Gommyr Power Networks

Microgrid experts

Solar-battery microgrids vs. solar home systems

Benefits and drawbacks, economics, and opportunities for rural electrification

Arnaud HENIN

Managing Director, Gommyr Power Networks

Bucharest 2018 Symposium on Microgrids

September 2018

The question

When are solar-battery microgrids preferable to solar home systems?

Africa is an exciting region with high growth and significant energy problems to be addressed

Africa trends

General and Macro-economic

- Continuing population growth to 2050 (increasing from 1.2 bn to over 2.5 bn)
- Young population (60% <25 years of age)
- Fast economic growth (non oil-exporting countries 4.1% from 2000-2010 increasing to 4.4% in 2010-2015)
- Fastest urbanisation rate (36% urban in 2010 to 50% in 2030)
- Significant infrastructure investments required for energy, transport and communication

Power sector

- < 35% of households have access to grid power
- Most business impacted by under-capacity and weak grid conditions –
  - estimated 6% loss of output for large firms and 16% for SMEs across SSA
  - >80% of business in Nigeria own a diesel generator
  - Total impact estimated at 2-4% of GDP
- Power costs higher than in other developing regions (rural populations can pay 20x cost that grid-connected users per kWh)

Sources: UN World Population Prospects 2017; Africa Progress Panel , McKinsey "Lions on the Move II"

Energy provision is expected to continue a tradition of innovation and technology adoption

Sample recent technology trends

Mobile telephony

- "Leap-frogging" of fixed line telephony by mobile
- High rates of mobile adoption (¬1 bn active SIMs in pop. Of 1.2 bn)
- Many consumers only access the internet through smart phones

2000 - today

Mobile banking

M PESA

- Low-cost payment and banking solutions
- Over 31mn subscriptions (from 42 mn population) in Kenya
- All mobile operators have competing payment offering

2007 - today

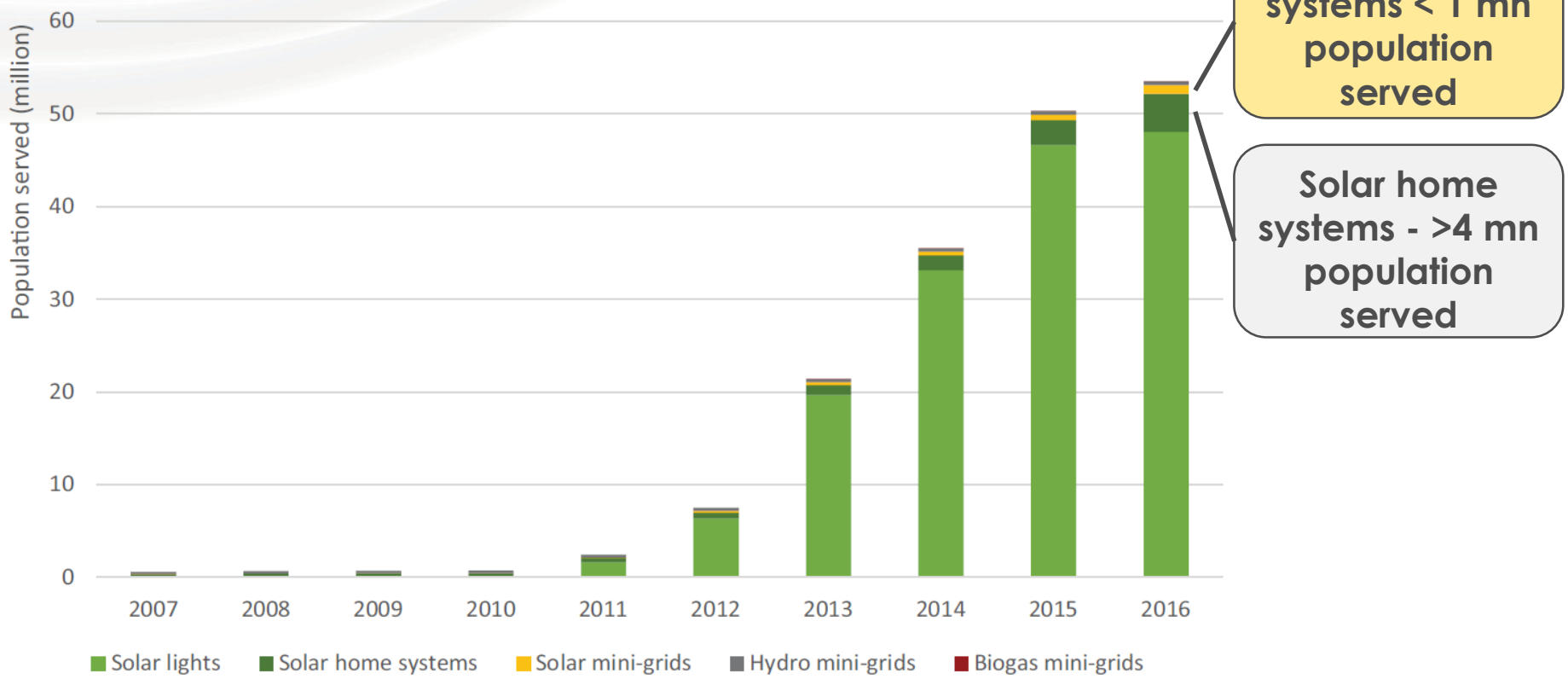
Renewable microgrids

- Adoption of localised on-site renewable energy systems
- Includes smart systems control and data management for system optimisation

future

SHS growth has been faster than microgrid growth in Africa

Population served by off-grid renewable energy solutions Africa

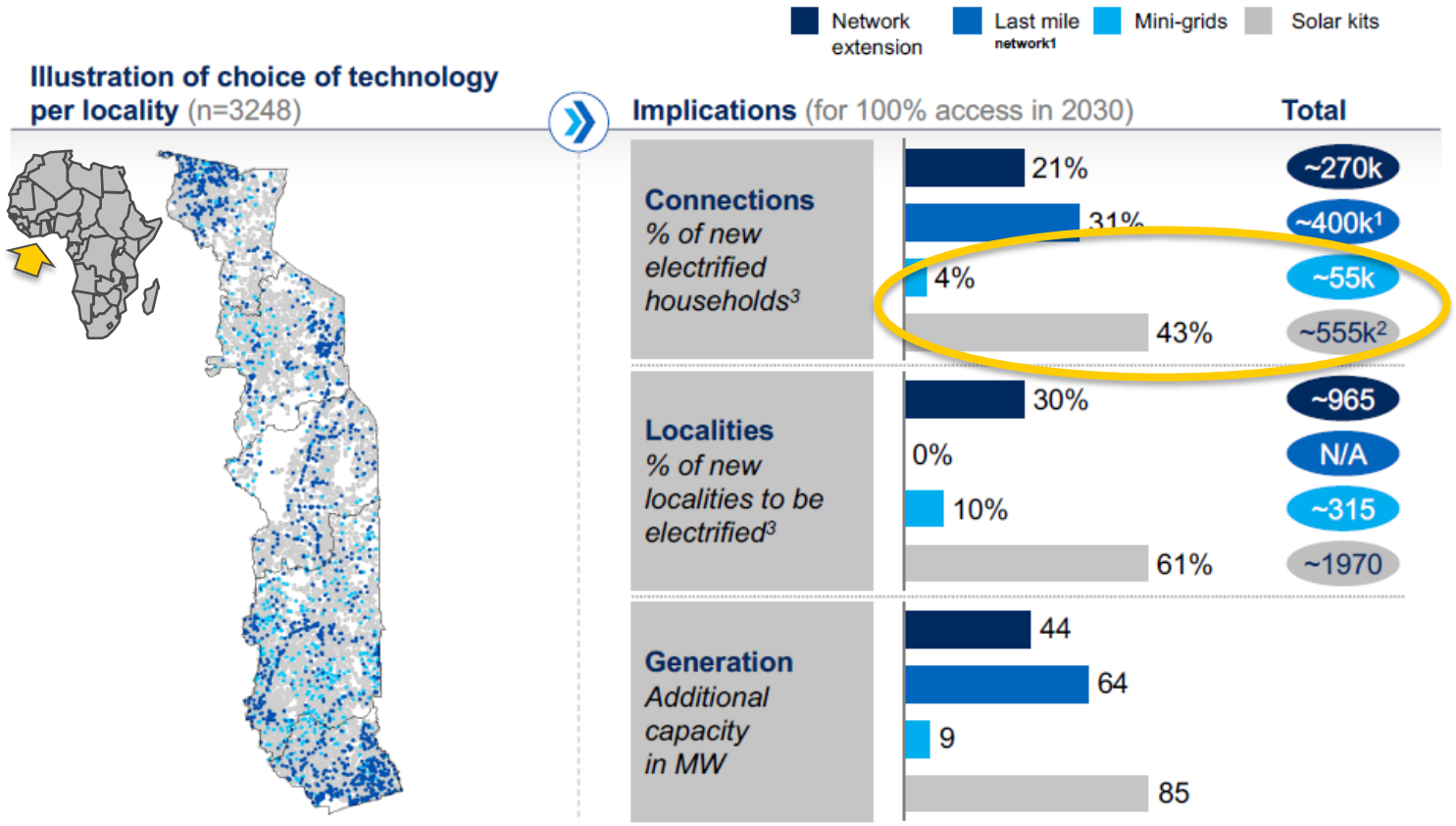


Source: IRENA (2018), 'Off-grid renewable energy solutions: Global and regional status and trends'. IRENA, Abu Dhabi.

And SHS is leading in emerging electrification strategies: Togo example

Togo electrification strategy targets

Result- To achieve electrification for all by 2030, close to 50% of additional households will have to be connected via off-grid solutions



1 Electrification at the last km, by the network, households currently not electrified in localites connected to the network
2 Includes households located in ~11k small communities outside 3248 defined localities
3 Perrcentages not summed to 100% due to rounding

Only 10% of connections to be provided through microgrids

Source: Electrification Strategy of Togo, 2018

However, there are trade-offs between SHSs and microgrids

SHSs

- Simple
- Standardised and scalable
- No expensive distribution system or metering
- System can be sized and tailored to loads
- Financial commitment per system is relatively low

Microgrids

- Larger scale
- More efficient use of generation and storage
- Can ensure higher reliability and power quality
- Can provide for larger loads and product use
- Can provide more data and control

And conditions where each system alternative is more appropriate

Grid Extension

- High quality grid
- Proximity to existing grid
- Grid power costs are low

SHSs

- Rural households with low existing power needs
- Low ability or willingness to pay for power
- Distributed loads with low density

Renewable microgrids

- Larger loads and loads with start-up currents
- Communities where transmission grid is far or grid is weak
- Users that require high reliability or power quality

Background on analysis for typical off-grid

Background and assumptions for economic assessment

Typical off-grid community assumed to have:

- 1'000 households
- Average daily consumption of 200 Wh
- Some small local business activities

Grid extension

- 10 km from existing MV grid
- MV connection (~1 MW)
- Utility PV connected on network to provide power
- Energy storage may or may not be required

Solar Home Systems

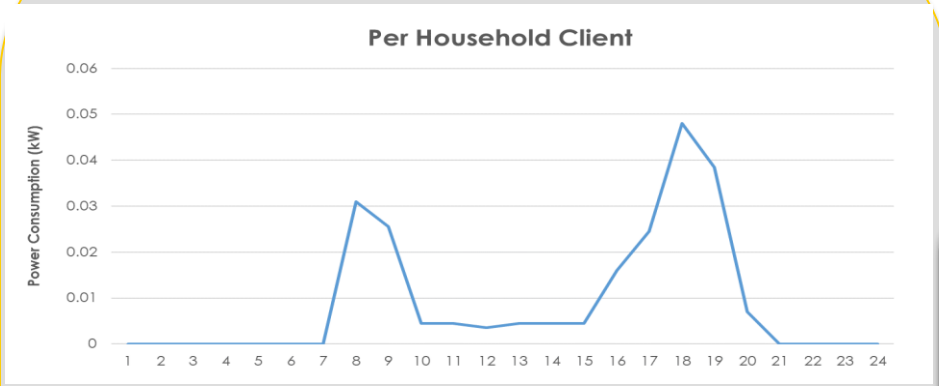
- 60-80 W panel required
- Lead acid battery
- Lights, appliances and peripherals not included

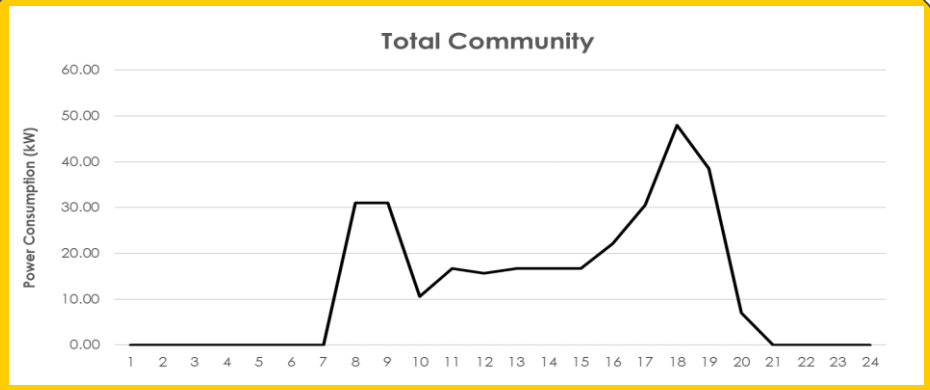
Microgrid

- Solar-lead acid battery system
- Local distribution network with single phase connection and meter

Typical load profile for off-grid community

Indicative daily load profile for typical 1'000 household off-grid community

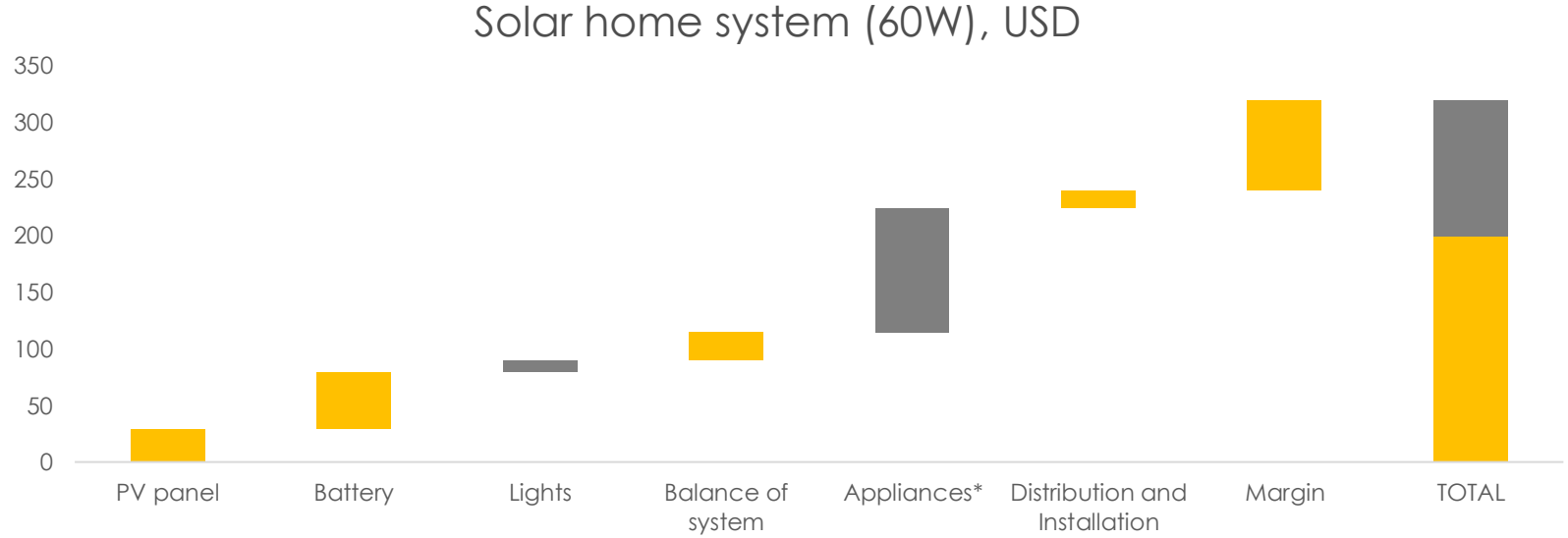


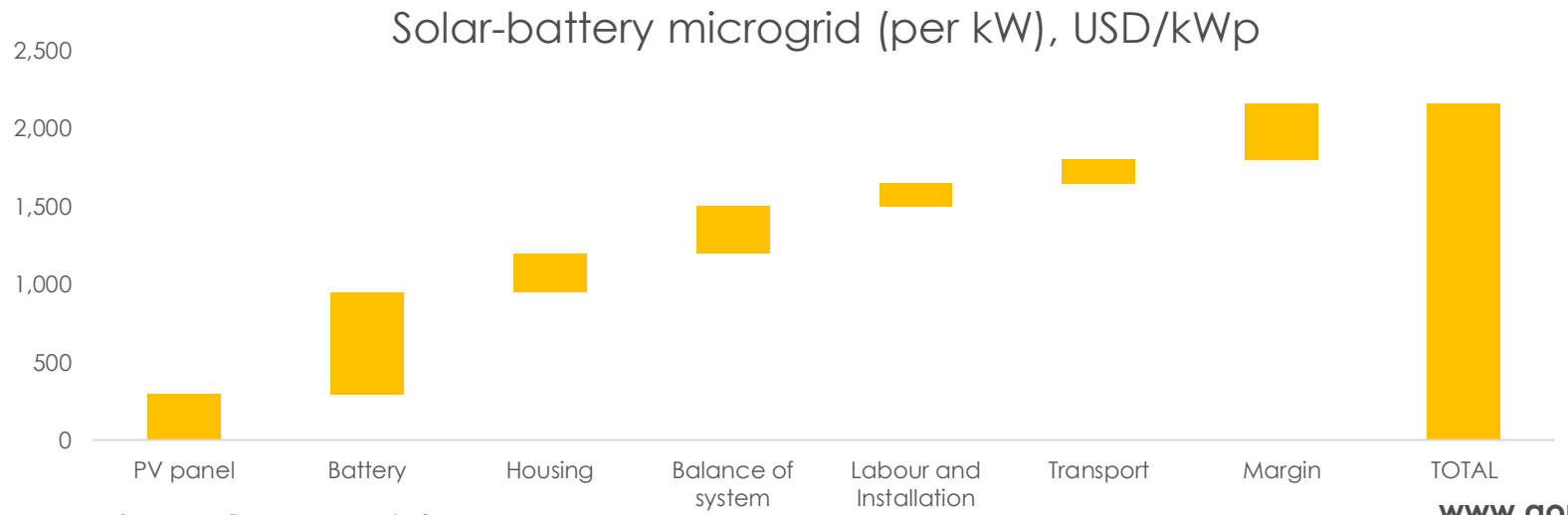


Source: Gommyr analysis

Breakdown of costs of SHSs and microgrids

Indicative CAPEX cost breakdown for typical systems

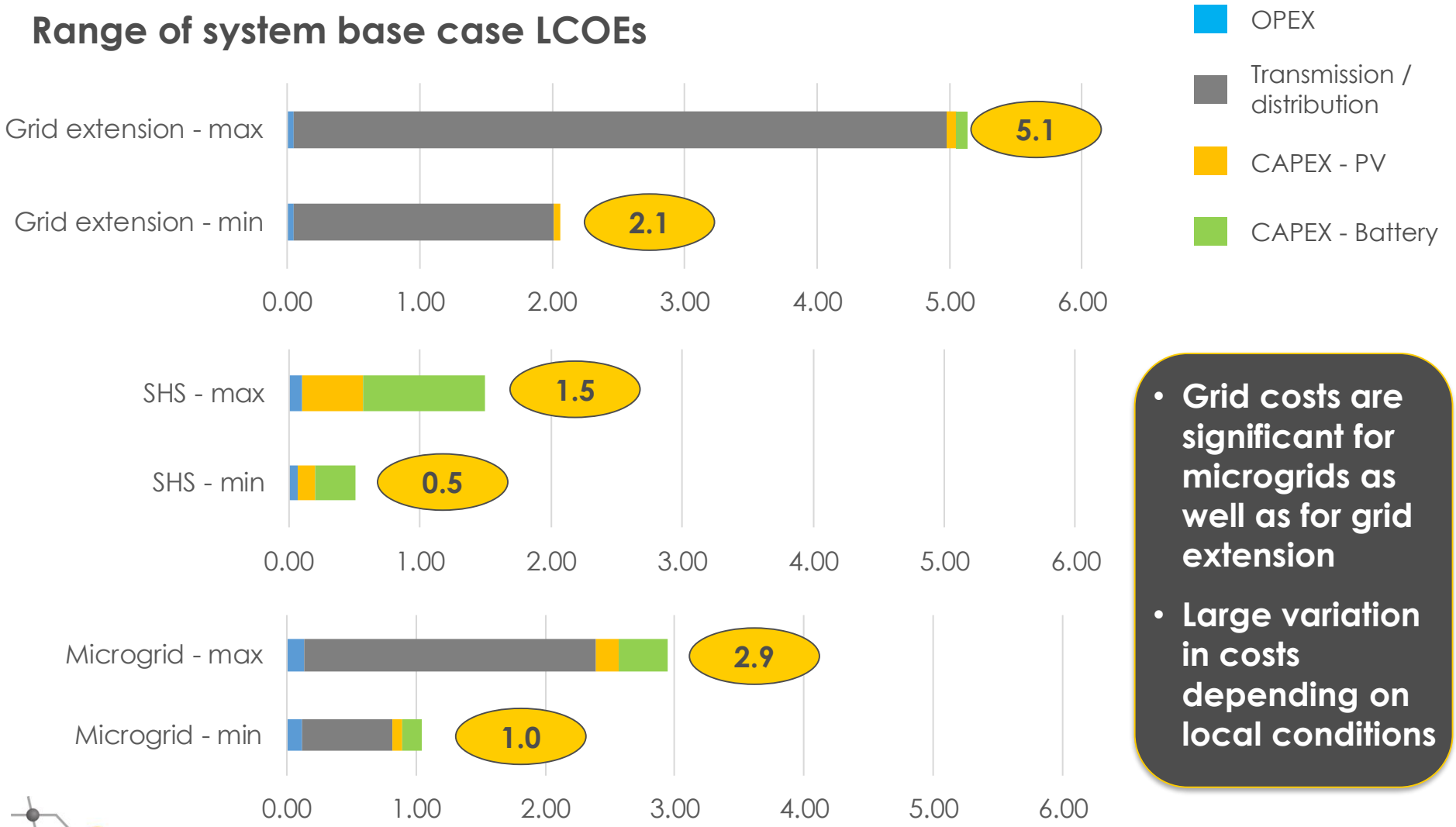




Source: Gommyr analysis

Comparison of levelised costs (LCOE) between systems

Range of system base case LCOEs

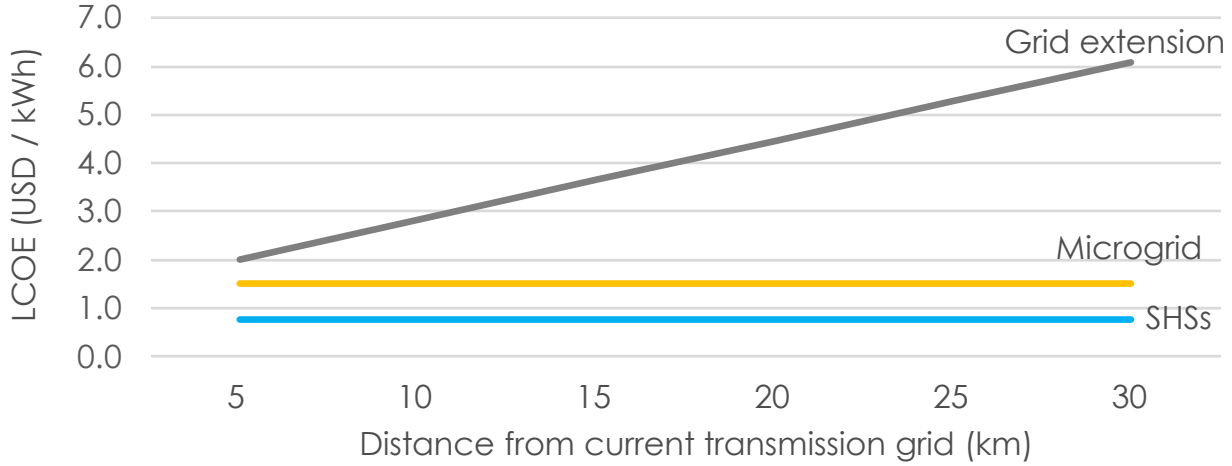


- **Grid costs are significant for microgrids as well as for grid extension**
- **Large variation in costs depending on local conditions**

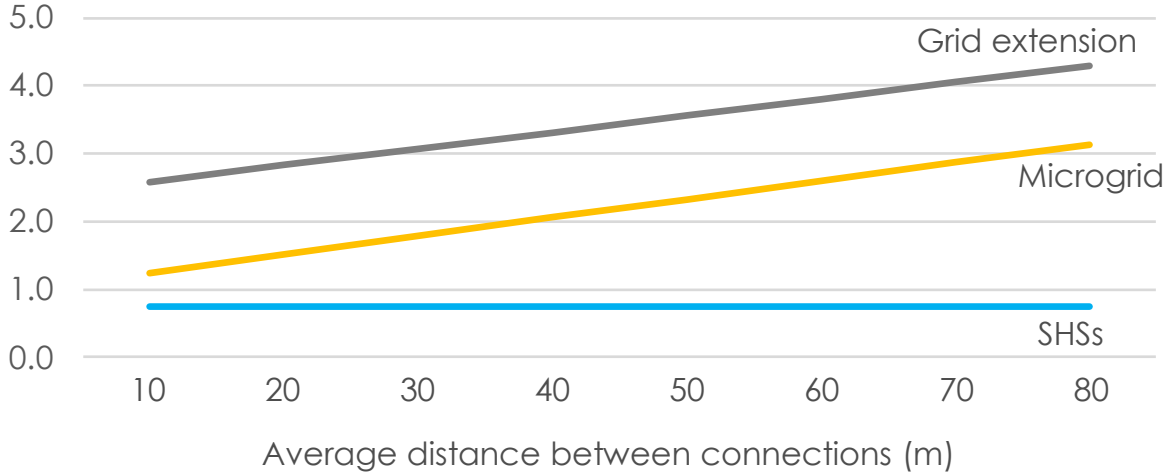
Source: Gommyr analysis

Key factors impacting the system LCOEs (1/2)

LCOE variation due to distance from grid



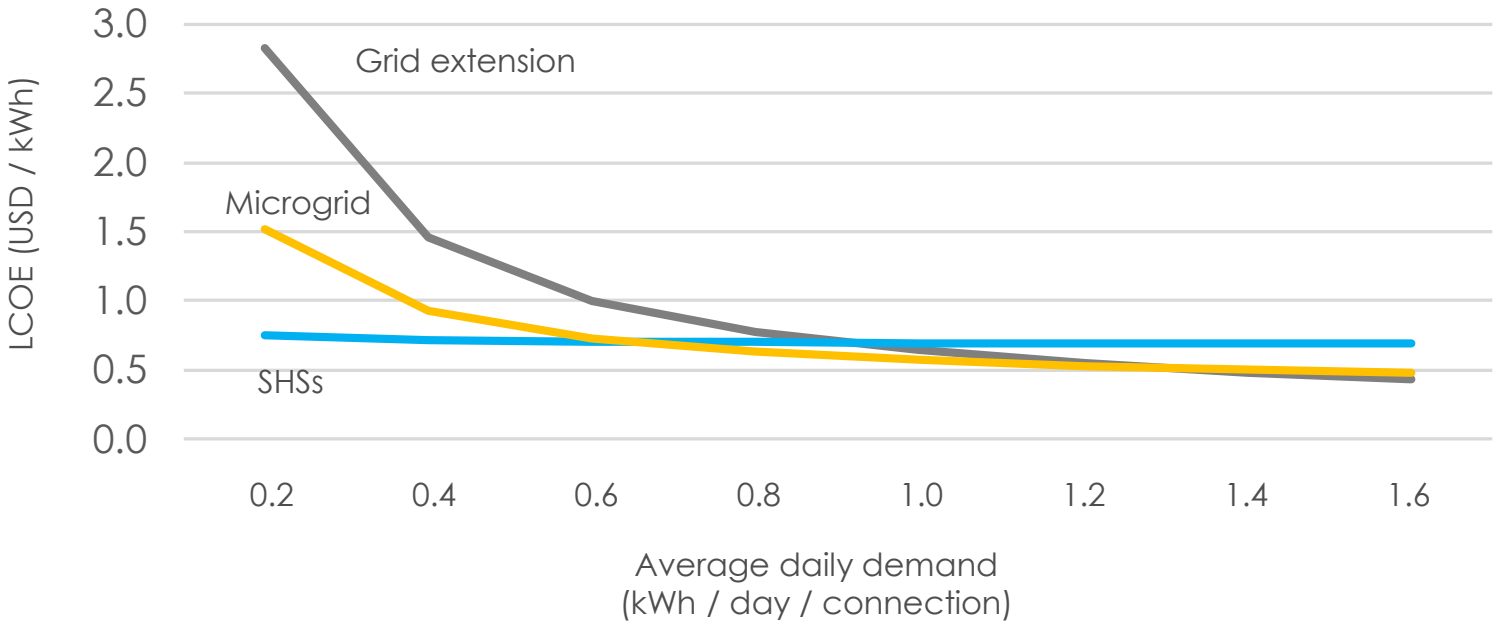
LCOE variation due to connection density (avg distance btwn connections)



Source: Gommyr analysis

Key factors impacting the system LCOEs (2/2)

LCOE variation due to average load (kWh / day)

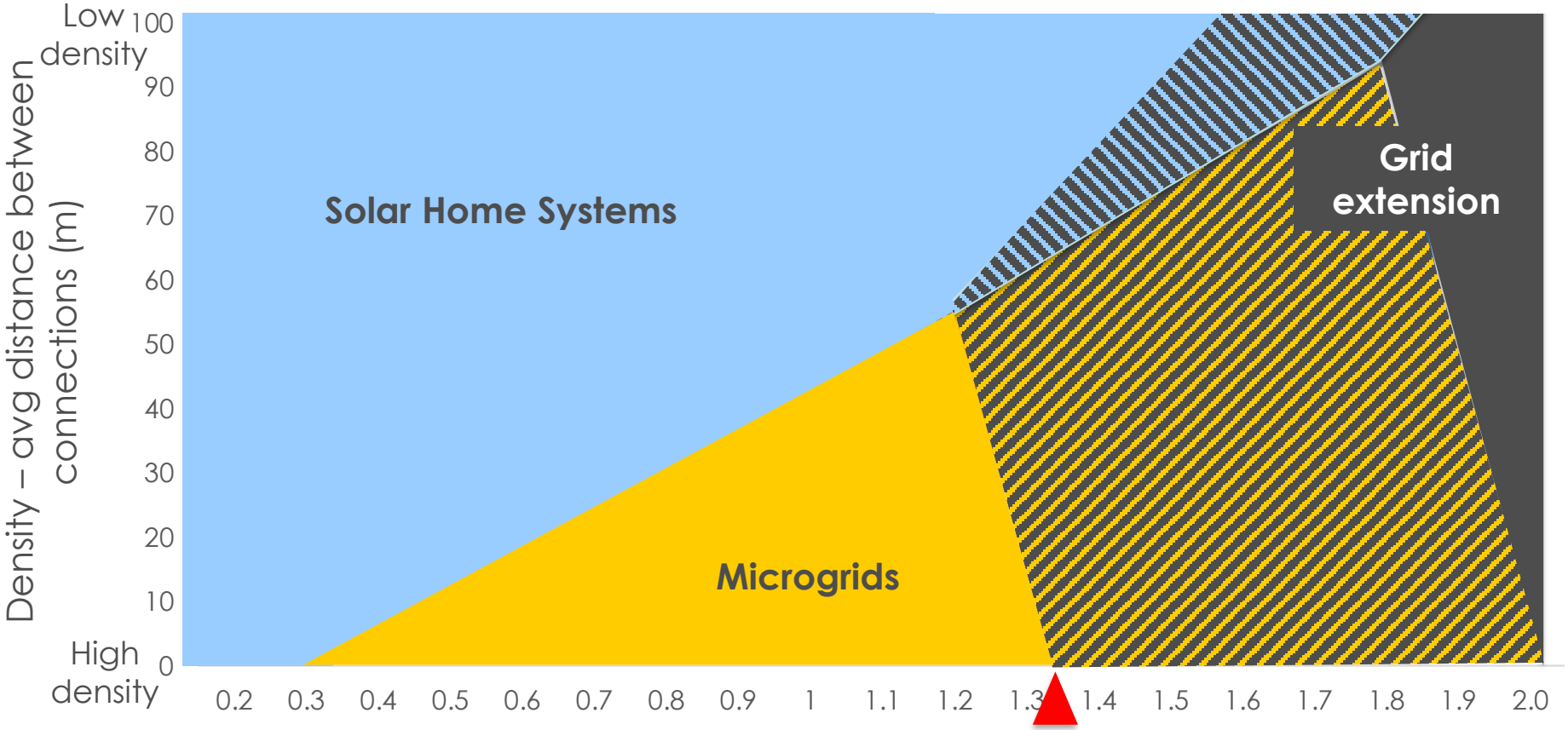


Microgrids (and grid extension) only become economically competitive with SHSs with larger loads

Source: Gommyr analysis

Each system has conditions under which they are the most economic for electrification

Areas of economic preference per system based on average load and connection density



Source: Gommyr analysis

Key points on system selection

- SHSs are the most economic alternative for small loads and low density connections – including for most rural areas in sub-saharan Africa today
- Microgrids start to be economically competitive at average loads of 400 – 500 Wh / day
- Grid extension is typically preferable to microgrids for <5 km of distance and not economic above 15 km of distance from existing grids (dependent on total load / community size)
- Cost of capital is critical with lower cost of capital favouring microgrid and grid extension

For most rural electrification projects today, microgrids are not economically competitive with SHSs

SHS providers have been more innovative in regards to additional services beyond energy

Financing and business model

- Financed solutions offering (15 – 30 USD / month)
- Pay as you go
- Mobile payment

Diversified offering

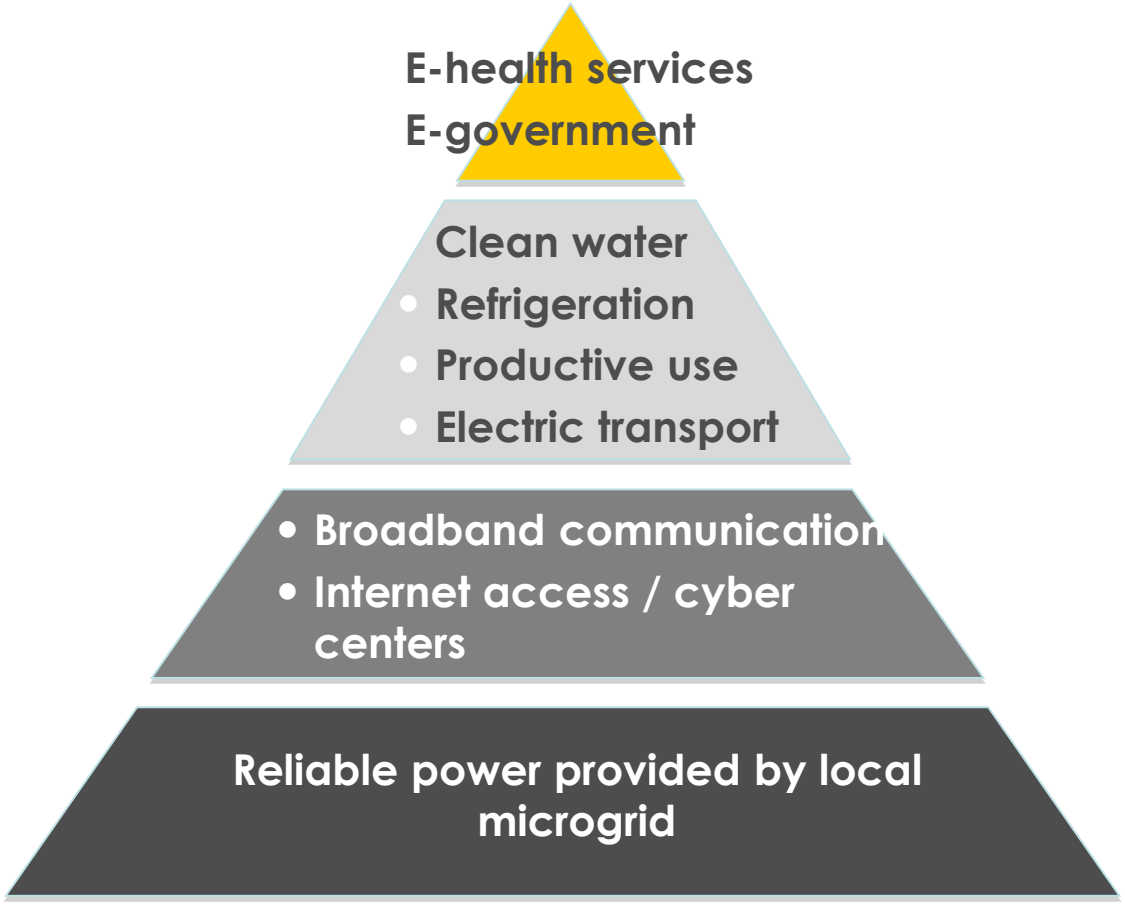
- DC only systems
- Bundling appliances (television, fridges)
- Diversifying revenue streams - advertising

Emerging offerings

- Financing of productive equipment for local entrepreneurs
- Sponsorship from corporations

Microgrids can be the platform for many additional services

Reliable local power can be the basis for a wide range of additional services and growth opportunities



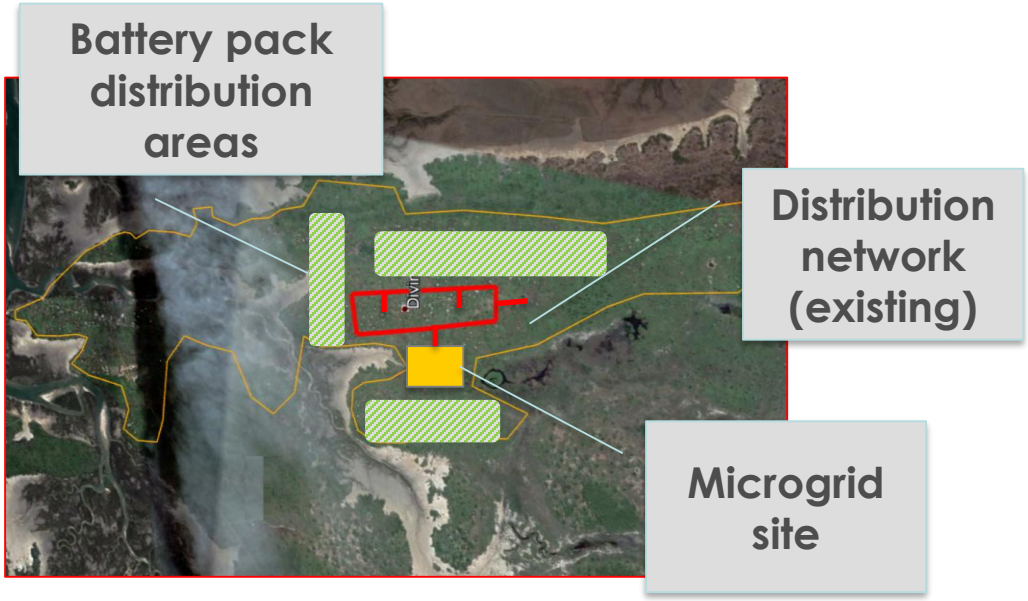
Emerging models: eStreet DRC Economic Zone (1/2)

- Provision of fully serviced business premises for commercial and light industrial use in off-grid and poor grid communities
- Focused on large (30k+ population communities in DRC)
- Based around communications towers
- Additional critical services such water, sanitation and security included based on reliable power supply

Emerging models: eStreet DRC Economic Zone (2/2)

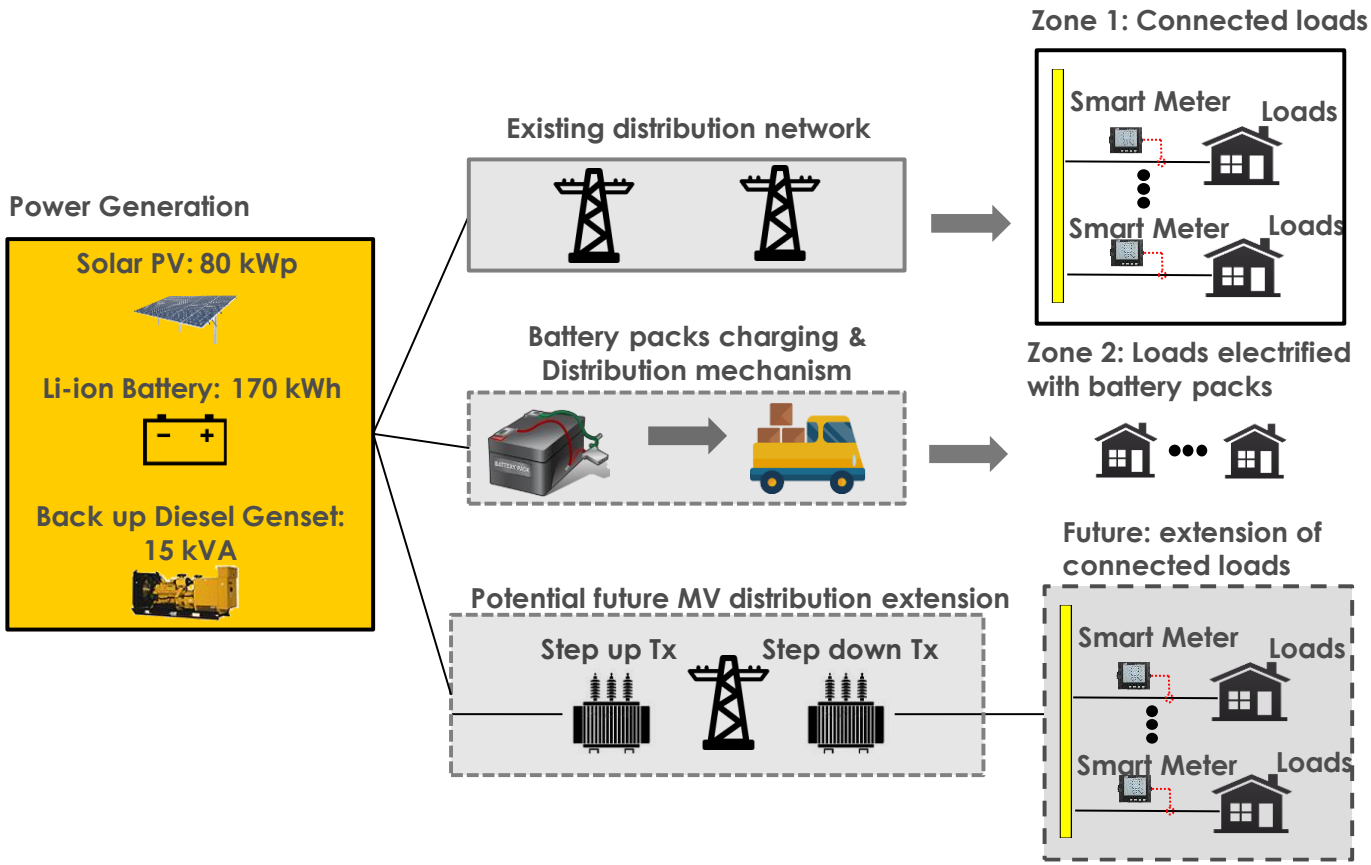
- Concentrated load with high reliability requirements
- Short distribution system (<100m)
- Focus on productive use means higher day-time usage and good fit with solar production
- Additional services (water, sanitation, communications, security) create high value for clients

Emerging models: Mozambique "Power zone" example (1/2)



- Serving of 10'000 person off-grid community based on solar-battery-diesel system
- Use of existing distribution network cover center of town with smart meters to provide some load control

Emerging models: Mozambique "Power zone" (2/2)



- Non-connected households can lease integrated battery packs
- Battery packs swapped 2-3x per week and charged at the microgrid
- Network can be gradually extended as is economically viable

Summary of main points

- Solar home systems are currently more economic for electrification of communities in sub-Saharan Africa
- Microgrids can offer additional benefits that can impact economic development
- Size of load and density are critical for microgrid economis
- Microgrid developers have opportunities to offer more innovative offerings

Thank you

Gommyr provides expert microgrid technical and economic project development, project integration, and project management.

We work with project developers, investors, and policy makers to accelerate microgrid deployment

Contact us:

www.gommyr.com

arnaud@gommyr.com