Efficiency for Access Design Challenge Technology Week:
Webinar 5: Power Management

EFFICIENCY FOR ACCESS

UK
ENGINEERS
WITHOUT BORDERS

Douglas Baguma,
Managing Director, Innovex

- Bachelor's degree in Civil & Environmental Engineering, Makerere University, Post-Grad in Business Administration, Uganda Management Institute.

- Over six years experience in renewable energy and innovating innovation with business

- Board member of the Uganda Solar Energy Association (USEA)

Harini Hewa Dewage,
Battery Research Lead, M-KOPA

- Energy storage background

- PhD in Battery Research at Imperial College London

- Managed multiple research and education projects in the sector

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![Efficiency for Access logo]

Douglas Baguma,
Managing Director, Innovex

Power Management

Douglas K Baguma- Innovex Uganda
BSc Civil Engineering,
MSC Management Studies
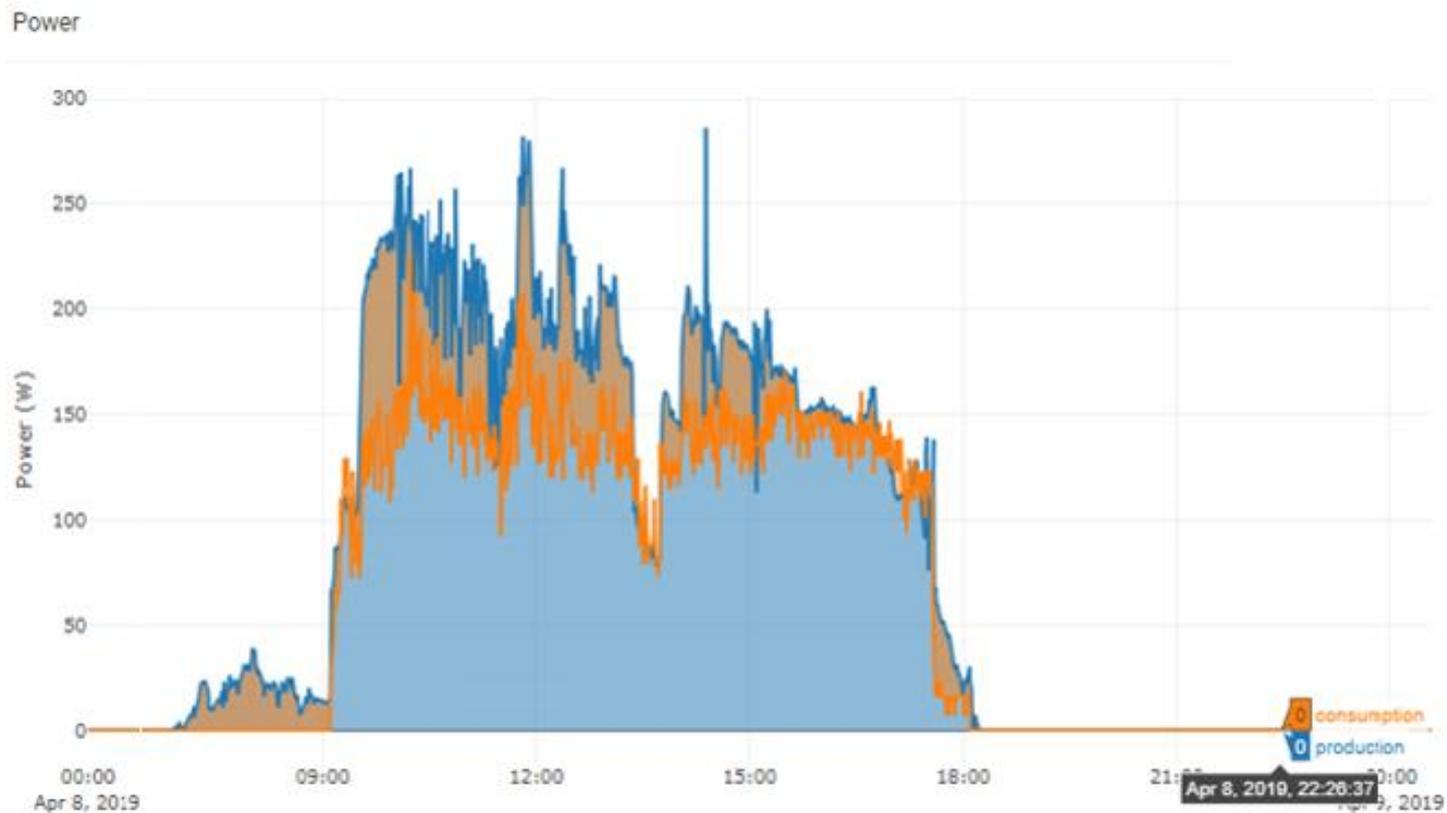
About Innovex

- Started 2015, commercial in 2017

- 4 University graduates

- IoT smart meter platform for solar systems and solar equipment, Remote solar monitoring and control

- Manufacture and distribute

- Data analytics, Machine learning & A.I

- B to B platform, 1,000 smart meters

- Operations in 5 countries; Uganda, Kenya, Tanzania, Ethiopia and DRC

Scope

Major discussion

- Aspects of power management

- Device to device Communication

- What's on the market?

- Challenges with products on the market.

- Technology barriers

Enabling technologies

- Smart meters

- Data analytics

- Machine learning

- Block chain

- Internet of Things

Mostly business development as opposed to technical perspective

Power management

Aspects

- Energy efficiency of solar equipment
- Control of power use
- Data
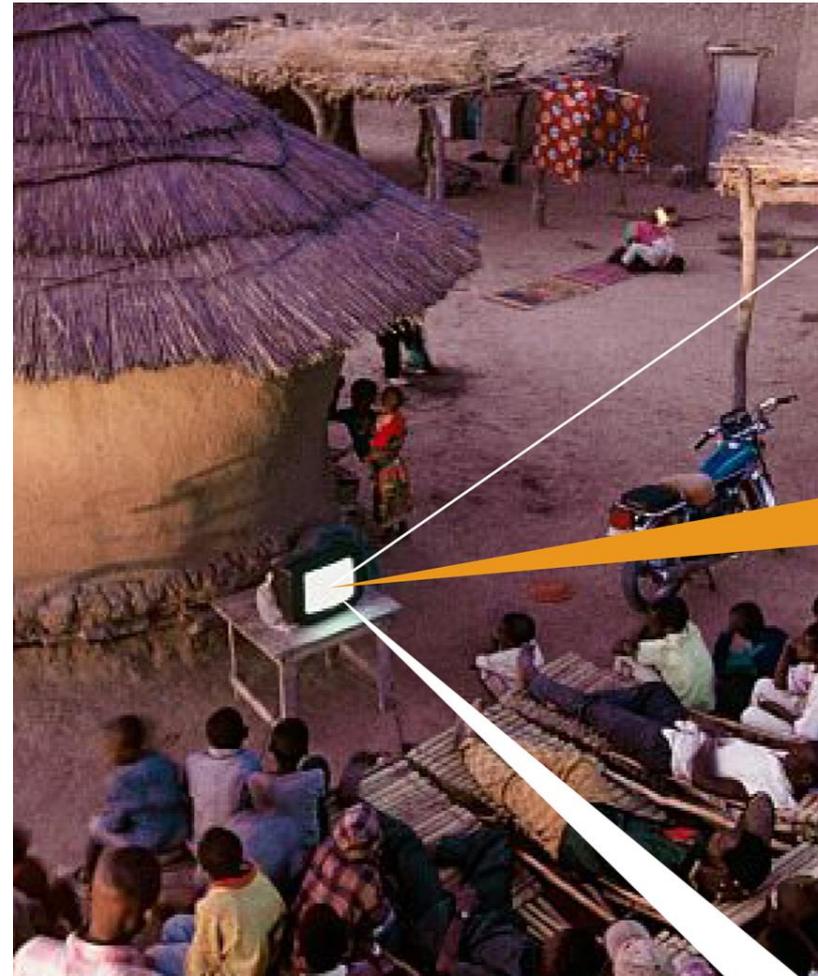
Solutions on the market

► **Connected devices**

 − Smart home technologies

  − Google, Amazon, Sonos, Apple,

  − Philips Hue, TP-link, Lifx

  − Lips bulbs, Magic light, Konxie, Teckin, Aukora, Legelite, Sengled

 − Smart home appliances

Solutions on the market

► **Power monitoring devices**

- Spark meter
- Solar analytics
- Clear blue technologies
- Meteo control
- Solar manufacturers; Victron
- SolarEdge
- Open energy monitor

Do you have any of the following Smart Home Devices?

Poll #2

In your daily life, what activity do you feel consumes the most power?

Challenges with current solutions

INNOVEX

- ► Market focus

- ► The technology

- ► Local application

- ► Cost
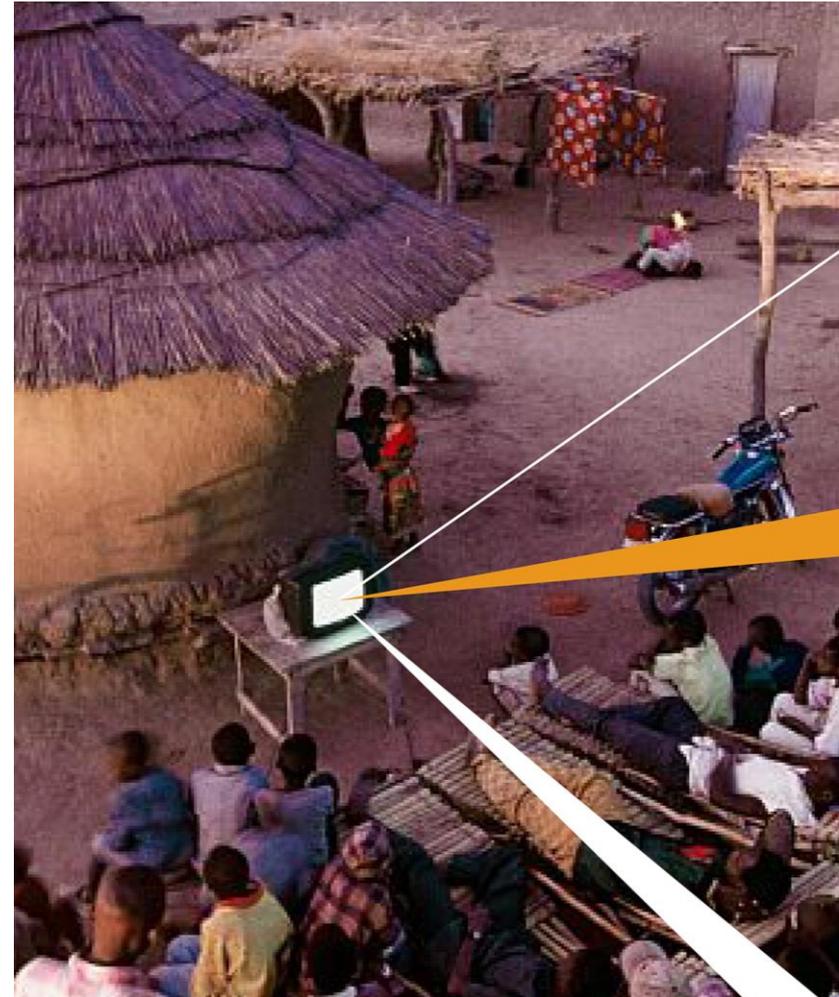
Market focus

► Most of the Product Development efforts are focused on solutions for the top of the pyramid.

► Investment in products for low income markets is seen as financially unsustainable.

► Mismatch between investment cycles and actual market needs

► Low income markets are hard to serve in terms;

− Distribution channels

− Payment channels
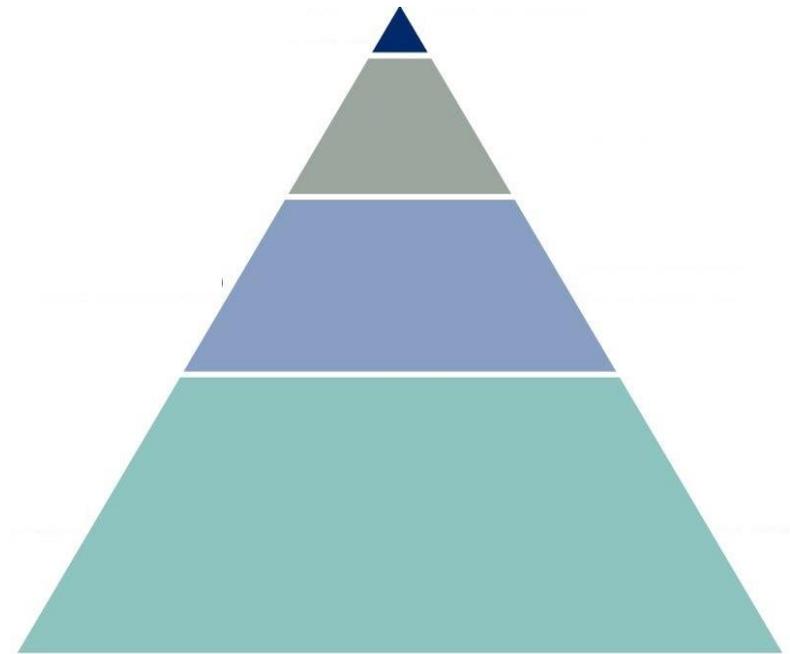
Bottom of the pyramid

The technology

Key challenges

► Communication

► Energy consumption

► User interface

► User experience

Causes

► Stage of development (Early stage)

► Difference in infrastructure

  − Communication

  − Product distribution

Local application and costs

- ► Mobile only continent

- ► Vast differences in user demographics, psychographics

- ► Level of development; education, awareness

Current market demand

- After sales market
- Equipment R&D
- Pay Go market
- Pay per use
- Solar for productive use

Enabling technologies

- Smart meters
- Data analytics
- Machine learning
- Block chain
- Internet of Things
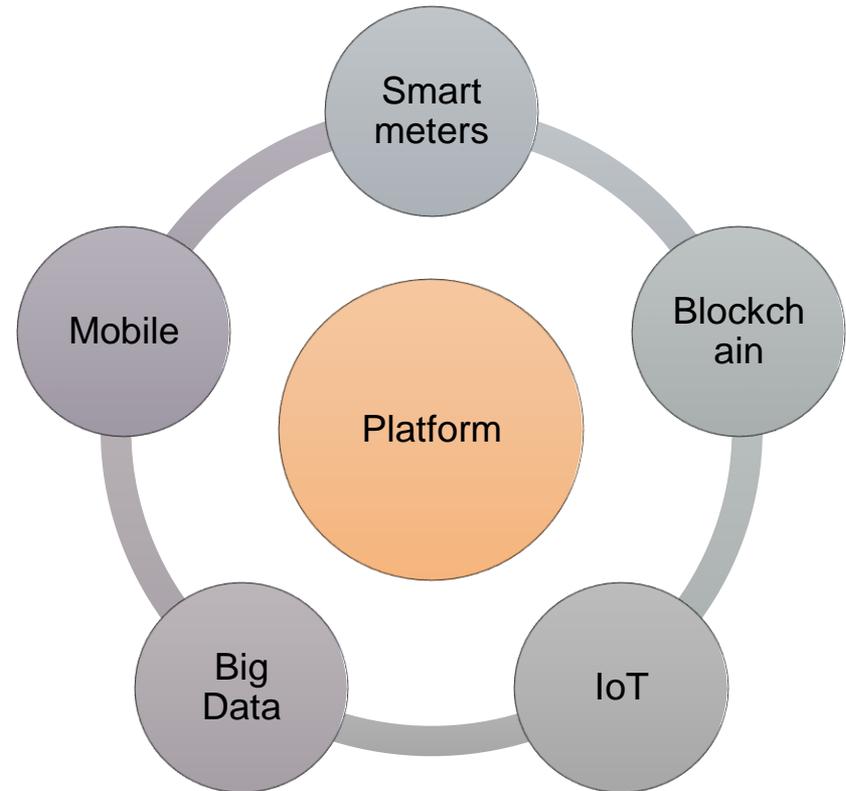
Connection to SDGs

► SDG 7; Affordable and clean energy

► SDG 8; Decent work and economic growth

► SDG 1; No poverty

► SDG 11; Sustainable cities and communities

► SDG 4; Quality education

► SDG 5; Gender equality

Market size

▶ 5 people per household

▶ Biggest markets for off-grid;
Kenya, Ethiopia, Tanzania,
Uganda, Nigeria

▶ 20 million households that can
afford a 5o watt peak solar
system, world over

T.A.M
121
million
HH,

USD 12
B

S.A.M
5.3 M H.H
in E.A,

USD 500
M

> 50 watt
USD 50 M
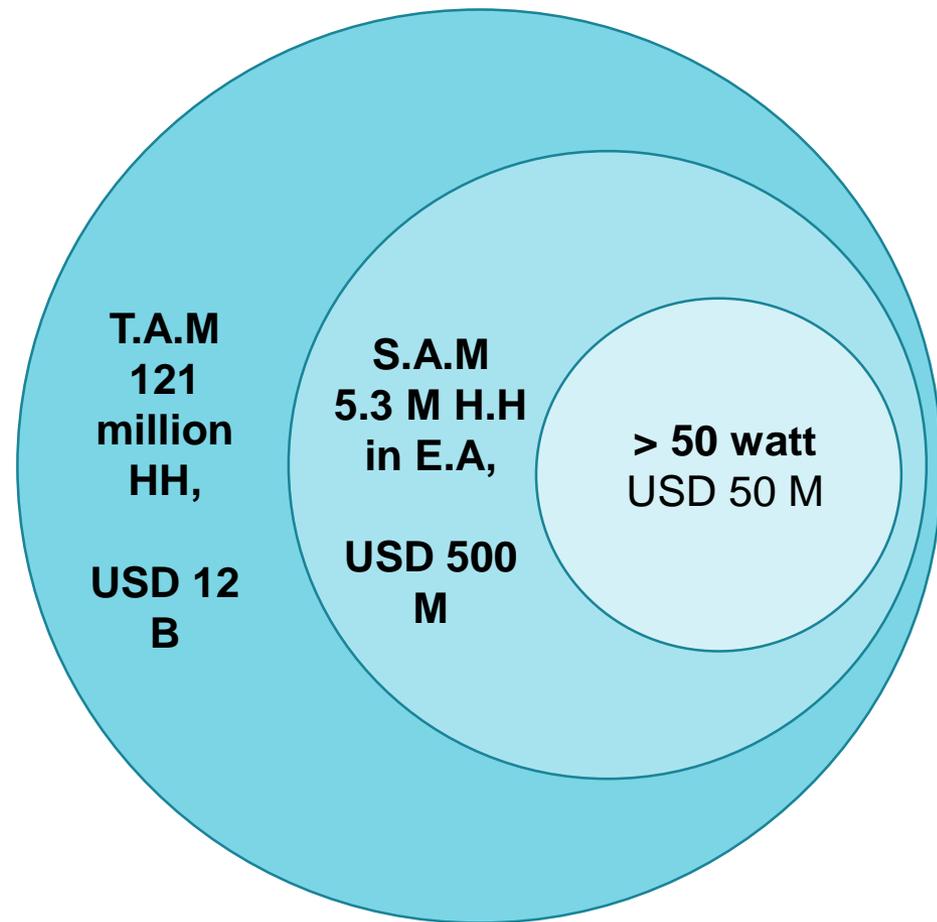
5 countries; **Uganda, Kenya,**
Tanzania, DRC, Ethiopia

3,000 solar agents

Applications

- Schools

- Health centers

- Businesses

- Agriculture

- House holds

Embrace the transition

"Stone Age did not end because we ran out of stones; we transitioned to better solutions. The same opportunity lies before us with energy efficiency and clean energy."

Stev Chu

Contact

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Any questions?

EFFICIENCY FOR ACCESS

Harini Hewa Dewage

Battery Research Lead, M-KOPA

Webinar: Power Management

M-KOPA Labs

The M-KOPA model

M-KOPA CUSTOMERS STEP ONTO A FINANCIAL PATHWAY TO "UPGRADE YOUR LIFE"

1 Customer buys an M-KOPA solar system for a USD $30 deposit

2 Saves $0.50 per day on kerosene, instead spends it for solar on a "pay as you go" basis

3 Payments made by mobile money

4 All systems monitored and controlled in real time by GSM connection

5 After one year of payments, customer owns their system

6 With a good credit record, they can upgrade for more power and other products / services

M-KOPA customer journey

The PAYG model enables M-KOPA customers to upgrade their lives affordably and on an ongoing basis

Cumulative payments, USD $

After demonstrating good credit, get a 6-month cash loan to help pay for school fees

First down payment and begin $0.50/day installment payments

Medical bills make money tight – use "okoa mwangaza" ("rescue your lights") to delay payments without losing light

Qualify for no-deposit TV upgrade at same daily rate (now you own your lighting system)

M-KOPA suspects your battery has degraded – an agent calls you to replace it

As you climb the economic ladder, decide to purchase M-KOPA's PAYG smartphone

Take your TV to a M-KOPA service center for a free repair to improve its signal

Months since first M-KOPA purchase

More power based on customers' needs

CORE

M-KOPA Classic — 2012

M-KOPA TV — 2015

M-KOPA Starter — 2016

M-KOPA Home — 2018

2012 · 2013 · 2014 · 2015 · 2016 · 2017 · 2018 · Future pipeline

M-KOPA TV Upgrade

M-KOPA Fridge

IoT Home

Draw-backs or design problems with current solutions?

- Quality of data
  - Missing data
  - Granularity of data limits what can be achieved with algorithms
- Battery quality
  - Quality and consistency between batches vary
  - Premature degradation
- Need to oversize battery/panel for some products

How does M-KOPA manages its fleet of devices?

20m
IoT device messages handled daily by machine-to-machine platform

50
independent applications on a distributed systems architecture

2M
payments processed monthly
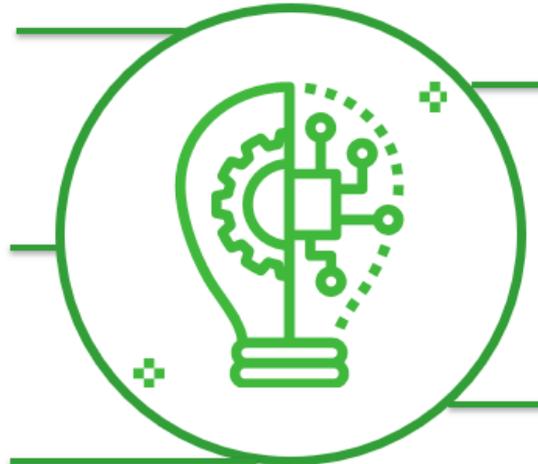
300GB
analytical data warehouse giving real-time access to critical business data

5
countries supported, with different languages, currencies, and payment providers
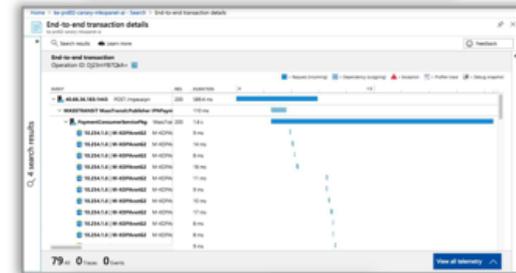
Remote Monitoring - individual devices

Having the capability to look at individual devices is key in order to troubleshoot remotely.
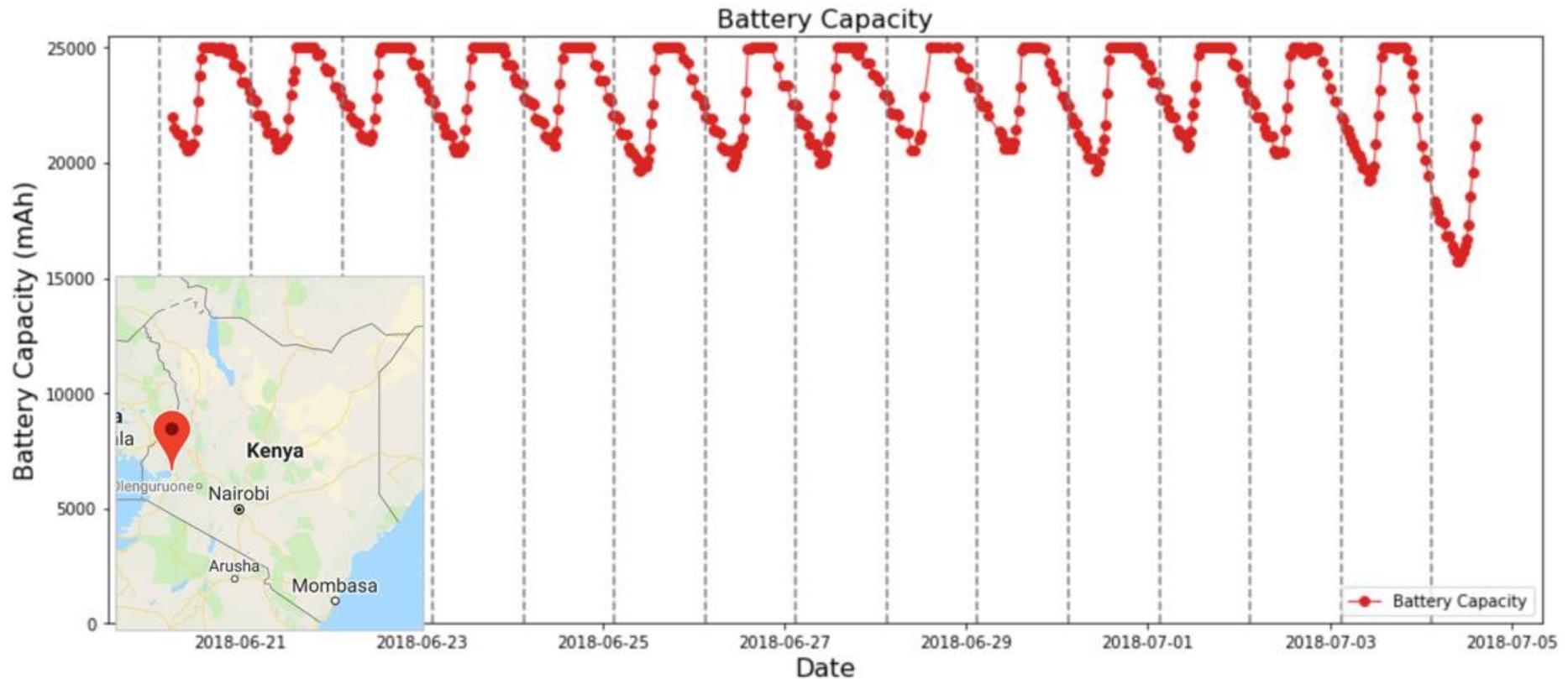
Remote Monitoring - population data

Representative daily battery use based on field observations. Battery charge value distributions are compared to simplified cycle used in laboratory test. Regions represent Night, Charging, and Full Charge.

Representative daily fridge cycle (43 devices, 3299 days)
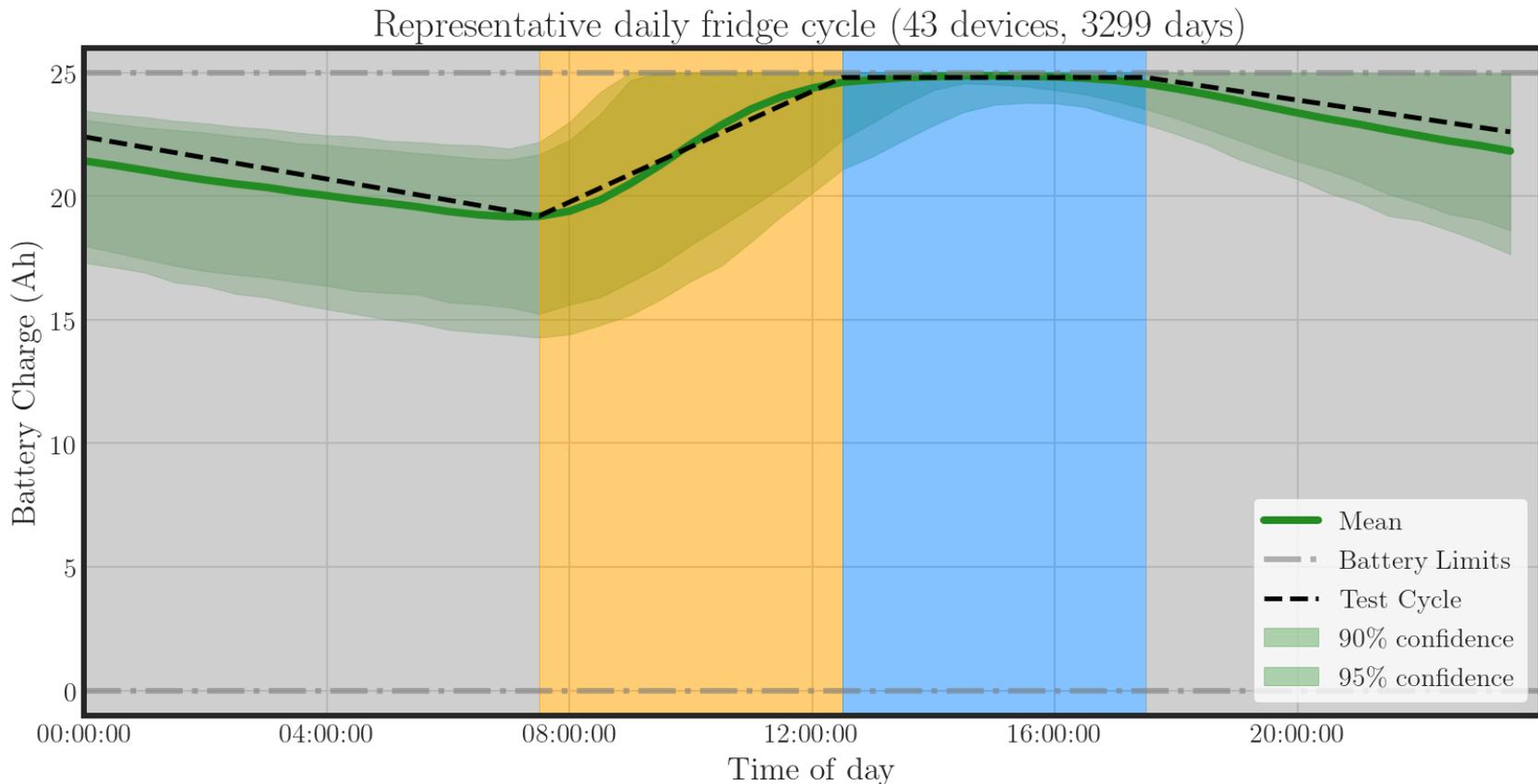
What is current technical solution?

Project: "Catalysing energy access in Africa through smarter energy storage management"

Feasibility study of the development of algorithms for calculating state-of health (SOH) and remaining useful life (RUL) and understanding of the most valuable application of device data

Partners
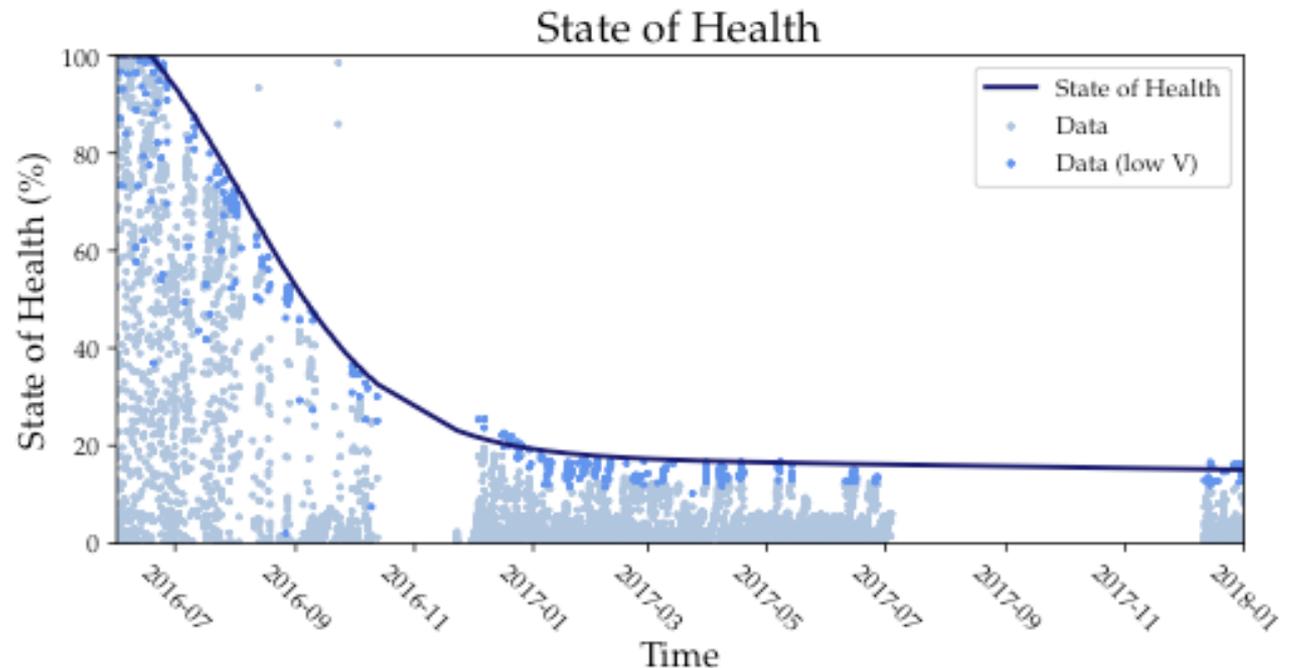
OBJECTIVES

1) **Device Data Exploration**
2) **State of Health (SOH) and Remaining Useful Life (RUL) Algorithms development**
3) **Implementation of Algorithms for Current Fleet**

Objective was to obtain a good (i.e.: low error estimate) SOH diagnosis. Then use the current SOH and the predicted SOH 6 months into the future to classify the devices into three categories.
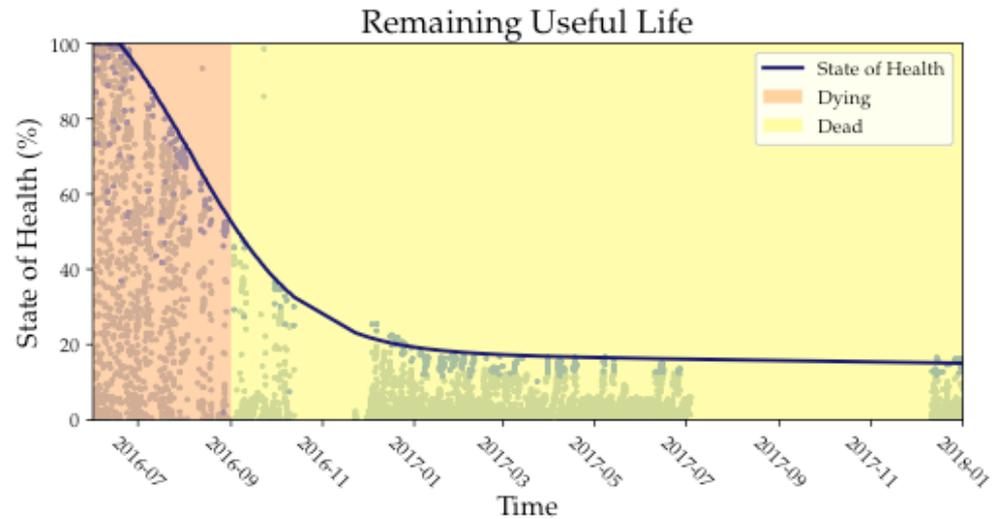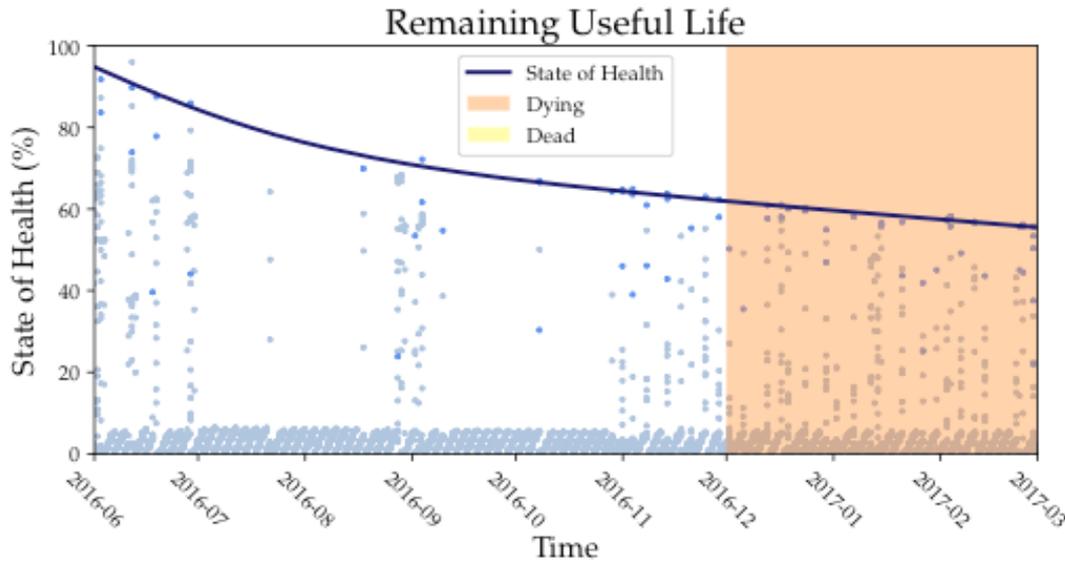
Context: The current battery market

Lithium ion battery cell suppliers by quality and volume

(Note: The tiers are arranged by industry reputation for quality lithium ion battery production and volume. You may get high quality producers in Tier 3 but the low output means they are not of strategic importance to the energy storage supply chain. To be a tier one and tier two supplier 2018 capacity must be over 5GWh. All Producers are striving for: Great Energy Density, Consistency, Volume. The Auto industry is driving these quality requirements)

BENCHMARK MINERAL INTELLIGENCE

US Market Share of Lithium ion Battery Capacity in 2018

Japan (16%)
S Korea (16%)
US (24%)
Total: 110GWh = 10m EVs
China (30%)
Poland (14%)

Tier 1 — TESLA, Panasonic, SAMSUNG SDI, LG Chem

Japan (4%)
S Korea (5%)
US (2%)
UK (2%)
Total: 85GWh = 1.8m EVs
China (87%)

Tier 2 — BYD, SK innovation, CATL, Automotive Energy Supply Corporation, LISHEN

Japan (3%)
Total: 88GWh = 1.5m EVs
China (97%)

Tier 3 — GEELY, SUNWODA, TN Power, BAK, DYNAVOLT, CITIC GUOAN GROUP 中信国安集团公司, Far East Foster New Energy, TESSONNE, YOULION BATTERY, ATL, GSR Capital Management, WANXIANGGROUP, FARASIS, EVE 亿纬锂能, Far East Foster New Energy

Source: Benchmark Minerals' Lithium ion Battery Megafactory Assessment, February 2019

Direction and current research projects happening in the industry?

- Larger and larger devices to power a wider range of appliances: TVs, fans, fridges, etc.

- Market expanding to new regions with its own challenges

- If the battery is the heart of the system, the battery management system (BMS) is its brain

- With funding from E4A, M-KOPA is developing a Smart Battery solution for improved remote monitoring and better longer lasting batteries in the field

Contact

Harini Hewa Dewage

Battery Research Lead

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