



WORLD BANK GROUP

Mini Grids: Lessons Learned from Around the World

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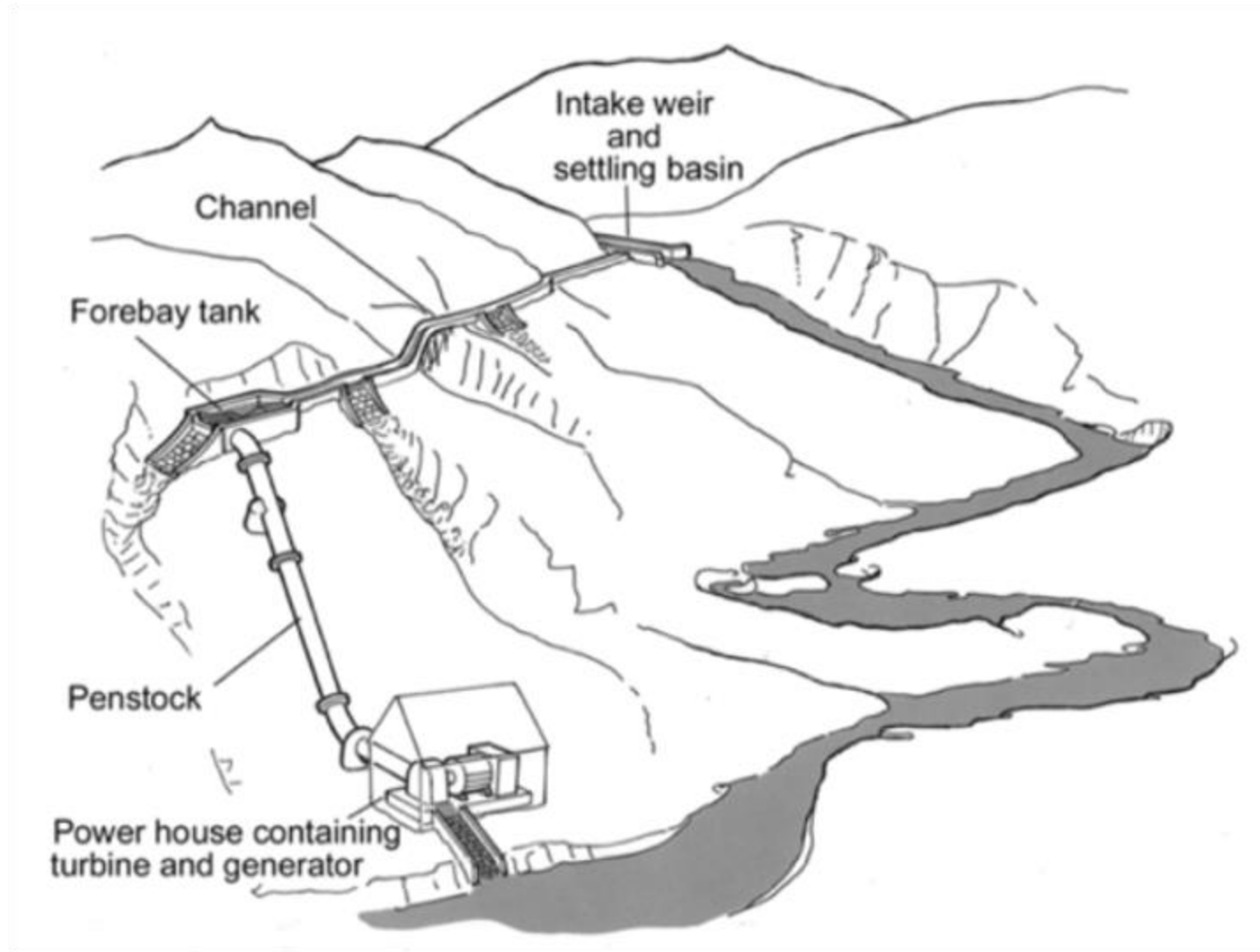
What is a mini grid?

A **mini grid** is
anything other than the main grid.

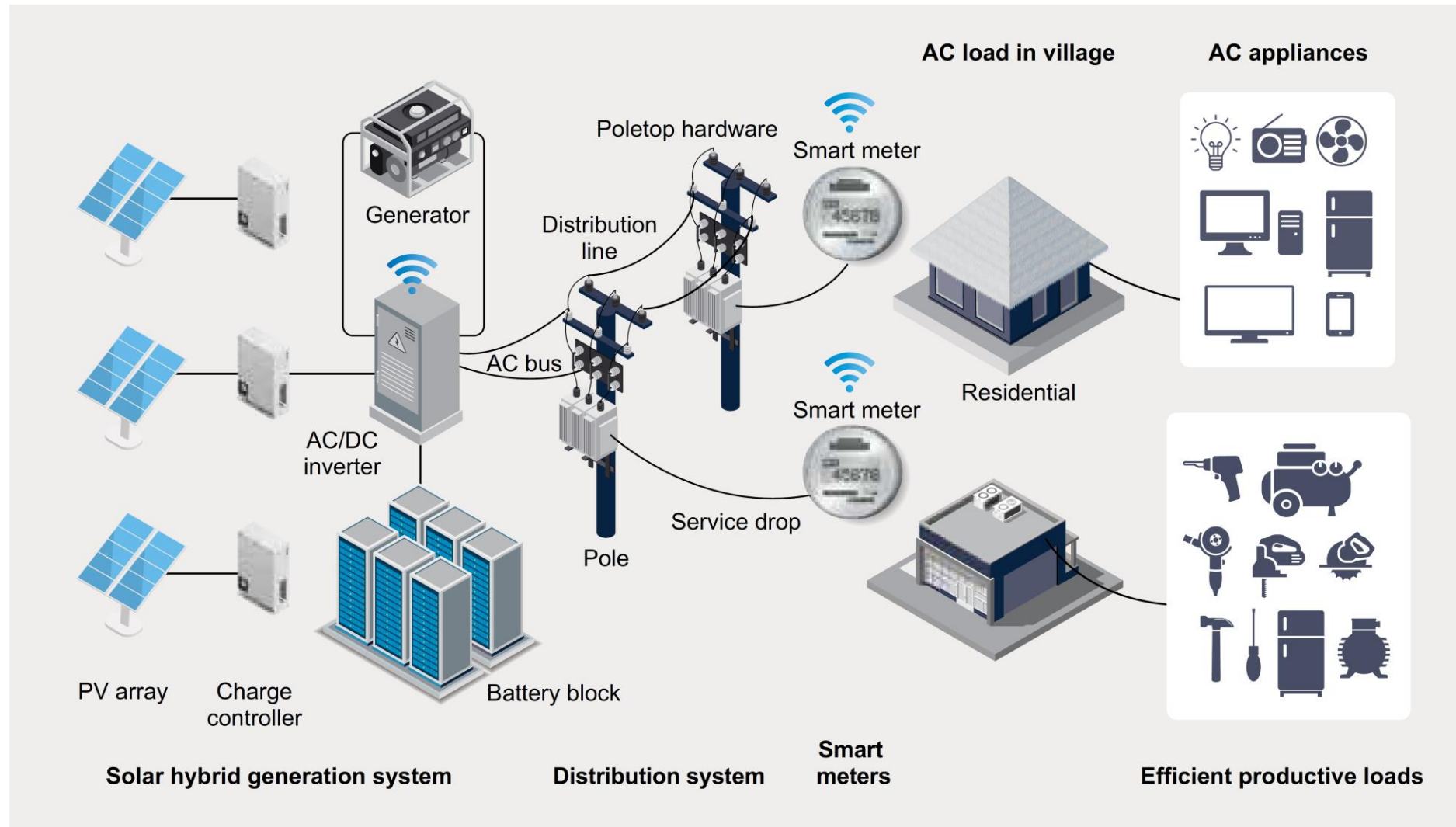
A mini grid is an electricity generation and distribution network that supplies electricity to a localized group of customers.
Mini grids can be isolated from and/or connected to the main grid.



2nd Generation of Mini Grids



3rd Generation of Mini Grids



Note: AC = alternating current; DC = direct current; PV = photovoltaic.

1,794
Million US\$

Total Funding for
Approved Projects

710

Million US\$
World Bank:
IDA, SREP, CIF, GEF

1,084

Million US\$
Private Sector and
Government

31

Countries

35

Operations

approved by World Bank board



INVESTMENTS APPROVED



INVESTMENT PIPELINE

430
 Million US\$
 Total Funding for
 Projects under
 Preparation

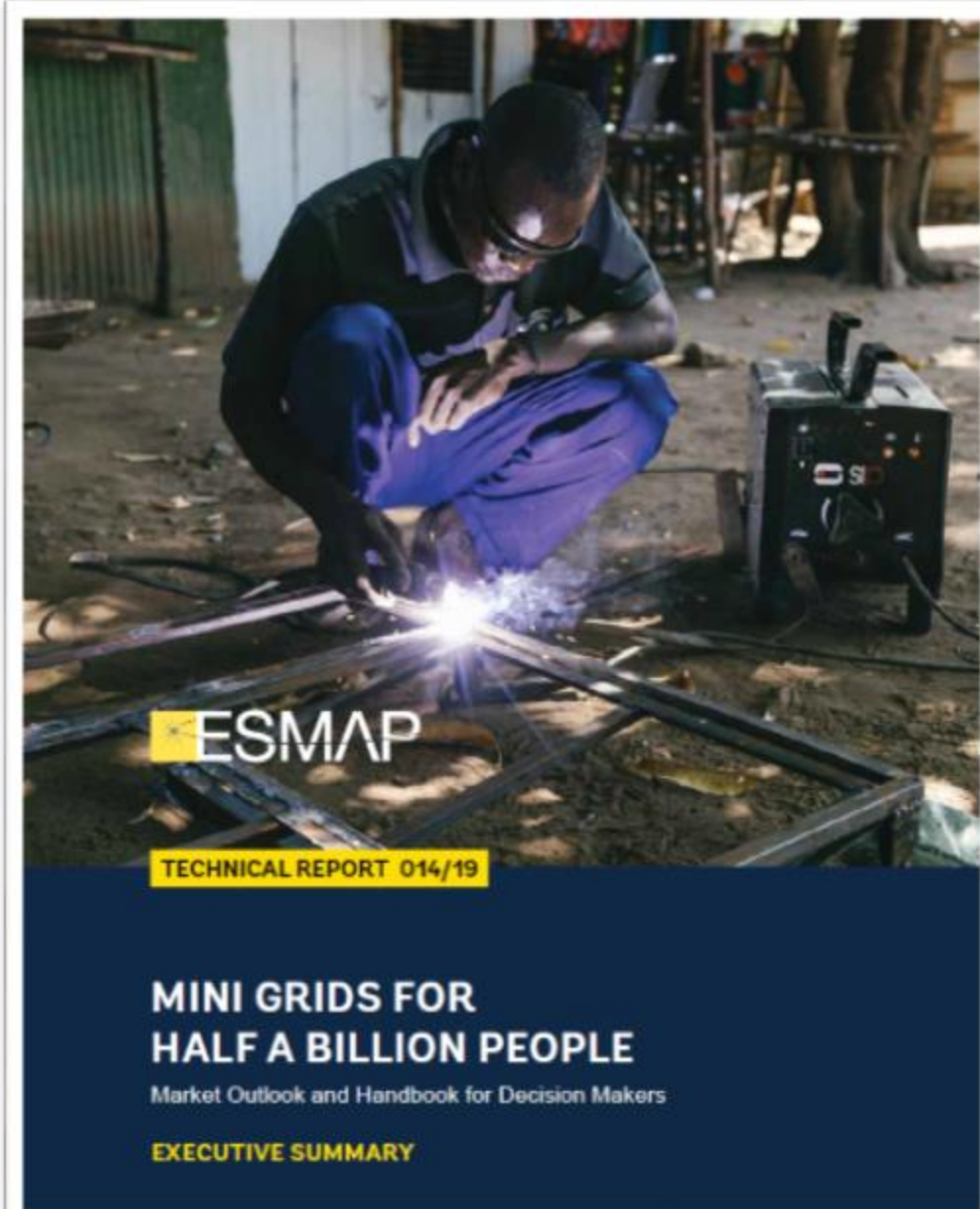
378
 Million US\$
 World Bank:
 IDA, SREP, CIF, GEF

52
 Million US\$
 Private Sector and
 Government

21
 Countries

15
 Operations
 approved by World Bank board

■ INVESTMENTS APPROVED ■ INVESTMENT PIPELINE



Part of a **comprehensive knowledge package** on mini grids that includes:

- 500-page book plus two volumes of annexes and case studies
- More than a dozen PowerPoint presentations on main findings
- Animations, infographics, and videos
- LiveWire publications
- Databases of 26,000+ mini grids globally, detailed costs, industry tracking
- Roster of Experts

English and French versions of the Executive Summary are available here:

<https://openknowledge.worldbank.org/handle/10986/31926>

For questions, please don't hesitate to send an email to:

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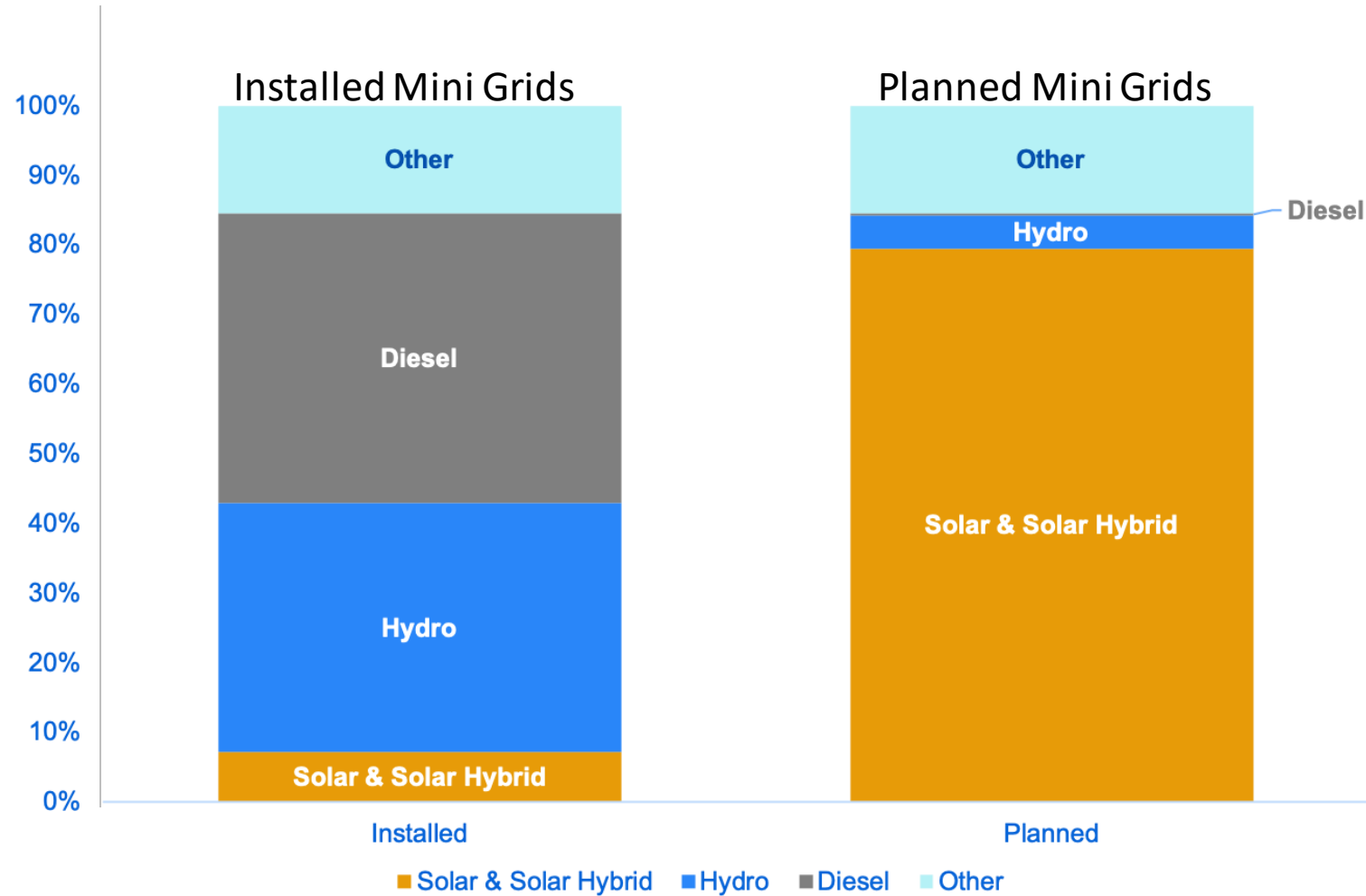
10 Building Blocks for Country Specific Mini Grid Industry Take-off

To Achieve Universal Access: **490 million people** served at least cost by **210,000 mini grids**, mostly solar-hybrids, requiring an investment of **\$220 billion**.

- Solar Hybrid Mini Grids and Costing
- Geospatial Planning
- Workable Regulations
- Enabling Business Environment
- Income-Generating Uses of Electricity
- Access to Finance
- Local and International Private Sector Involvement
- Community Engagement
- Training and Skills Development
- Institutional Set-up / Business Models

Where We Are Today: **47 million people** connected to **19,000 mini grids**, mostly hydro and diesel-powered, at an investment cost of **\$28 billion**. *Plus: 7,500 mini grids planned, mostly in Africa, mostly solar-hybrid, connecting more than 27 million people at an investment cost of \$12 billion.*

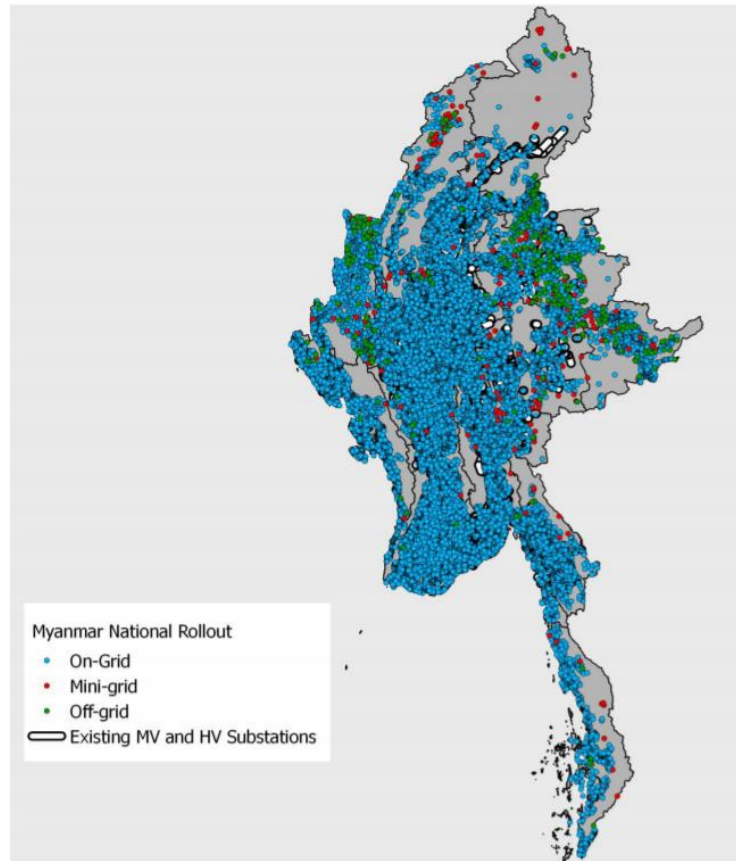
1. Innovative Technology



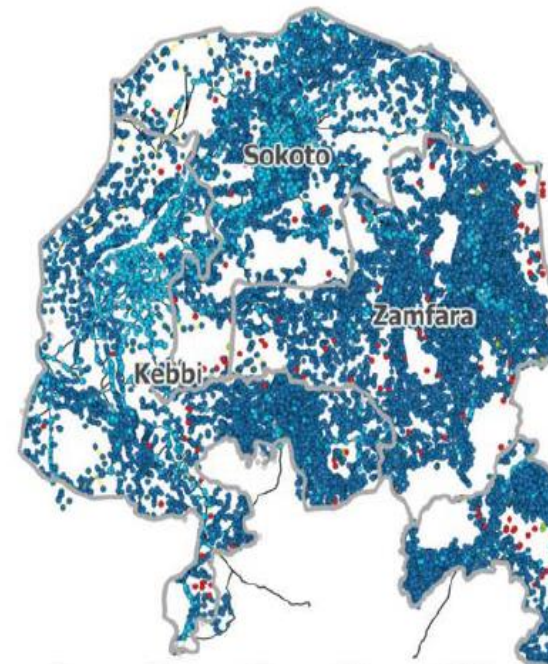
2. Geospatial Planning

National Least-Cost Electrification Planning

Grid Extension | Mini Grid | Off-grid



Source: Myanmar National Electrification Program (NEP) Roadmap and Investment Prospectus, Castalia, 2014;

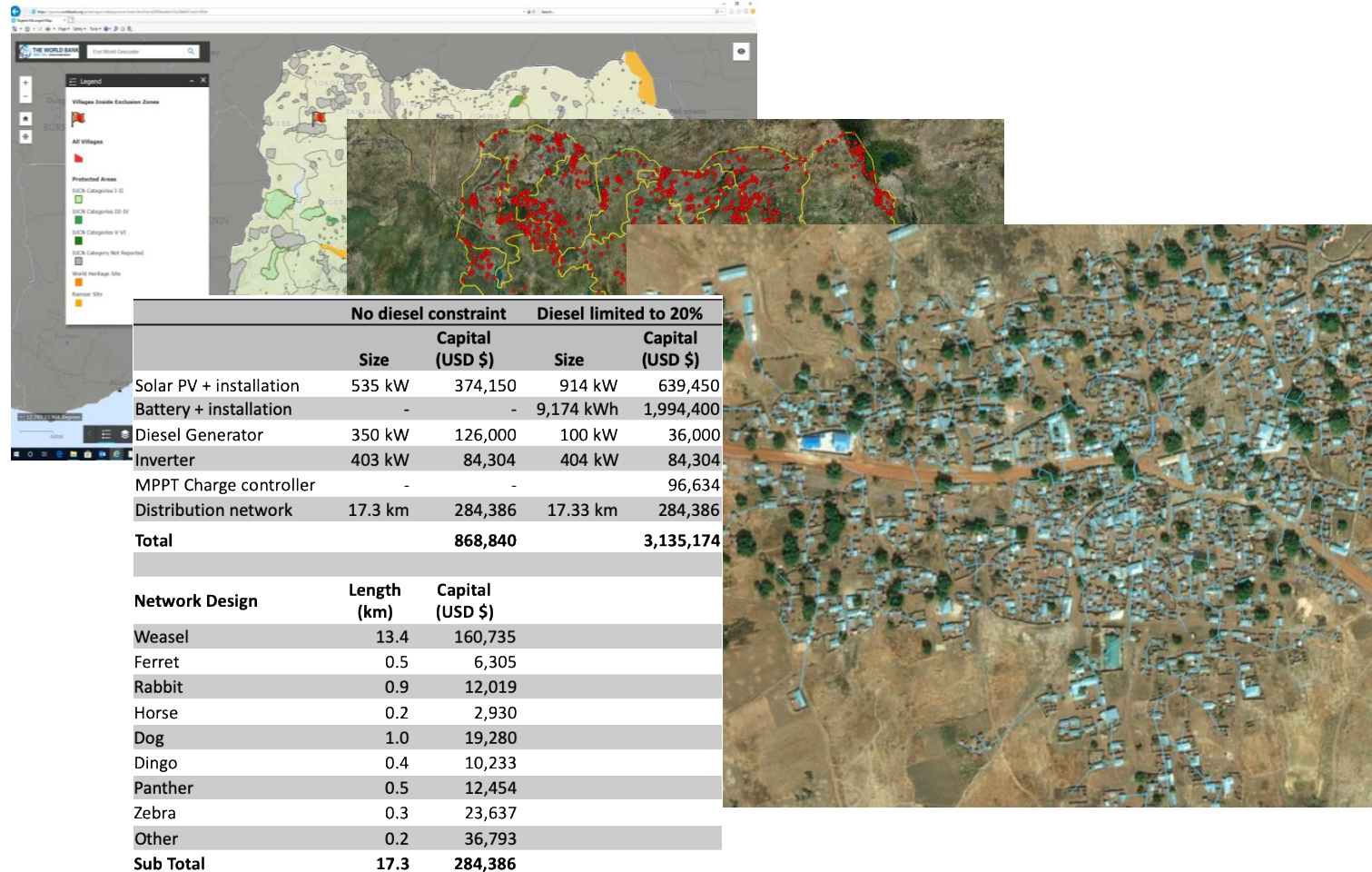


Source: Achieving Universal Access in the Kaduna Electric service area, World Bank, 2015

2. Geospatial Planning

Mini Grid Portfolio Planning

Magnitude Change in Costing | \$3,200 per site



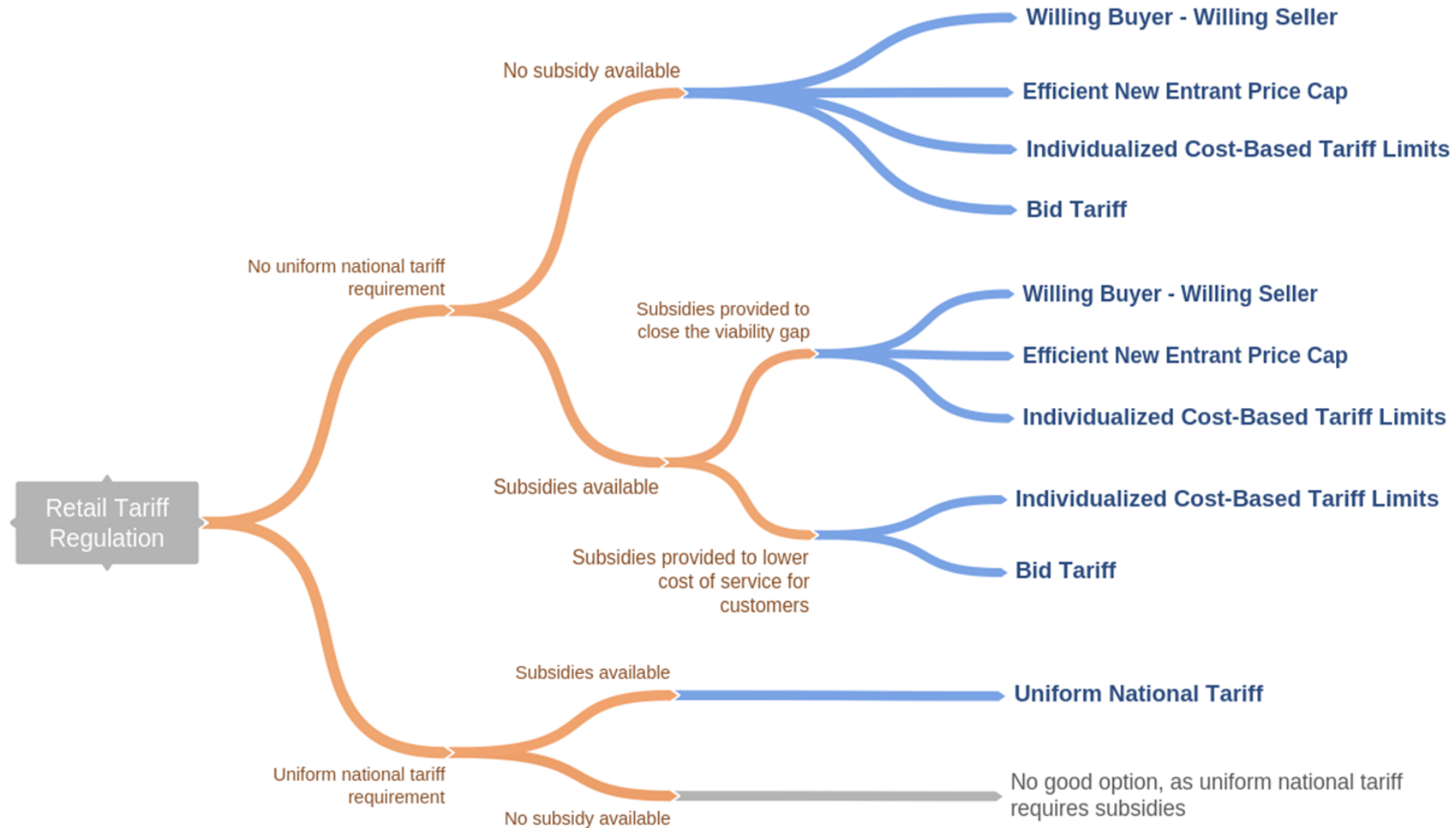
3. Workable Mini Grid Regulations

Four Key Topics in Mini Grid Regulations:

1. **Entry** to the market – licensing, permits
2. **Retail tariff**—tariff charged to customers
3. **Technical and service standards**—quality of power, quality of supply, quality of commercial services - safety, equipment or construction quality, connection with the main grid, environmental sustainability
4. **Relationship with the main grid**—commercial options available for the mini grid developer when the main grid arrives

3. Workable Mini Grid Regulations

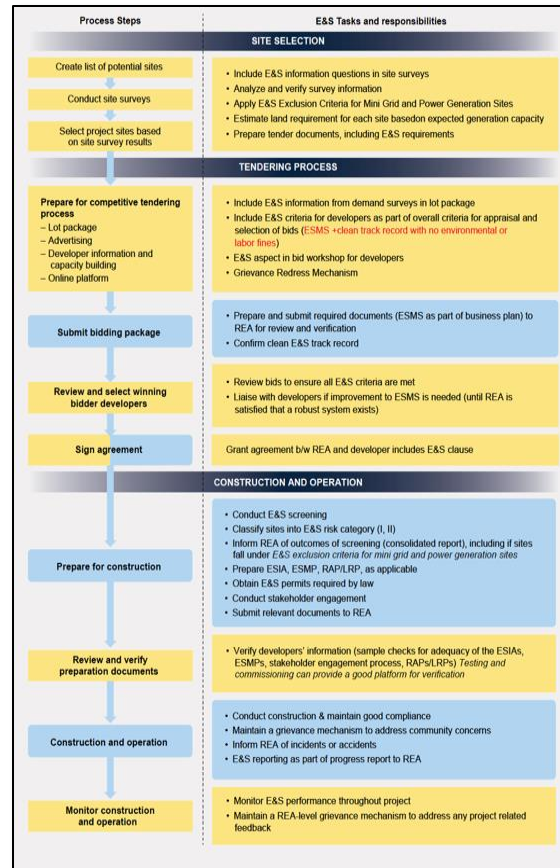
Non-Prescriptive Decision Trees



LESSONS LEARNED

4. Enabling Business Environment

Standardized, Pre-Approved Templates



Nigeria ESMS

STANDARDIZED POWER PURCHASE AGREEMENT
FOR PURCHASE OF ELECTRIC ENERGY FROM A GENERATION FACILITY
CONNECTED TO THE MAIN GRID
NAMESLY

BETWEEN

(The Buyer)

AND

(The Seller)

DATED.....2.....

Tanzania PPA

TEMPLATE
Agreement Between
the Mini-Grid Owner:

and
the Utility/Discom:

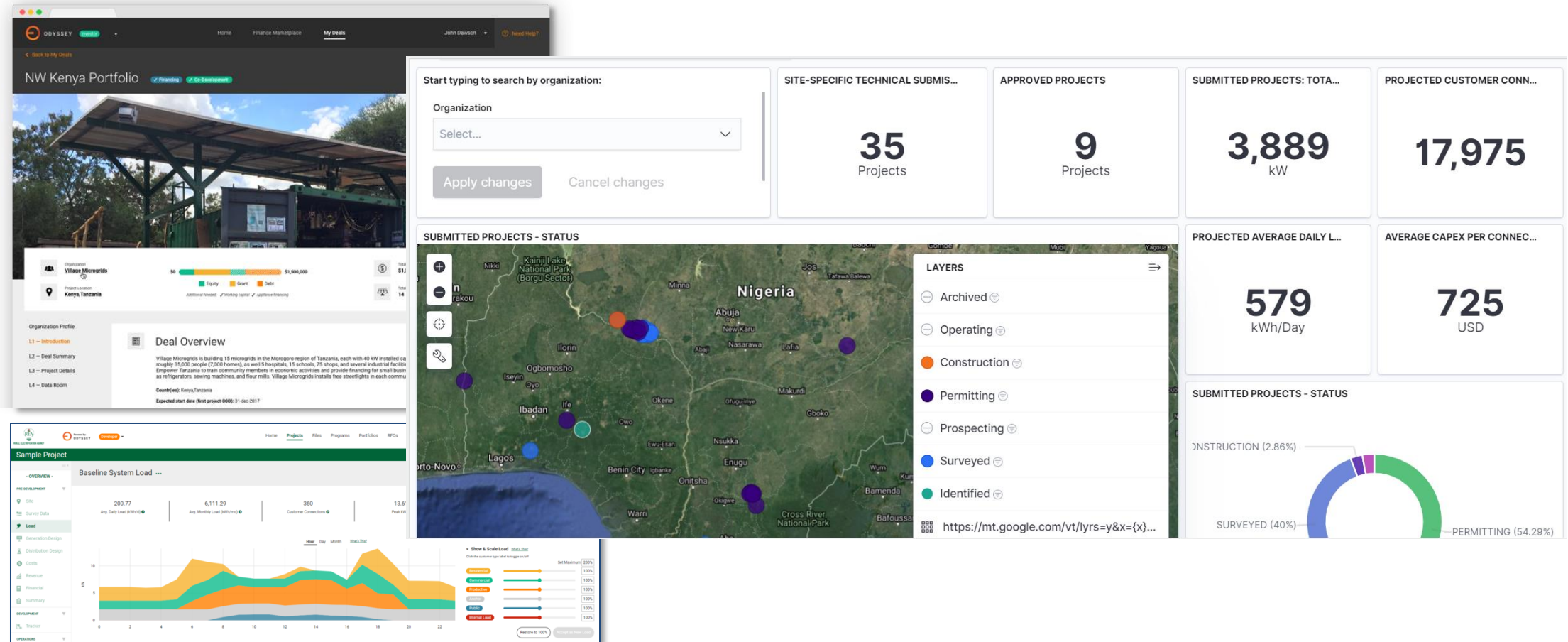
for the
Transfer of Mini-Grid Assets to the Utility/Discom
and the
Compensation Due to the Mini-Grid Owner

Asset Transfer
Template
(Under preparation by
ESMAP)

Examples

4. Enabling Business Environment

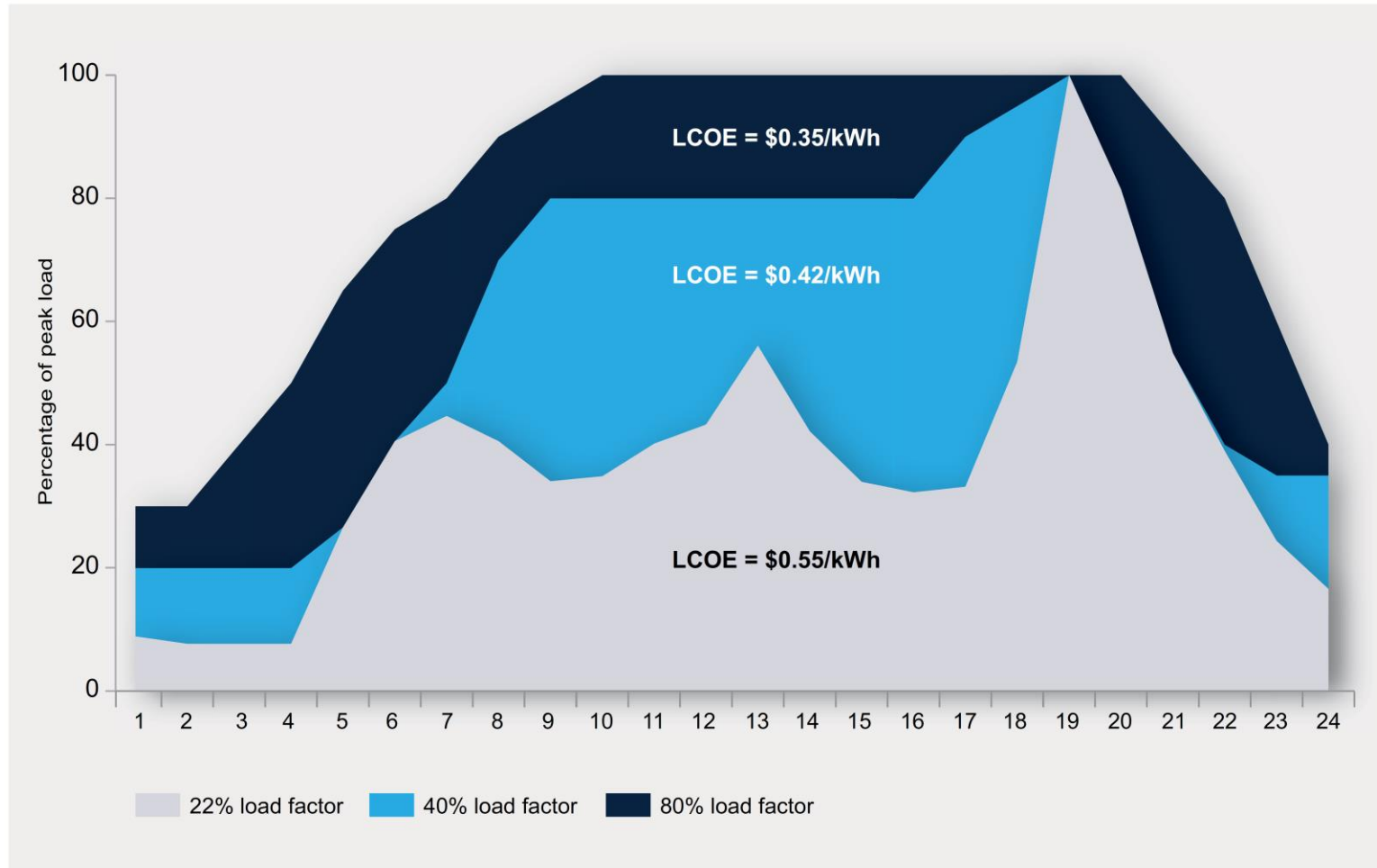
Data-Based Technology Platforms



LESSONS LEARNED

5. Income-Generating Uses of Electricity

Impact of Increased Load Factor on LCOE



Source: ESMAP analysis.

Note: kWh = kilowatt-hour.



5. Income-Generating Uses of Electricity

30+ Appliances with Payback of < 1 Year Need Suppliers and \$1.3 Billion in Microfinance

Sector	Activities / Appliances	Power required (kW)	Cost from supplier (\$)	Payback period (months)
Primary industries (agriculture, fishing)	Egg incubator	80 to 160W	\$50 to \$100	1 to 3
	Grinder for pulses and beans	5.2 kW	\$1,500 to \$4,000	6 to 12
	Water irrigation pump	3.7 to 22.4 kW	\$200 to \$1,000	3 to 6
	Sterilizer (for dairy processing)	3 to 6kW	\$600 to \$2,000	1 to 3
	Packager	250W to 3kW	\$500 to \$1,000	6 to 12
Light manufacturing	Electronic welding machine	3 to 7.5 kW	\$200 to \$300	6 to 12
	Jigsaw	400W	\$100	3 to 6
	Electric drilling machine	400W	\$20 to \$50	3 to 6
	Popcorn maker	1.5 to 2.1 kW	\$50	1 to 3
Commercial and retail activities	Computer	15 to 100W	\$250 to \$800	3 to 6
	Printer/scanner for stationery	0.5 to 2kW	\$150 to \$250	3 to 6
	Sewing machine	200W	\$30 to \$100	3 to 6
	Television for local cinemas and bars (including decoder)	50 to 200W	\$100 to \$200	1 to 3

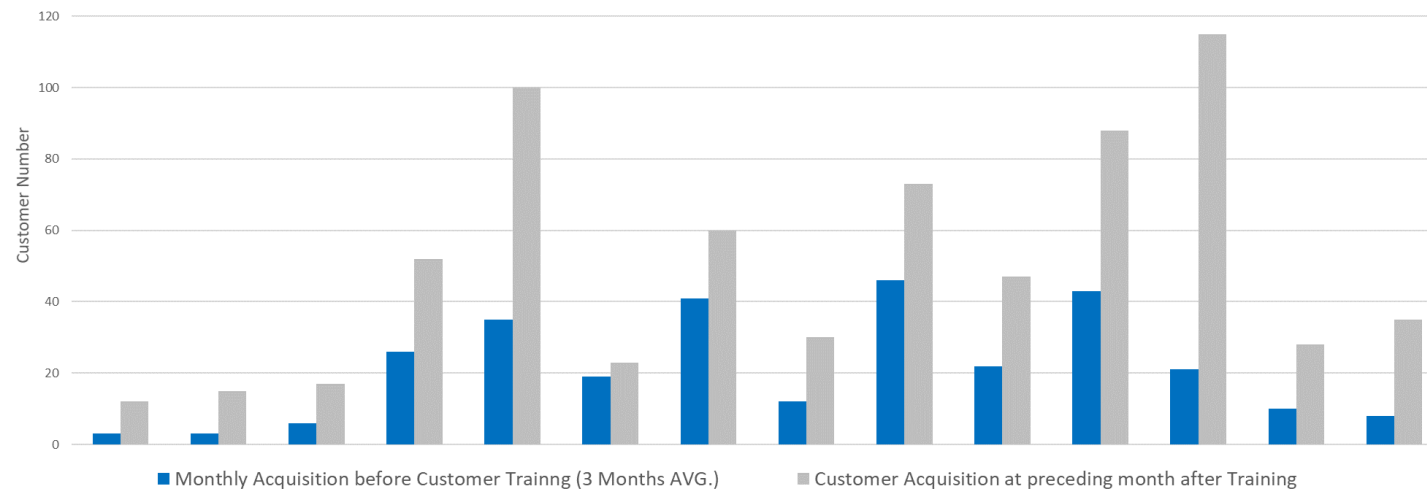
Source: ESMAP, Alibaba, Inensus.

Note: Chapter 5 of the main report provides the full table of 37 income-generating machines and other equipment.

kW = kilowatt; W = watt.

5. Income-Generating Uses of Electricity

Extensive customer awareness campaigns increased load uptake in Bangladesh...



Source: IDCOL

Yet there is 50 times more financing available to generate electricity than for promoting its consumption in Africa (RMI)

LESSONS LEARNED

Institutional Framework / Business Models

Typical Mini Grid Delivery Models

Build-Own-Operate

Private sector carries out all steps from design to operation and co-finances the mini grid alongside development partners, the government, investors, and lenders

PPP

Contractual: Gov. builds and owns the mini grid and private sector operates it.

Split Asset: Private sector builds all or part of the mini grid; gov. and private sector divide asset ownership; private sector is operator

Concession

Government grants a concession to the private sector under a contractual arrangement usually for a pre-specified duration, with terms to which developers must adhere in exchange for service area exclusivity

Utility

The national utility carries out all steps from design to operation, or may contract with the private sector for some of these steps

Cooperative

Local communities co-finance (typically through grants) and own the mini grid, often contracting with a third party to design and build the system and train the community on operations and maintenance

Some First Ideas for Mini Grid Delivery Models in Ethiopia

Fully Public Sector Funded

Maximum Private Sector Contribution

Utility with Private Sector

EEU EPC + O&M Contracts

EEU contracts with private for EPC & O&M for a portfolio of 100 mini grids located relatively close to the existing main grid to facilitate post-contract handover to EEU staff. Demand stimulation during O&M contract phase will increase economic viability for main grid arrival in the medium term. World Bank funding would reduce EEU outlays.

Objective: 100 mini grids by 2025
Cost: \$60 Million ^a
Public/Private Cost Share: 100/0

Split-Asset PPP

EEU PPP for Hybridization

Solar hybrid generation on existing EEU diesel mini grids tendered out to the private sector under a PPA with EEU, for a portfolio of about 25MW in solar PV plus storage. This would be a win-win-win for EEU (reduces diesel generation costs), customers (increases electricity availability to 24/7), and the private sector (reduces risks). It is also in line with the new investment law. World Bank funding would fill the viability gap between tariff required by private sector and tariff paid by EEU.

Target: 100 ^b mini grids by 20205
Cost: \$50 Million ^c
Public/Private Cost Share: 50/50

Build-Own-Operate

Minimum Subsidy Tender

EEU would select 50 sites, divided into 2-5 portfolios, in areas where there is likely to be significant private sector interest. EEU would invite private sector developers to bid for minimum capital cost subsidies needed to build and operate the mini grid portfolios. World Bank funding would support market intelligence and portfolio preparation in addition to the capital cost subsidies. The Odyssey platform (<https://www.odysseyenergysolutions.com/>) would manage the process.

Target: 100 mini grids
Cost: \$60 Million ^a
Public/Private Cost Share: 40/60

Build-Own-Operate

Results-Based Financing

Private sector developers would be invited to submit proposals to build and operate mini grid portfolios in sites of their choosing, given a fixed per-connection subsidy paid partly upfront to offset capital costs and partly based on number of successful connections. The global mini grid industry fully supports this approach, and aligns with current private sector, regulatory, and policy momentum in Ethiopia. The process would be managed using the Odyssey platform.

Target: 100 mini grids
Cost: \$60 Million ^a
Public/Private Cost Share: 40/60

Assumptions

- a. 100 mini grids x 150kW per mini grid x \$4,000 per kW
- b. 500kW per mini grid of which 50% is PV+storage (based on 25MW PV+storage)
- c. 100 solar + PV generation systems x 250kW generation capacity x \$2,000 per kW



10 Building Blocks

- Solar Hybrid Mini Grids and Costing
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