies four business models for undergrid minigrids that are viable today

- **Minigrid Operator-led –** Private minigrid operator leads development of minigrid with consultation across the DisCo and community

- **SPV-led –** Development is led by an SPV (potentially formed by a DisCo's investors) and certain specialized functions are subcontracted to a minigrid operator

- **Cooperative-led –** A cooperative formed by the community leads minigrid development

- **Collaborative SPV-led –** Ownership and operation functions are spread across the DisCo, minigrid operator, and undergrid community (via a co-op)

Source: *Electrifying the Underserved.* RMI, Cleantech Hub, All On, EMRC. *rmi.org/insight/undergrid-business-models*

Utilities 2.0: The Approach and Umeme's Perspective

- **Identify and exploit comparative advantages; Utility builds the network and DRE partner builds up the customer**
- **Lowest Capex Models (Lowest cost provider builds the network, consideration for Project equipment leases, cheaper battery storage alternatives.**
- **Lowest Opex Model (use of existing systems with partners such as billing systems)**
- **Thus shortening the learning curve and creating channel 2 revenues**

3 MAIN DRIVERS OF LCOE AND CONNECTION COST

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- **UP-FRONT CAPITAL INVESTMENT (CAPEX)**
  - **UTILITY VIEW:** LIMITED, REGULATED, ULTIMATELY IN CUSTOMER TARIFF, NEEDS TO BE APPROVED
  - **MINI-GRID IPP VIEW:** SCARCE, EXPENSIVE, OFTEN USE EQUITY CAPITAL TO FUND INFRASTRUCTURE ASSETS (WHERE LONG TERM, LOWER COST DEBT WOULD BE MORE APPROPRIATE); RISK OF 'STRANDED ASSETS (GRID ARRIVAL)
  - ***SENSITIVITY:*** *A 50% CAPEX REDUCTION COULD YIELD A $0.40-$0.60/KWH POWER COST REDUCTION*
- **OPERATING COSTS (OPEX)**
  - **UTILITY VIEW:** REGULATED, IN CUSTOMER TARIFF, CONSTANT PRESSURE FOR OPERATING EFFICIENCY, TO SERVE MORE CUSTOMERS FOR LESS – UTILITIES EXPERIENCED WITH OPERATING AT LOW COST
  - **MINI-GRID IPP VIEW:** PRIORITIZE CUSTOMER SERVICE AND RELATIONSHIP; BUT LIMITED WAYS TO LEVERAGE FIXED COSTS AND LARGE SCALE IN FUNCTIONS LIKE BILLING, COLLECTIONS, CUSTOMER SERVICE INQUIRIES
  - ***SENSITIVITY:*** *A 20-25% OPEX REDUCTION COULD YIELD A $0.30-$0.60/KWH POWER COST REDUCTION*
- **COST OF CAPITAL**
  - THERE'S ONLY SO MUCH CASH FLOW – MORE TO INVESTORS MEANS LESS TO IPP OR HIGHER COST TO CUSTOMERS
  - UTILITY MAY HAVE STRONGER BALANCE SHEETS, ACCESS TO LOWER COST DEBT
  - ***SENSITIVITY:*** *A 600 BASIS POINT (6 PERCENTAGE POINTS) REDUCTION IN CAPITAL COST COULD YIELD AT LEAST A $0.50/KWH REDUCTION IN POWER COST*

THESE ARE THE FINANCIAL DRIVERS MOTIVATING NEW BUSINESS MODELS

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LOOKING INTO 3 ALTERNATIVE BUSINESS MODELS

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- **'LEVERAGE CLEAR COMPARATIVE ADVANTAGES' MODEL ('LEVEL 1')**
  - **APPROACH:** PARTNER WITH EQUAL OR BETTER QUALITY AT LOWER COST PROVIDES THE FUNCTION
  - **CURRENT VIEW:** UTILITY BUILDS THE NETWORK, IPP OWNS CUSTOMER/BUILDS DEMAND, OTHER OPTIONS BEING EXPLORED – ***WITH THE GOAL OF DRIVING DOWN OPEX WITHOUT COMPRIOMISING CUSTOMER SATISFACTION AND DEMAND***
- **'LOWEST CAPEX' MODEL ('LEVEL 2')**
  - **APPROACH:** DRIVE DOWN SOFT COSTS AND HARD CAPEX COSTS THROUGH STANDARDIZATION, LEASING AND MOBILITY
  - **CURRENT VIEW:** STANDARDIZED, MODULAR SOLAR GENERATION, LOWEST COST PROVIDER BUILDS THE NETWORK, EQUIPMENT IS LEASED TO REDUCE CAPEX, FIND LOWER-CAPEX ALTERNATIVES TO BATTERY STORAGE
- **'LOWEST COST OF CAPITAL' MODEL ('LEVEL 3')**
  - **APPROACH:** LEVERAGE UTILITY BALANCE SHEET AND LOWER CAPITAL COST TO PURCHASE AND FINANCE AT LOWER COST
  - **CURRENT VIEW:** UTILITY BUYS AND FINANCES THE ASSETS, IPP OWNS THE CUSTOMER/BUILDS DEMAND, POTENTIAL ECONOMICS AND SHARING OF VALUE BETWEEN PARTNERS BEING EXPLORED

EACH MODEL FOCUSES ON ONE OF THE KEY FINANCIAL DRIVERS

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Customers

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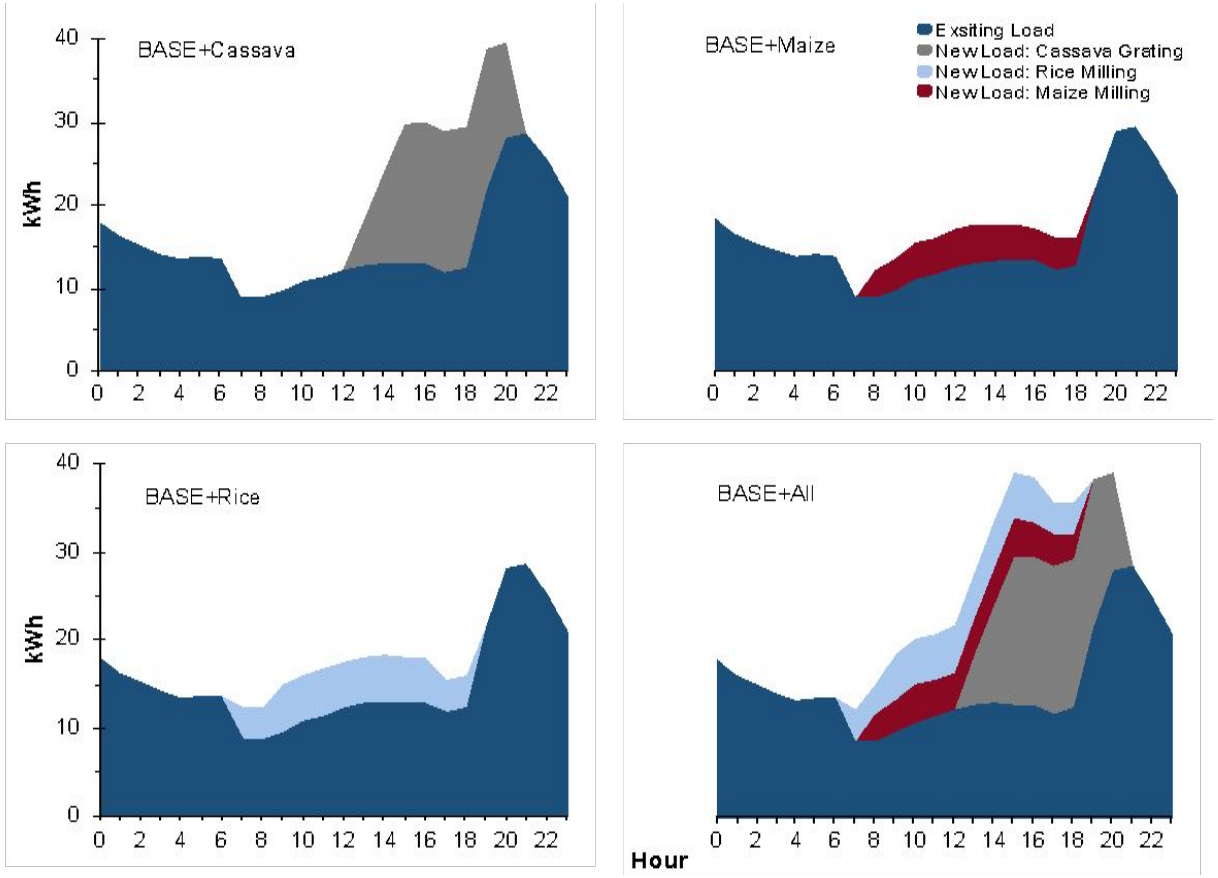
Reliable power addresses a primary barrier to adoption of electric agroprocessing equipment, unlocking load growth

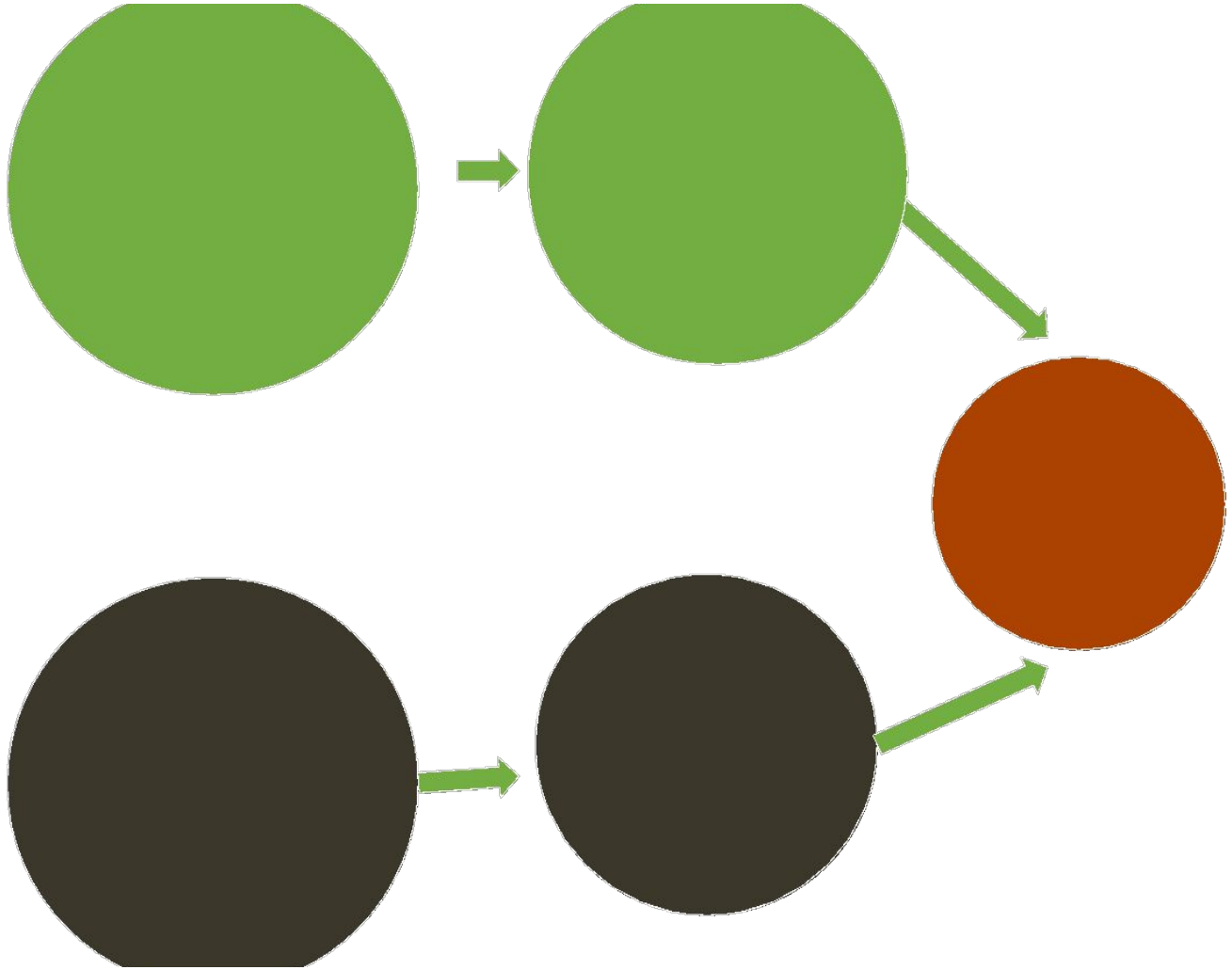


In grid-served communities, fee-for-service processors prefer electric mills but must often pause milling for days when power is out.

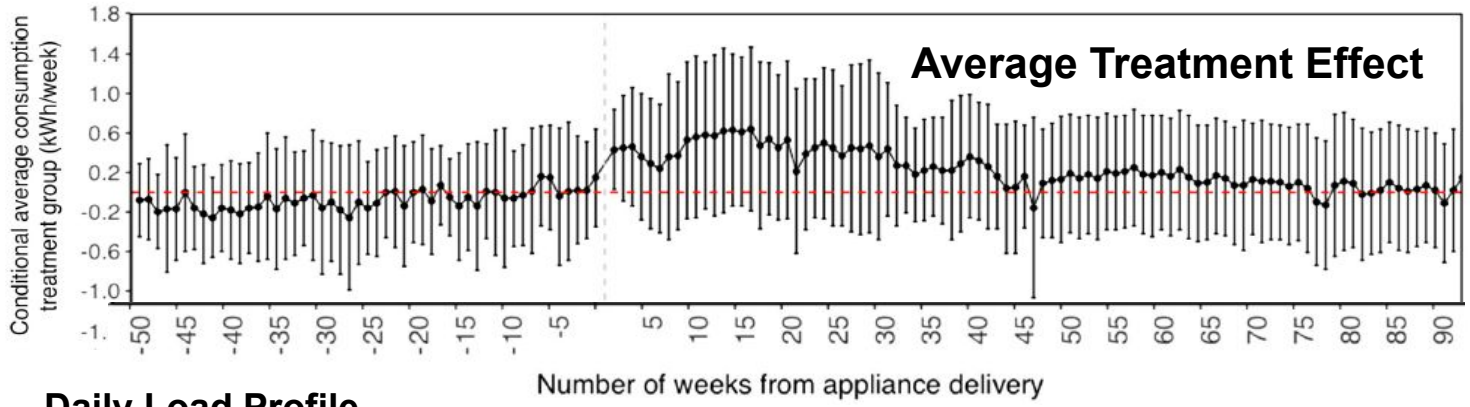
Source: *Productive Use Stimulation in Nigeria Value Chain & Minigrid Feasibility Study* (Forthcoming), USAID NPSP & RMI

Scaling Demand

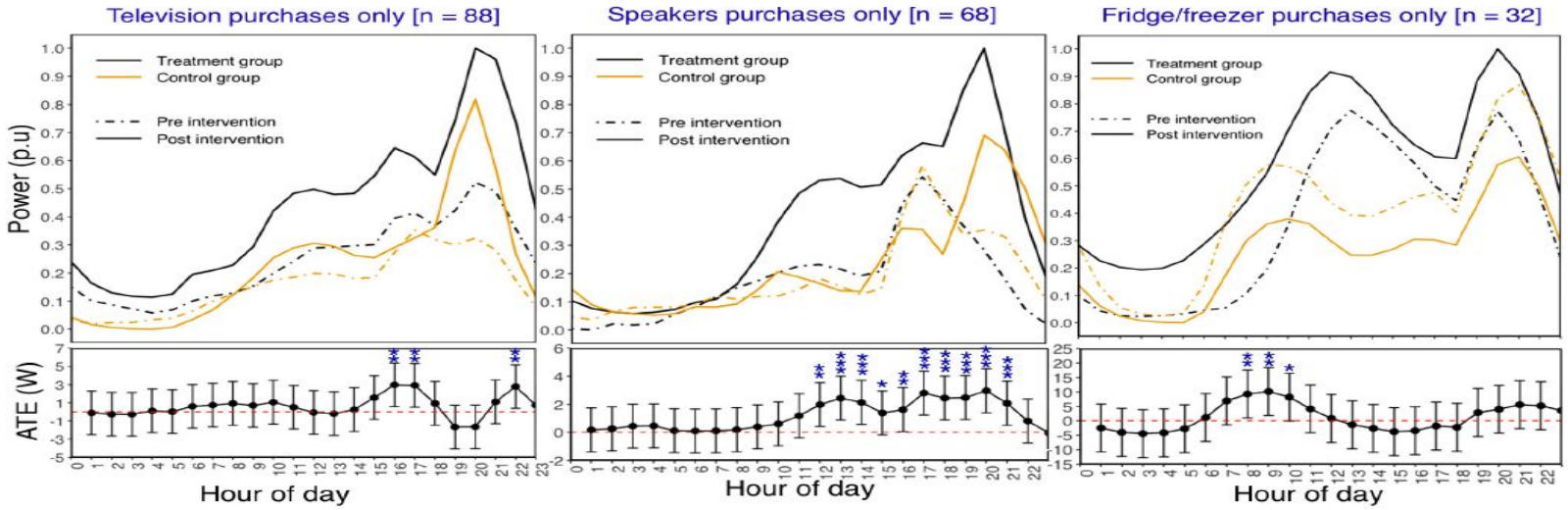
- Project feasibility: Analysis shows that it takes 4 years for annual consumption to grow from 50Kwh to 200Kwh for new green field customers
- Per-capita consumption in Uganda at 80Kwh vs Gov't target of 500Kwh.
- 2020 Installed Capacity expected at 1,852MW vs peak max demand of 629 MW



Mini-grid Innovation Lab: Appliance Financing Program



Daily Load Profile



- Customers wanted appliances! Data points to appliance financing being commercially viable.
- Power consumption surges: 66% increase on average in weeks following appliance delivery.
- But then a slow decline: A year later, consumption is still up 20%. 85 weeks after appliance delivery, consumption has returned to baseline levels.
  - Can't afford electricity bills?
  - Appliance novelty wears off?
- Program not effective in shifting peak load

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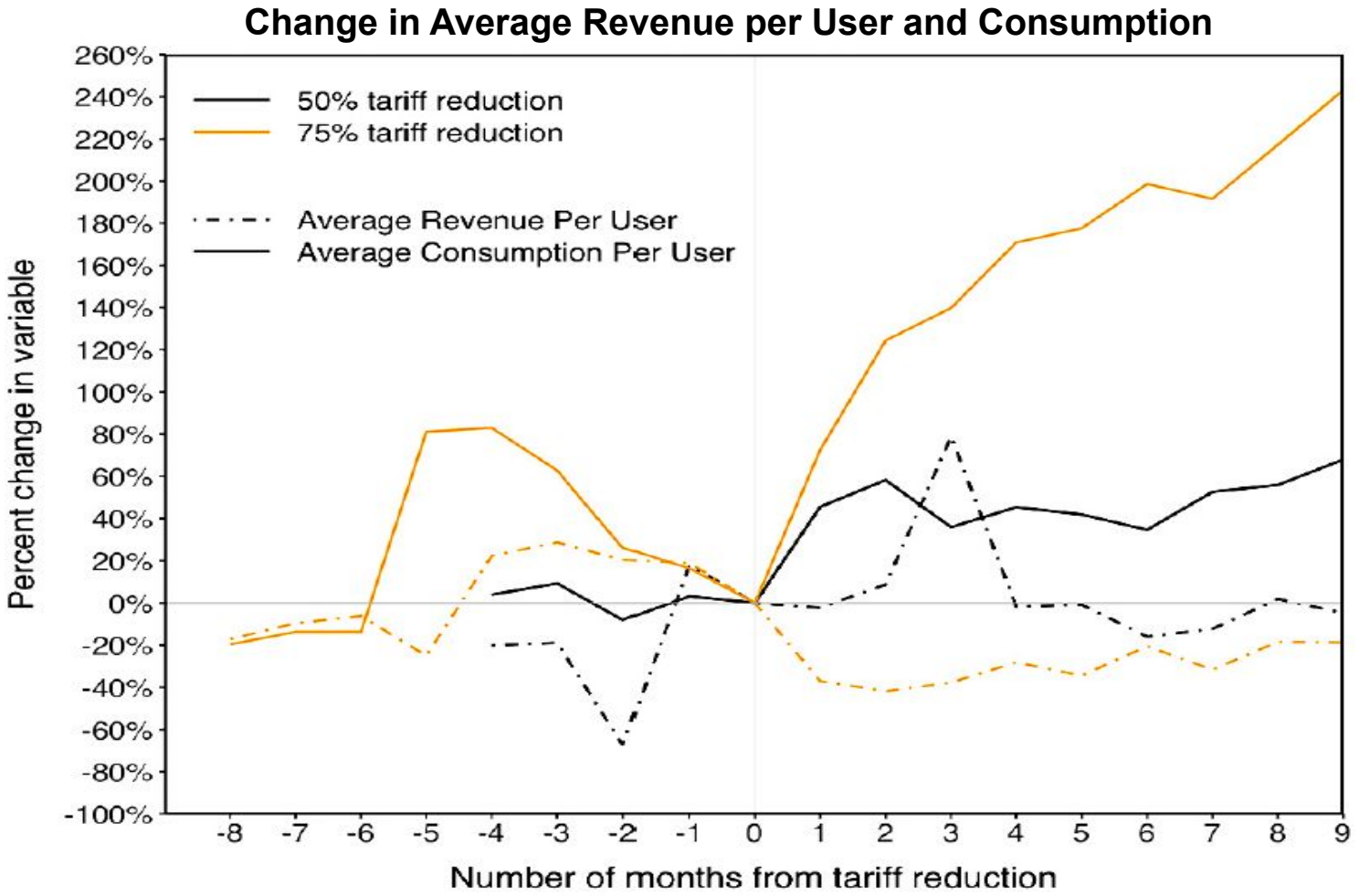
Mini-grid Innovation Lab: Tariff Subsidy Program



- A 50% tariff subsidy drove demand growth enough to hold revenue constant
- Critical questions requiring further exploration:
  - What are the marginal energy services that households are adding as energy costs drop?
  - What happens when you withdraw the subsidy?

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Scale

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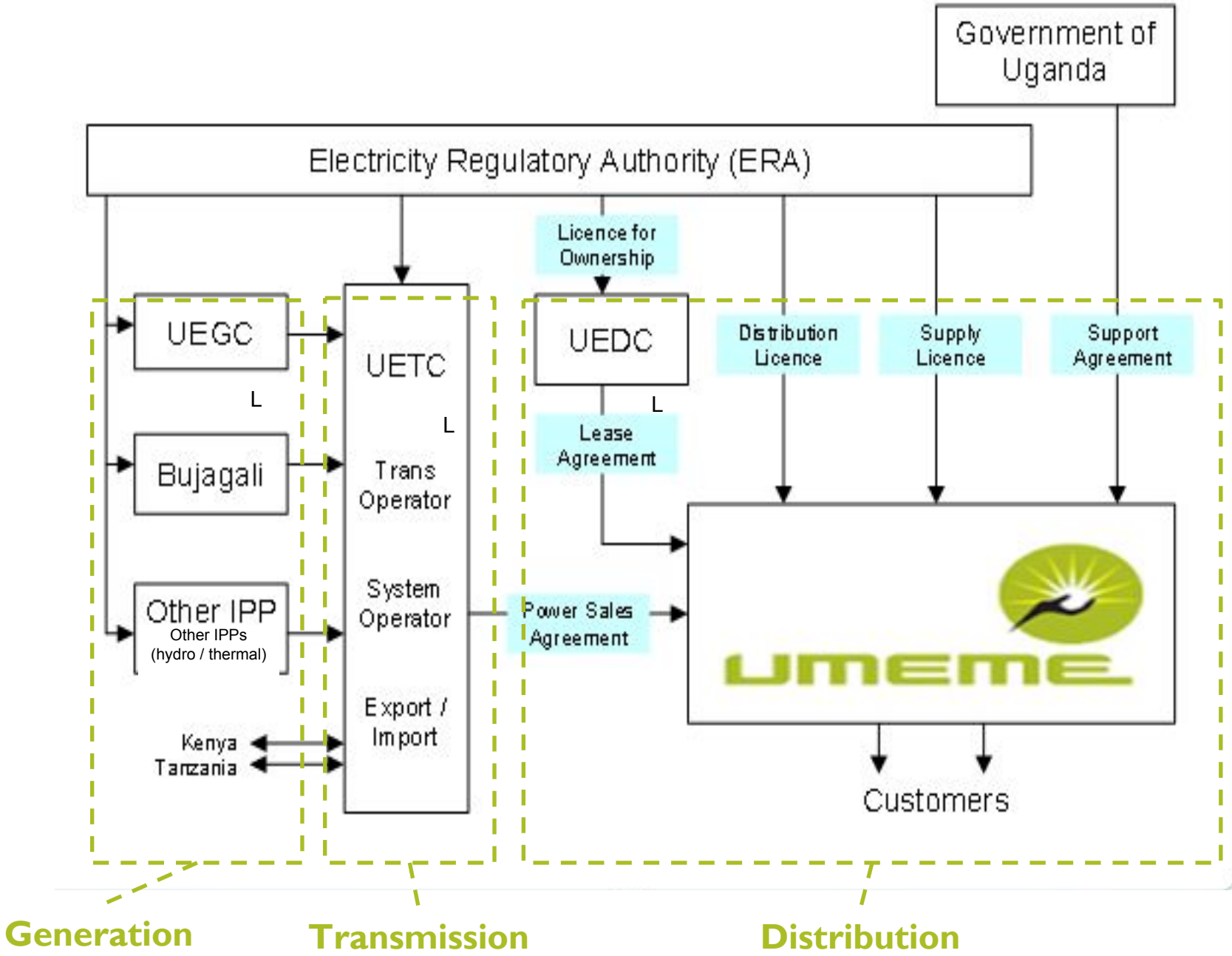
Government of Uganda
Electricity Regulatory Authority (ERA)
Licence for Ownership
UEGC
Bujagali
Other IPP
Other IPPs (hydro / thermal)
L
UETC
L
Trans Operator
System Operator
Export / Import
Kenya
Tanzania
UEDC
L
Lease Agreement
Distribution Licence
Supply Licence
Support Agreement
Power Sales Agreement
UMEME
Customers
Generation
Transmission
Distribution

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