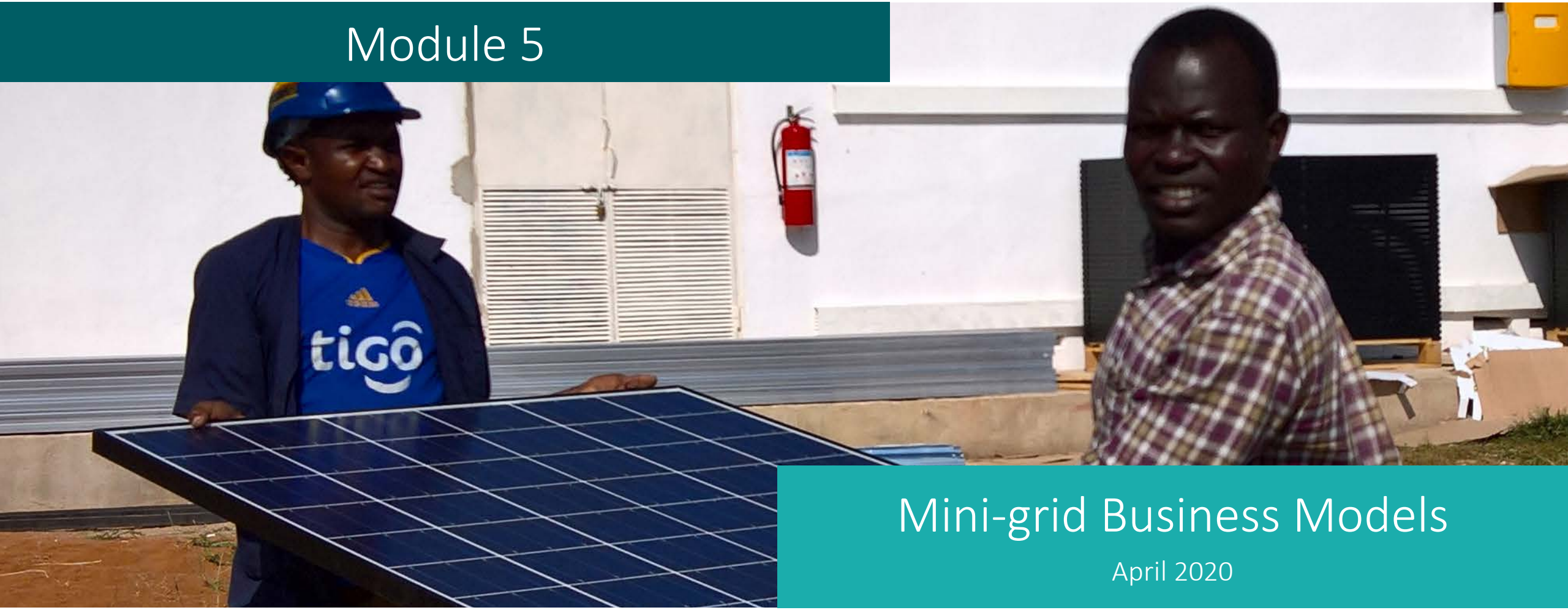
GREEN MINI-GRID HELP DESK

Module 5



Mini-grid Business Models

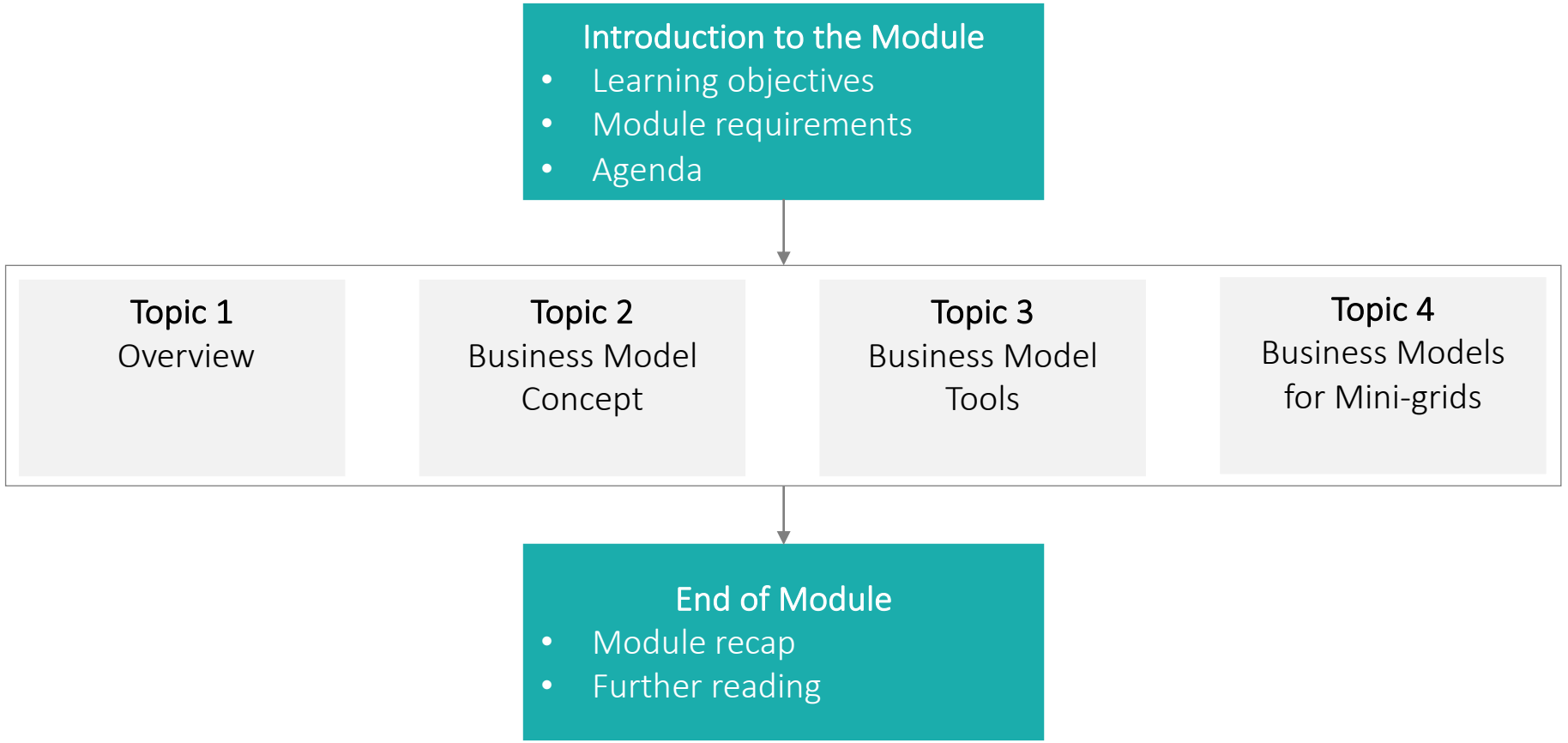
April 2020

ENERGY4IMPACT
ACCELERATING ACCESS TO ENERGY

INENSUS

SUSTAINABLE ENERGY FUND FOR AFRICA

Module Overview



Objectives & Requirements

Learning Objectives

- Learn about the generic process for designing a business model.
- Learn about the different elements of mini-grid business models, including customers, tariffs, revenue collection and service quality.
- Discover strategies for improving mini-grid economics such as demand side management, end user financing and clustering.

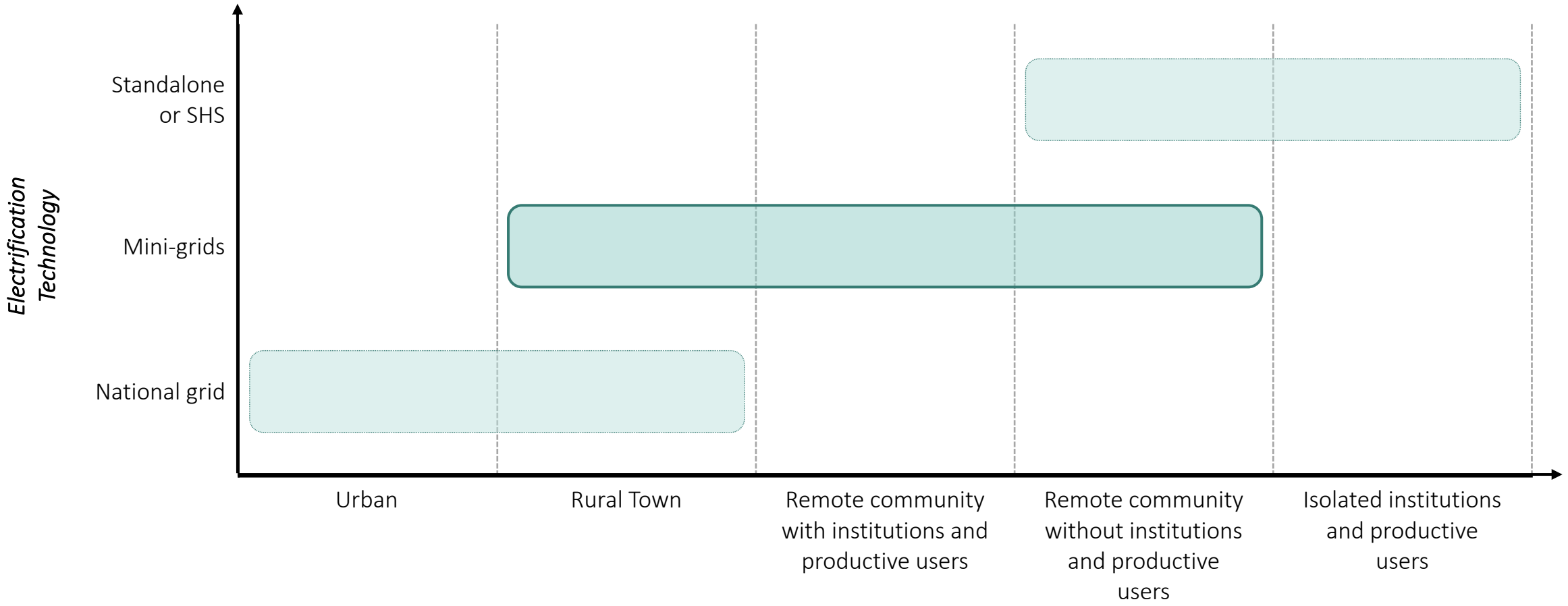
Module Requirements

- This module is targeted at mini-grid developers and operators at all stages of development.
- They are expected to have a basic understanding of rural, off-grid energy markets and community dynamics in developing countries.
- No detailed knowledge of mini-grid business models is required.

Agenda

1. Overview
   - Setting the Scene
   - Business models for mini-grids
   - Reliance on grant funding
2. Business Model Concept
   - Definition
   - Business Model Objectives
3. Business Model Tools
   - Developing a Business Model
   - Business Model Canvas
4. Business Models for Mini-grids
   - Customers, tariffs, revenue collection, service quality, demand side management, productive use, end user financing, KeyMaker model, e-waste

Setting the Scene: MG locations/markets



Setting the Scene: Types of Mini-grid

Customer Type	Size	Off-taker	Comments
Type 1	1-10 MW	State utility Anchor client Local community	Small IPP Often connected to grid More predictable revenue stream Post payment Captive supply licence
Type 2	100 kW to 1 MW	Local community Anchor client	Micro concessions or micro IPPs Part of licencing and tariff regime
Type 3	Less than 100kW	Local community	No standard business models May be exempt from licencing and tariff regime

Business Models for Mini-grids

There are no proven business model for mini-grids

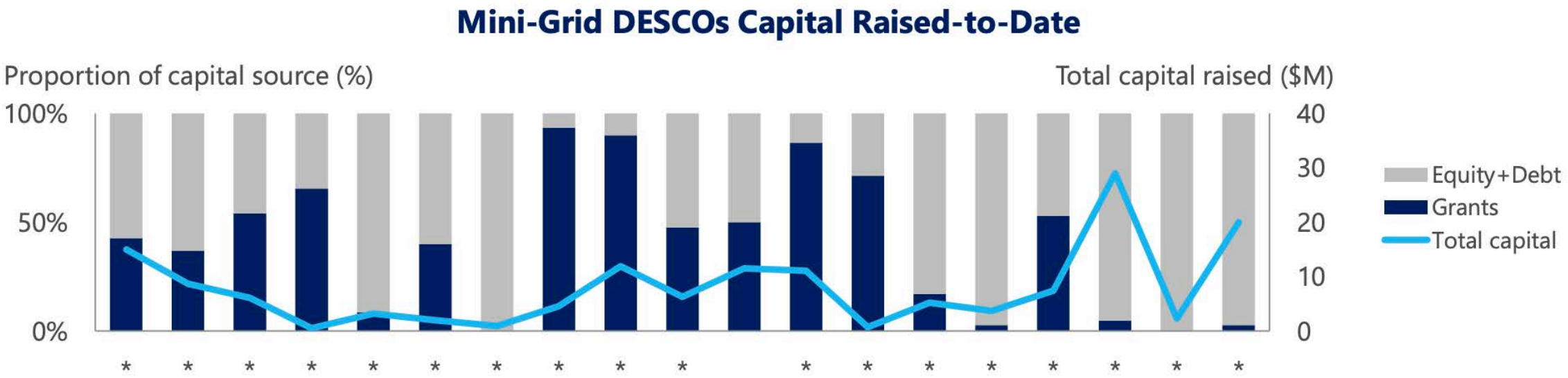
Business models vary by **ownership/operatorship**, **project size**, **customer target** and whether they are **technology or developer focused**

Many strategies exist to make mini-grids successful:

- Quality of electricity service
- Demand management
- Productive end use
- End user finance
- Community engagement
- Revenue collection
- Tariff design

Reliance on Grant Funding

Mini-grids in Sub-Saharan Africa and other parts of the world are still heavily reliant on grant funding



Graph: proportion of capital that came from grant funding, vs. equity or debt, for 19 mini-grids in the Africa, Asia and the Caribbean.
Source: IFC. (2018)

High Opex

Opex and admin costs may not always cover revenues

Average **Opex: 58% revenue**

Average **Opex + Admin: 128% revenue**

Based on data collected from 13 mini-grids from across Africa & Asia

Source: IFC (2018)

Definition

A business model is a plan for the successful operation of a business, identifying sources of revenue, the intended customer base, products, and details of financing.

Source: Oxford English Dictionary

Business Model Objectives

- A successful mini-grid business model should have the following objectives:
  - Produce reliable power and satisfy its customers' needs
  - Generate sufficient revenue to maintain, service & repair mini-grids
  - Have potential to scale up
  - Repay investors and generate a satisfactory return for them
  - Meet all financing obligations
  - Comply with relevant regulations

Developing a Business Model

3-step process for business model development.
Source: Adapted from Baringa Consultancy

Business model development is the process of answering 3 questions: Define, Challenge/Improve and Execute

The Business Model Canvas can be used to define and improve the business model

- One-page description of how a company runs its business, in the present or in the future
- Tool that helps to define and determine key elements of a business

Scenarios where it is useful:

- Finalise product / service offer
- Identify customers and revenue streams
- Identify key risks and gaps in business case
- Challenge and improve an existing business model

Business Model Canvas

Value Proposition

What is the value that the business brings? *(Types of value: Social, Economic, Environmental)*

Customers

Who are the customers? What different types of customers does the business have?

(Households, Businesses, Anchor Loads, Institutions, etc.)

Products and Services

What products or services does the business provide?

(1-Phase/3-Phase connection, energy as a service, etc.)

Resources

What resources are required to deliver it?

(Technology, Financing,/Licence / Permits, etc.)

Cost Structure

What are the main costs and when do they occur? What currency are they in?

(Proj. dev costs, capex, opex, productive use assets etc..)

Tariff methodology

What is the basis for customer payment, and at what rate will they make repayments?

(*Pay to buy / Pay per use, $/kWh, $/year)*

Payment Channels

How does the customer pay for the product?

(Mobile money, Vouchers, Currency, etc.)

Partners

Who are key partners who facilitate the implementation of this model?

What roles do they play?

(Govt. Bodies , NGOs, Payment Partner, Data collection partners, O&M partners, etc)

Source: Adapted from Baringa Consultancy

Customer Focus

- Customers are the number one priority for mini-grids
- Target combination of different customer categories
  - Households
  - Small businesses
  - Anchor clients
- Importance of **productive use** customers
  - Critical mass of sales
  - Demand profile
  - Social & economic development
- **ABC* model not well established** in Africa
- No **minimum mini-grid size**, but > 1,000 connections is recommended

Photo: Examples of productive use customers (bakery, welding, movie theatre, and cafe).
Source: Booth, S., Li, X., Baring-Gould, I., Kollanyi, D., Bharadwaj, A., & Weston, P. (2018).

*Anchor-Business-Community Model

Tariff Design

Tariffs calculations

- Ability and willingness to pay
- Projected demand
- Tariff must cover costs:
  - Fixed costs
  - Variable costs

Lessons

- Keep simple and transparent
- Provide justification for different tariffs between different customer types
- Consider seasonality

Types of tariff

- Energy-based
- Power-based
- Flat rate or service tariff
- Pay in advance (the norm) or after usage
- Limited or unlimited power consumption

More information about tariffs can be found in:
Boursier, S., et.al. of INENSUS, and Otieno, B., et.al. of Energy 4 Impact (2019), and
Boursier, S., et.al. of INENSUS, and Browne, C., et.al. of Energy 4 Impact (2019).

Revenue Collection

Factors affecting revenue collection

- Design tariff for local conditions
- Metering technology
  - Measure electricity consumed
  - Track for billing
- Anti theft measures
- Good staff management

Metering technology

- Pre-paid or post-paid
- Conventional vs. smart meters
- Smart meters are most popular
  - Manage consumption and payment without manual intervention
  - Allow remote monitoring

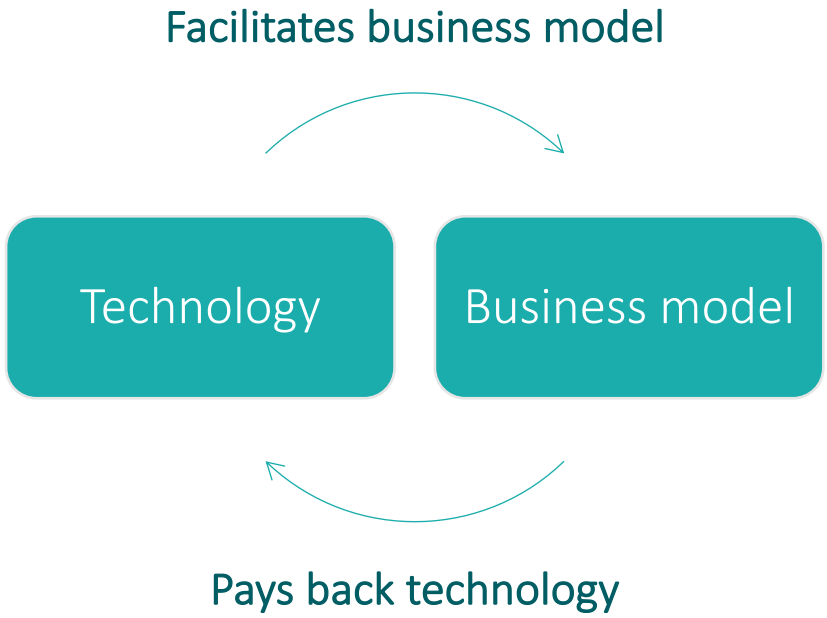
  … but
  - Prone to outages due to unstable internet connection in villages
  - Relatively expensive
- Cost of meter & applicable software

Technical Considerations

Business models can require certain technology / hardware / capabilities:

- Generation & distribution network
  - e.g. a model serving large productive use customers will need appropriate generation & distribution technology
- Smart metering & other data recording
  - e.g. some operation and online payment models require certain data to be collected and remote monitoring capability

All technical investments have a cost which feeds back into the business model



Mini-grid Clustering

- Clustering is the process of building more than one mini-grid sites in close proximity to another.
- They can remain isolated networks or be interconnected between sites.
- Benefits of clustering
  - Cost sharing: personnel / management / maintenance / logistics / economies of scale shared between sites
  - Economic benefits of electrification spread over a larger area, developing larger economically-active markets
  - Interconnected mini-grids can create wider, more resilient power networks, and can better integrate into the national grid when it arrives. ECCDSERG (2018)

Quality of Service

- Quality of electricity service defined in 3 ways:
  - Ability to serve different customer types
  - Availability (hrs/day)
  - Continuity
- **Developers must decide early** what tier of electricity service they offer for different customer types and measure their **willingness and ability to pay** for such service cost

- **Productive users** require **higher levels of service**
- Level of service also important for **customer agreements**

Quality of Service: Multi-tier framework

ESMAP Service Tiers

Service Tier	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Peak Power Available	None	3 - 50W	50 - 200W	200 - 800W	800 - 2,000W	P > 2,000W
Allowable daily energy consumption	None	12 - 200Wh	200 - 1,000Wh	1,000 - 3,400Wh	3,400 - 8200Wh	> 8,200Wh
Duration of Supply	None	> 4hrs	> 4hrs	> 8hrs	> 16hrs	> 23hrs
Evening Supply	N/A	> 1hrs	> 2hrs	> 3hrs	> 4hrs	> 4hrs
Reliability	N/A	> 85%	> 90%	> 95%	> 97%	
Typical Applications	Lighting with traditional fuels	Lighting of 1,000 lumen-hours /day, phone charging	General lighting, fans, TV, light office needs	Tier 2 + food processing, task oriented food preparation	Tier 3 + Refrigerators, pumps, expanded food preparation	Tier 4 + Air conditioning, light industrial, commercial food preparation

Source: Bhatia, M., & Angelou, N. (2015)

Demand-side Management (DSM)

- DSM is the process of actively influencing electricity demand on mini-grids so it matches electricity generation. It is generally cheaper to adjust demand than supply.
- It is important for the project economics of mini-grids, particularly for intermittent sources such solar mini-grids which generate only electricity in daylight hours.
- A common DSM strategy is to shift demand to times of higher renewable resource availability (e.g. high solar irradiation) and away from times of lower availability.

More information on DSM available in Module 3 (Productive Use and Demand Side Management).

Productive Use

Productive use (PU): agricultural, commercial and industrial activities that generate income, increase productivity, enhance diversity and create social and economic value through the consumption of electricity.

Benefits:

- enhanced social and economic impact
- increased electrical sales important for viability of mini-grids

More information on PU is available in Module 3

Photo: Saw mill at KIS, a mini-grid in Uganda
Source: Booth, S., Li, X., Baring-Gould, I., Kollanyi, D., Bharadwaj, A., & Weston, P. (2018).

Productive Use: Rutenderi Mini-grid in Rwanda

Photo credit: Energy 4 Impact. Absolute Energy's 49 kW mini-grid at Rutenderi in Rwanda

Payback on Productive Use Loans

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.

Table source: ESMAP (2019)

End User Finance (1)

- Stimulate demand through financing end users, especially productive income generating users
- Cover upfront cost of connections (sometimes also household wiring) and electrical appliances
- Offer short-term loans or grants

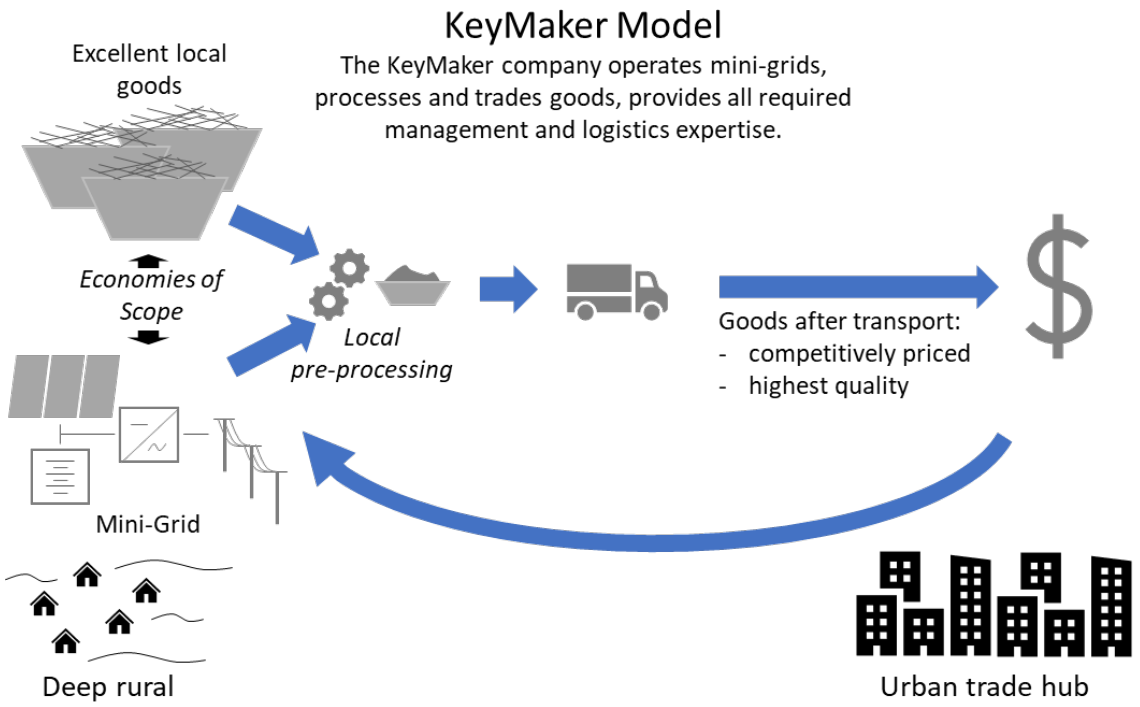
End User Finance (2)

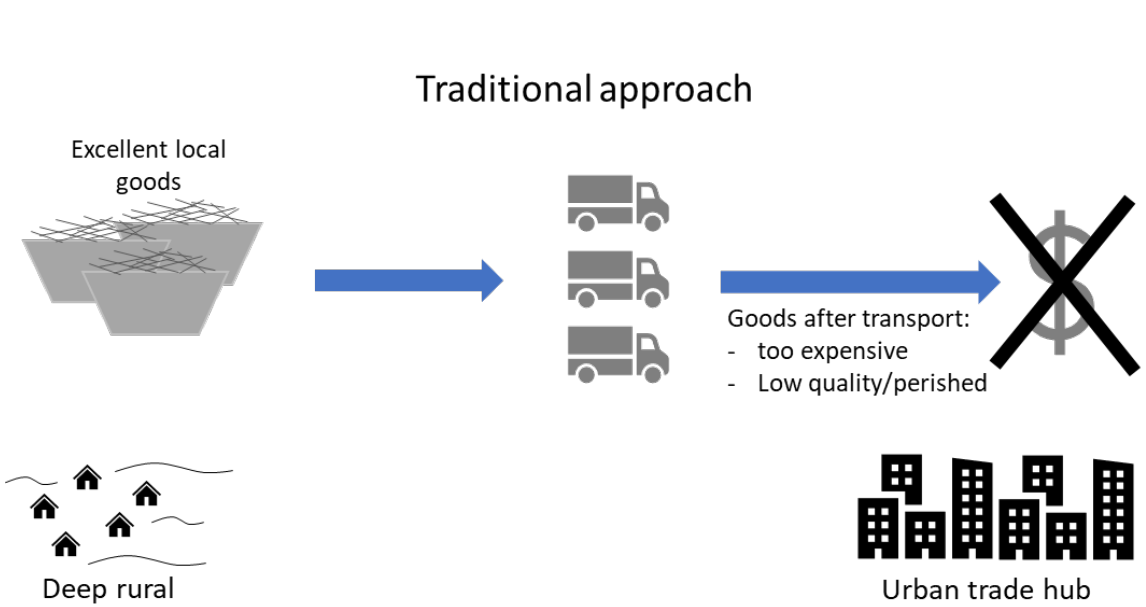
Partnership structures

- One-stop shop (developer only)
- Financial institution
- Third party payment provider

KeyMaker Model

The KeyMaker Model exploits electricity generated by mini-grid to process local goods and resources. It can help lower transport costs and improved quality of the goods sold





Source: INENSUS

Jumeme: Case Study of KeyMaker Model

Developer: Jumeme

Location: Lake Victoria, Tanzania

Generation: PV-diesel hybrid

Scenario: Low demand in the day.
Irrigation pumps used in early morning and evening to protect seeds.
Large fishing community in village which sells only to local markets.

DSM strategy / technology: In addition to the mini-grid, JUMEME has a fish freezing and trading business (KeyMaker model).
JUMEME purchases tilapia from local fishermen at a set rate, stores them in freezers, then transports them to the capital city Dar es Salaam to sell wholesale. An icemaker powered by the mini-grid is used to make ice for transporting the fish on the island

Impact of strategy / technology: Local fishermen have a secure customer to whom they can sell their fish at a fixed price.

The fish business has increased **overall demand on the mini-grid,** especially **during the day**. It now consumes about 10% of the total electricity produced, and generates revenues that are the same, or greater than, the electricity sales made to all other customers on the mini-grid.

Photo: JUMEME's mini-grid facility on the shore of Lake Victoria.
Credit: JUMEME

E-waste

Solar e-waste is a big issue

- 350,000 off-grid solar appliances sold in last 6 months 2018 (source: GOGLA)
- Kenya produces 44K tons of e-waste a year, but only 1% is recycled

Key solar e-waste issues

- Product take-back and collection
- Handling
- Transport
- Recycling
- Refurbishment
- Safe disposal

Product take back at end of life

- Company collection points
- Informal collectors
  - Process majority of e-waste
- Incentive schemes
  - Do not distort market
  - Post warranty service included in initial cost of products
- Residual value
  - Value of lead in lead acid batteries

E-waste legislation

- Draft law in Kenya (NEMA)
- Provisions for batteries
- May be expanded to off-grid products, but will need lobbying

Module Recap

- No single proven business model for mini-grids.
- Nearly all mini-grids are heavily reliant on grant-funding.
- Key aspects of a mini-grid business model include customers, tariffs, revenue collection, service quality, and environmental sustainability.
- Strategies to boost revenues include demand side management, productive use, end user finance, and mini-grid clustering.

Further reading

AMDA (2018). Mini-Grids on the Trajectory of Rural Electrification in Africa. http://africamda.org/wp-content/uploads/2018/10/WHITE-PAPER-Mini-Grids-on-the-Trajectory- of-Rural-Electrification-in-Africa.pdf

Attigah, B. and Mayer-Tasch, L. (2013) *Productive use of Energy (PRODUSE): The Impact of Electricity Access on Economic Development: A literature review*. Eschborn: GIZ. http://www.produse.org/imglib/downloads/PRODUSE_study/PRODUSE%20Study_Literature%20Review.pdf

Augusto, C. F. R. (2017). *Evaluation of the potential of demand side management strategies in PV system in rural areas*. Universidade De Lisboa. http://repositorio.ul.pt/bitstream/10451/30607/1/ulfc121584_tm_Catarina_Augusto.pdf

Best, S., Garside, B. (2016). *Remote but productive: Using energy access investments to catalyse enterprises and income in Tanzania's rural communities*. IIED Working Paper, IIED, London. http://pubs.iied.org/16627IIED/?k=Tanzania

Bhatia, M., & Angelou, N. (2015). *Beyond Connections, Energy Access Redefined.* World Bank. https://openknowledge.worldbank.org/handle/10986/24368

Blodgett, C., Moder, E., Kickham, L., Lead, H., (2016). *Powering Productivity: Early Insights into Mini Grid Operations in Rural Kenya.* Vulcan Impact Investing. http://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/Kenya-Mini-Grids-White-Paper-VI2.pdf

Booth, S., Li, X., Baring-Gould, I., Kollanyi, D., Bharadwaj, A., & Weston, P. (2018). Energy 4 Impact and NREL. *Productive Use of Energy in African Micro-Grids: Technical and Business Considerations.* https://www.energy4impact.org/file/2039/download?token=8ardN8he

Boursier, S., et.al. of INENSUS, and Otieno, B., et.al. of Energy 4 Impact (2019). *Billing, Revenue Collection and Metering Models for Mini-Grids.* Green Mini-Grid Help Desk. https://greenminigrid.se4all-africa.org/sites/default/files/billing_models_for_minigrids_april_2019.pdf

Further reading

Boursier, S., et.al. of INENSUS, and Browne, C., et.al. of Energy 4 Impact (2019). *Demand Side Management for Mini-grids.* Green Mini-Grid Help Desk. https://greenminigrid.se4all-africa.org/sites/default/files/afdb_gmg_dsm_report_final_draft_cb.pdf

Contejean, A., Verin, L., (2017). *Making Mini-Grids Work: Producitve Uses of Electricity in Tanzania*. Working Paper, IIED, Hivos. http://pubs.iied.org/16632IIED/

Deichmann, U., Meisner, C., Murray, S. and Wheeler, D. (2011). *The economics of renewable energy expansion in rural Sub-Saharan Africa*. Energy Policy, 39(1), pp.215-227. https://www.sciencedirect.com/science/article/pii/S0301421510007202

ECCDSERG (2018). *Clustering Mini-Grid Networks to Widen Energy Access and Enhance Utility Network Resilience*. University of Southampton http://www.energy.soton.ac.uk/fortis-unum2018/

EEP Africa. (2018). *Opportunities and Challenges in the mini-grid sector in Africa*. https://eepafrica.org/wp-content/uploads/EEP_MiniGrids_Study_DigitalVersion.pdf

Energy 4 Impact and Inensus (2016). *Green Mini-Grids in Sub-Saharan Africa: Analysis of Barriers to Growth and the Potential Role of the African Development Bank in Supporting the Sector.* AFDB. https://www.se4all-africa.org/news-resources/news/article/publication-green-mini-grids-series-1-analysis-of-barriers-to-growth-and-potential-role-of-afdb-150/

Energy 4 Impact and INENSUS (2019). *Mapping of Cereals, Fisheries and other Productive Use Businesses for Village Mini-grids: A Review of 15 African Countries.* Green Minigrid Help Desk https://www.energy4impact.org/file/2097/download?token=HAPpuCJW

Further reading

ESMAP. (2019). *Mini Grids for Half a Billion People : Market Outlook and Handbook for Decision Makers*. ESMAP Technical Report;014/19. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/31926 License: CC BY 3.0 IGO.

ESMAP. (2008). *Maximizing the Productive Uses of Electricity to Increasethe Impact of Rural Electrification Programs.* The World Bank Group, Energy, Transport and Water Department. https://openknowledge.worldbank.org/handle/10986/17538

GIZ and EUEI-PDF. (2013). *Productive Use of Energy (PRODUSE): A Manual for Electrification Practitioners.* http://www.euei-pdf.org/sites/default/files/field_publication_file/150907_euei_productive-use-manual_rz_04_web.pdf

Global Leap, Dalberg and CLASP (2016). *The State of the Global Off-Grid Appliance Market*. https://s3.amazonaws.com/clasp-siteattachments/The-State-of-the-Global-Off-Grid-Appliance-Market-Report.pdf

Harper, M. (2013). *Review of strategies and technologies for demand-side management on isolated mini-grids*. https://www.osti.gov/servlets/purl/1171615

IFC. (2018). *Benchmarking Mini-Grid DESCOs 2017 Update.* https://www.ifc.org/wps/wcm/connect/87b7df8f-94da-43ed-b168-3099b1edff45/IFC+Mini-grid+DESCO+Benchmarking+2017+Update.pdf?MOD=AJPERES

IIED. (2017). *Making mini-grids work: Productive uses of electricity in Tanzania*. https://pubs.iied.org/pdfs/16632IIED.pdf

NREL. (2017). *Quality Assurance Framework Implementation Guide for Isolated Community Power Systems*. https://www.nrel.gov/docs/fy17osti/68634.pdf

Further reading

NREL. (2016). *Quality Assurance Framework for Mini-Grids.* https://www.nrel.gov/docs/fy17osti/67374.pdf

Renewable World. *Community Implementation Model*. https://renewable-world.org/app/uploads/2015/11/2014-RW-Community-RollOut-Model.pdf

Santana, S., McCall, M. (2018). *Closing the Circuit, Stimulating End-Use Demand For Rural Electrification*. Rocky Mountain Institute. https://rmi.org/insight/closing-the-circuit/

Weston, Peter, Kalhoro, Wakar, Lockhart, Eric, Reber, Tim & Booth, Sam. Energy 4 Impact and NREL (2018). *Financial and Operational Bundling Strategies for Sustainable Micro-grid Business Models*. https://www.energy4impact.org/file/2074/download?token=WZ183t75

World Bank Group. (2017). *Mini-grids & gender equality: inclusive design, better development outcomes*. https://www.climateinvestmentfunds.org/sites/default/files/mini-grids_and_gender_equality.pdf

World Resources Institute, TaTEDO. (2016). *Accelerating Mini-Grid Development in Sub-Saharan Africa: Lessons from Tanzania*. https://www.wri.org/publication/tanzania-mini-grids