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Module 3
Case studies from digitalization and renewable energy

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International Cooperation and Development

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Outline

1. Introduction – Digital Technologies and the Digital – Energy nexus
2. Impacts of the digital – energy nexus
3. Regulation
4. Commercial examples
5. Case studies under TAF
6. Recommendations
7. Resources for Delegations

1. Introduction – Digital Technologies and the Digital – Energy nexus

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Digital Technology - Definition

Digital technology is an umbrella term for computer-based products and solutions. Considering that nearly everything designed and developed these days uses computers, it is a rather vague term. Digital technology may refer to using new algorithms or applications to solve a problem even if computers were used to develop solutions in the past[1].

[1]*PC Magazine Encyclopedia*

Minigrids and Productive Uses of Energy

Minigrids are small-scale power supply networks, which can work either autonomously or interconnected with a larger grid.

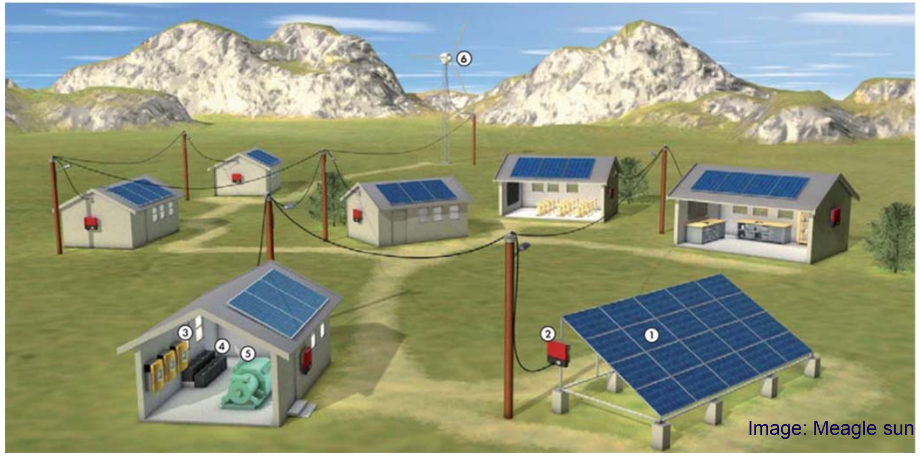
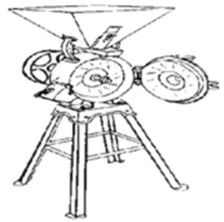
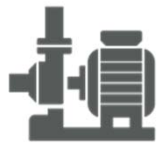
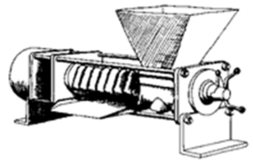


Image: Meagle sun

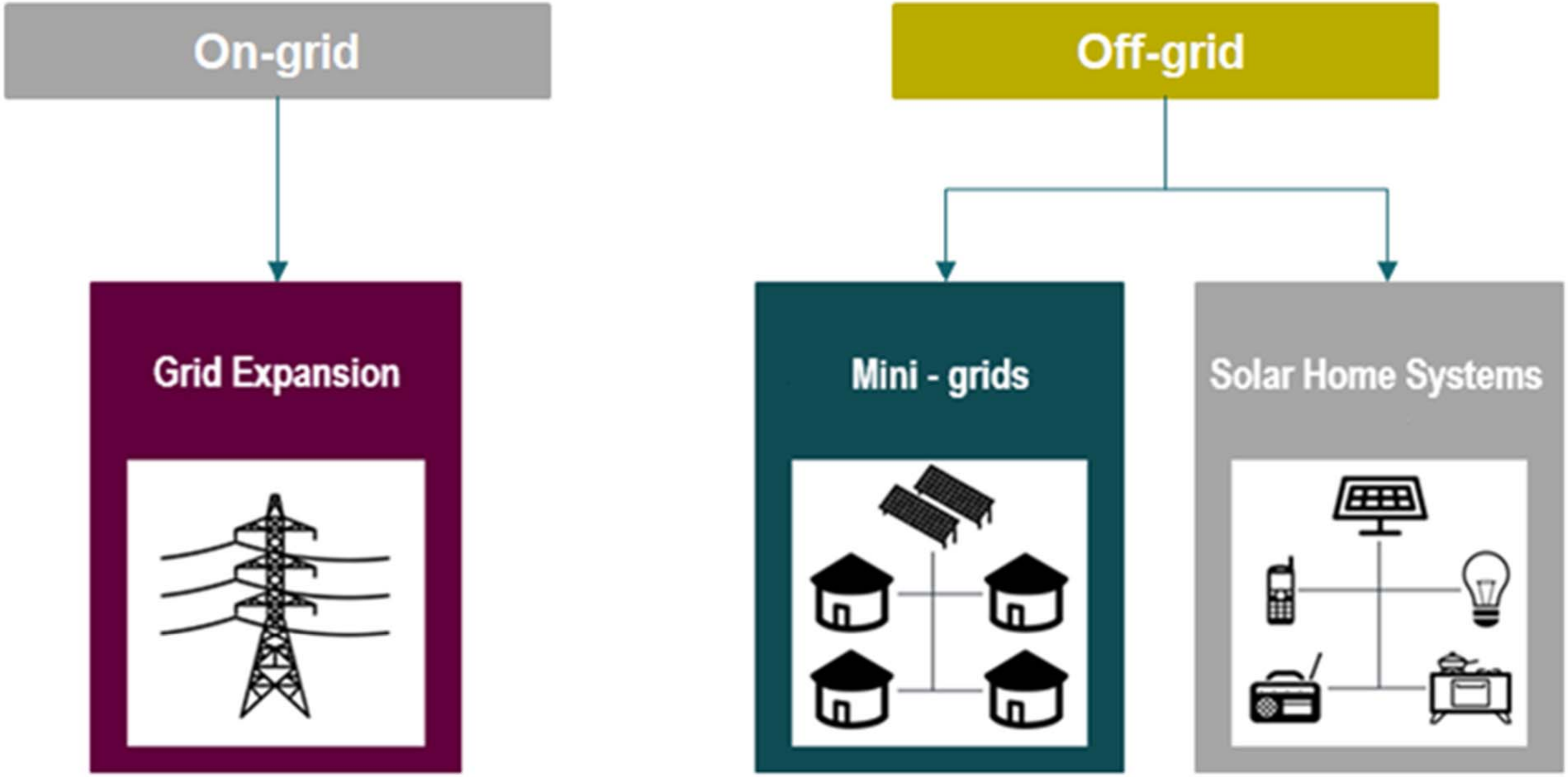






Productive uses of electricity are agricultural, commercial and industrial activities involving electricity services as a direct input to the production of goods or provision of services.

Cost of rural electrification



$ 2000 - 3500

$ 500 - 1200

$ 150 - 500

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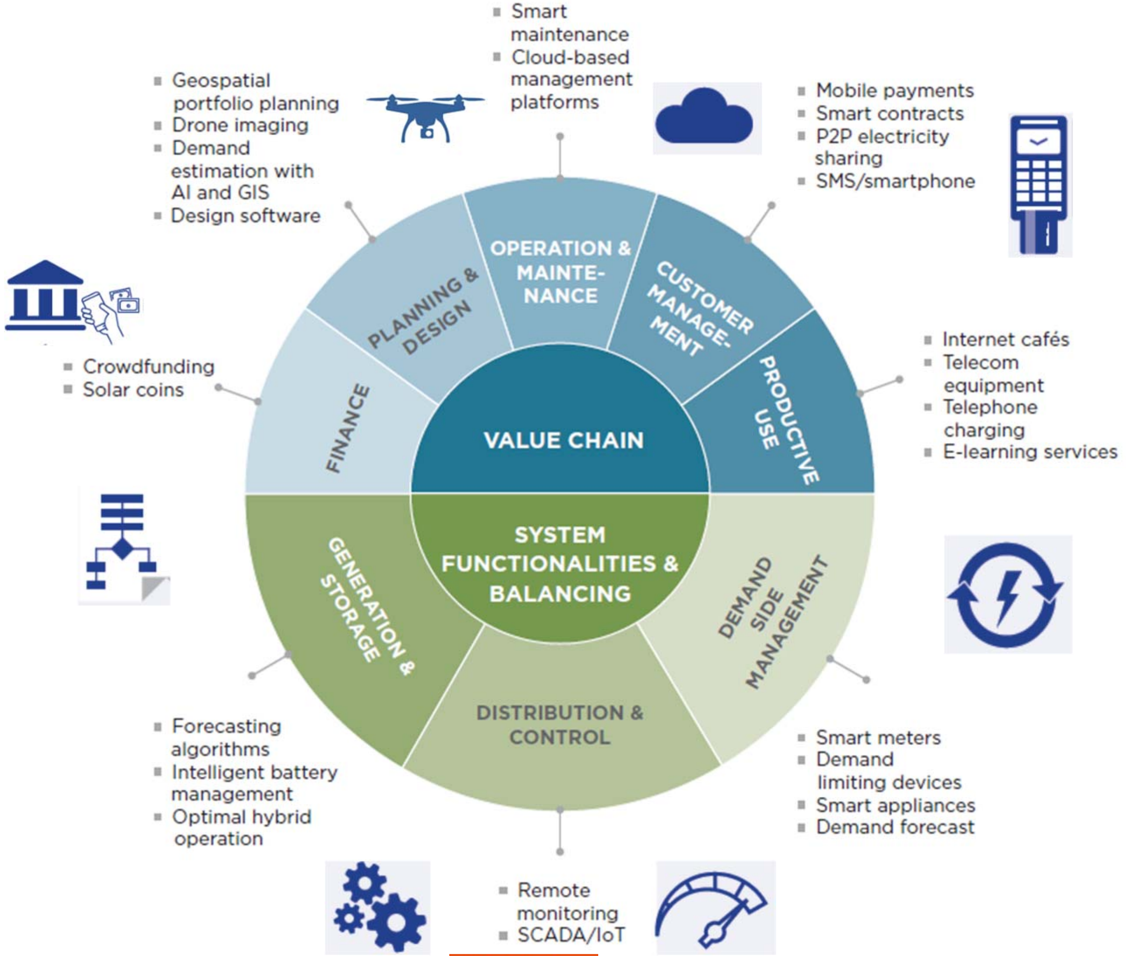
Digital Technologies in Minigrids



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Source: Fritzsche K., Shuttleworth L., Brand B., Blechinger P., Exploring the nexus of mini-grids and digital technologies - Potentials, challenges and options for sustainable energy access in Sub-Saharan Africa, IASS Study, 2019

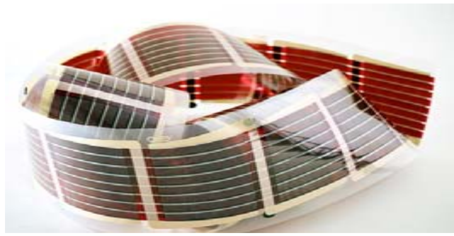
What is a digital-energy nexus solution?

A Digital-Energy Nexus Solution is a basic device or service that features a digital technology application in the energy field.

Examples:

- smart-meters
- software for the design and sizing of a minigrid
- a printed photovoltaic

HOMER Pro



What is a Digital-Energy business model offered by a company commercially?

A Digital-Energy business model offered by a company commercially is the combination of basic devices or services in order to create a marketable device and/or service.

Example: Pay-As-You-Go smart meter platform enabling mobile money use

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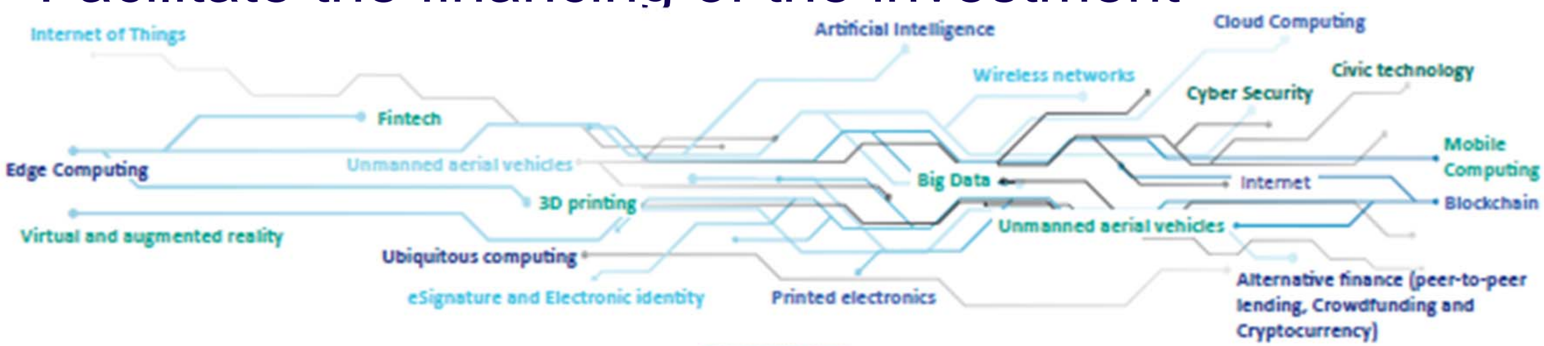
What is a Digital Enabled Minigrid?

A digital minigrid is the integration of digital technological services and technologies in the process of mini-grid development and operation.

Objectives:

1. Reduce the cost of electricity supply
2. Promote the productive use of electricity to create revenue sources than also contribute to overall affordability
3. Facilitate the financing of the investment



2. Impacts of the digital – energy nexus

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Energy-digital benefits

1. **Cost reduction and efficiency improvements**: Digital solutions with potential to facilitate the deployment of mini-grids - attributes of a digital mini-grid that can make mini-grid investments economically viable
2. **Facilitation of productive uses and broadening of revenues**: Currently available business models based on renewable generation, digital solutions and focusing on productive uses that can ensure financial viability
3. **Facilitation of financing**: Innovative financing mechanisms that can respond a. to these emerging business models and b. to mini-grid developers since they are actually the ones to install and operate a mini-grid.

Digital vs Finance-ability of rural electrification

Digital solutions address quite a number of challenges mini-grids face and therewith can increase the finance-ability, although not all issues are addressed by one business model.

1. Revenue security
2. Revenue increase
3. Feasibility increase
4. Lead time shortening
5. Decrease of investment cost
6. Decrease of O&M cost
7. Decrease of tariffs

3. Regulation

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Is there a need for special considerations?

- Many digital technologies need regulatory provisions

  Examples:
  - Mobile telephony networks
  - Mobile money
  - Personal data protection

- The digital paradigms used in energy usually do not need extra provisions for application in energy systems

Digital technologies and new regulatory needs

- Economics of rural electrification are challenging with low profit margins.
- New business models on the rise to meet the economic challenges utilizing digital technologies.

  Examples:
  - Pay-as-you-go, Pay-to-own, Provision of services

- Regulation needs to make provisions for allowing:
  - Sale of services instead of kWhs
  - New technical solutions e.g. AC minigrids with provision of DC electricity to households.
- Regulatory frameworks need to facilitate innovation if we want to meet SDG 7.

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Regulatory documents adopted by the African Union

- Strategy for a Harmonized Continental Regulatory Framework for the Electricity Sector in Africa
- Action Plan for a Harmonized Continental Regulatory Framework for the Electricity Sector in Africa
- Guidelines for Institutional and policy model for micro- / mini-grids
- Guidelines for -Minimum Energy Performance Standards (MEPS) Energy Labelling and Eco-Design at the Continental Level
- Guide for Application of Standards for appliances used in rural electrification systems in Africa (under development)

4. Commercial examples

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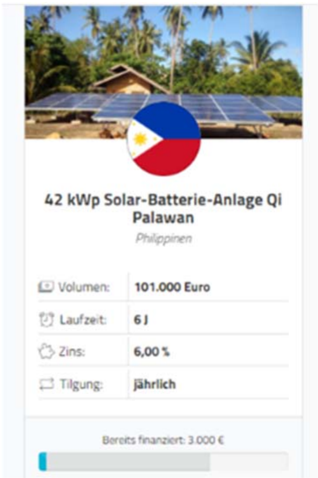
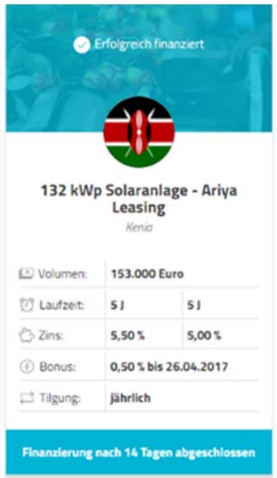
Crowdfunding – ecoligo.

Benefits for energy off-takers

- Reduced energy costs,
- Fully financed and maintained solution,
- Own the solar system after lease agreement is over,
- Increased sustainability of business practices.





Benefits for the crowd-investors

- Investments from 100€,
- Fixed returns of 5-6% p.a.,
- Investments save CO_2 emissions and support local economy,
- Transparent and tangible investment opportunity.

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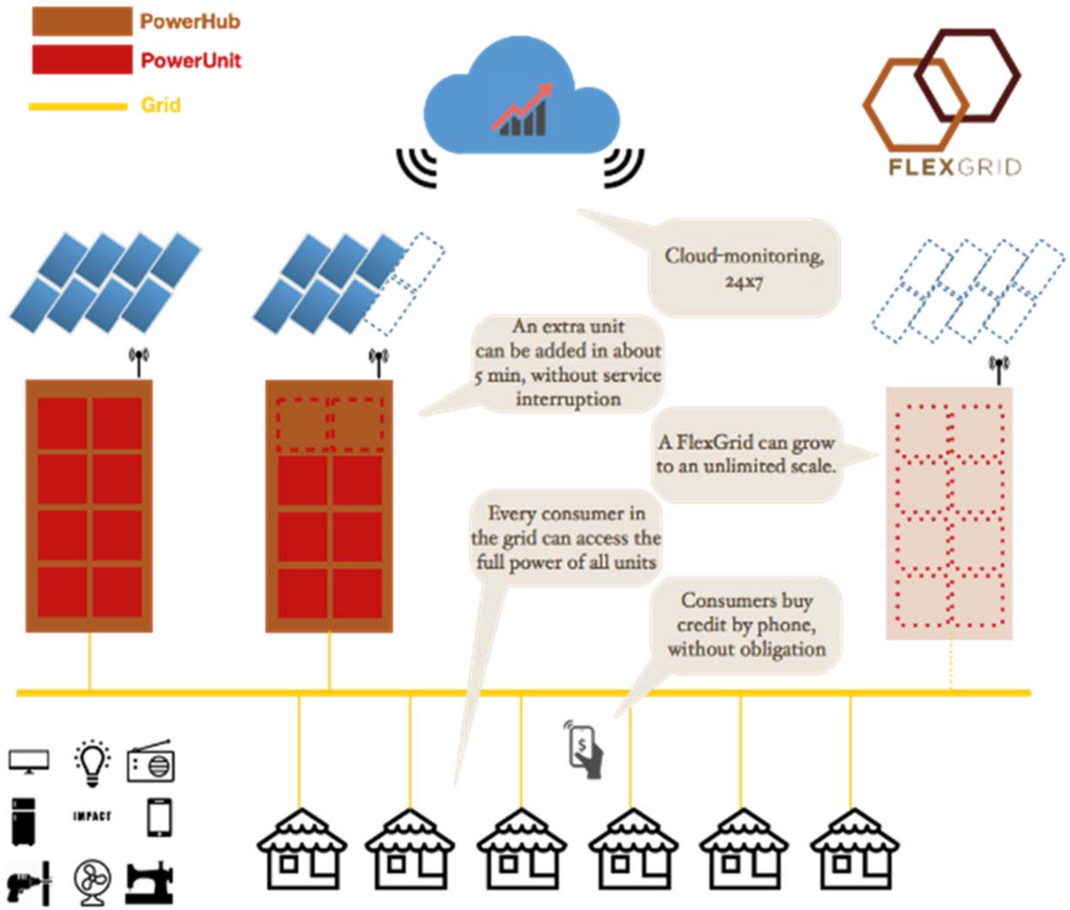
Swarm Electrification – Power-blox / Flexgrid

- Building block:
  - Individual, intelligent energy cubes with an integrated battery.
  - Each cube provides 200 Watts



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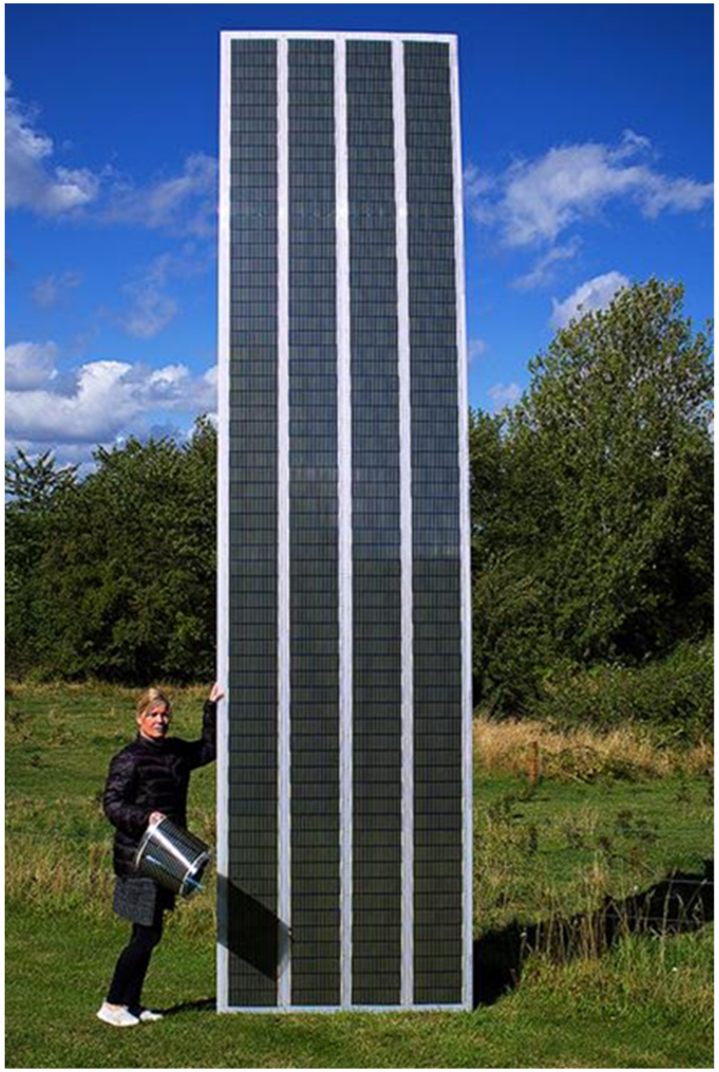
Printed Photovoltaics – Infinity PV

- Organic solar cells
- Several layers including a photo-active and two electrode layers
- Printed like newspapers
- Very low cost and when carbon electrodes are used they can be disposed as normal household waste for recycling.



5. Case Studies under TAF

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Rwanda off-grid schools electrification

- Provision of stable, affordable and reliable electricity supply to primary and secondary schools as well as clean and efficient cooking facilities to boarding public secondary schools in Rwanda.
- Digital solutions used:
  - Software for sizing of the system components based on optimization of Net Present Cost (Homer Energy)
  - Use of smart-meters and remote monitoring facilitating maintenance and troubleshooting in case of problems
  - Proposal to use a simple demand side management system to protect the system battery.

Software for sizing of the system components

- Homer Energy is a commercial software package, but a free to use older version is available for developing world projects. This version is adequate for a large number of projects.
- 120 scenarios
- Over 25,000 simulations
- Yearly simulations with an hourly time-step.
- Caution is needed because if some of the variables used are not set correctly the results will not be realistic (e.g. setting of operating reserve parameters and use of random variability to the load).

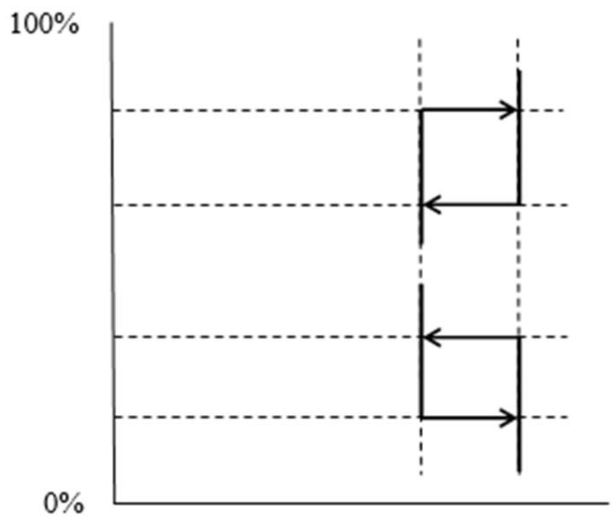
HOMER
The Micropower Optimization Model

Smart meters and remote monitoring

- Smart meters allow the implementation of pre-payment models like PAYG.
- Remote monitoring allows to evaluate the operation of the system remotely and also perform diagnostic checks from a distance in case of problems. Data is transmitted through mobile telephony network.

Demand side management system

- Each school to have 2 separate power lines. One for the lighting loads which are (high priority) and the other the rest of the consumptions.
- This protects the battery and extends its operational lifetime, ensuring increased sustainability of the system overall since the battery is the most common cause of system failure.



Burkina Faso Visualization Tool

- The tool is a mapping platform designed to explore the least-cost energy technology for rural electrification.
- Brings together a wide range of indicators, including number of beneficiaries, costs and type of electricity use.
- Indicators are mapped to highlight the social, economic and environmental impacts of the least-cost option.
- Allows users to identify where are the main electrification gaps and better plan electrification options (e.g. grid extension, minigrids and solar home systems).

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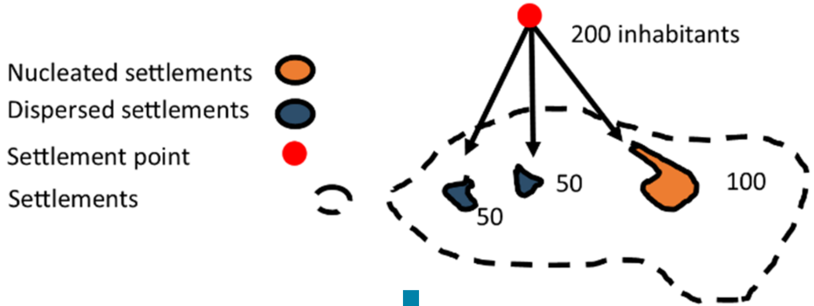
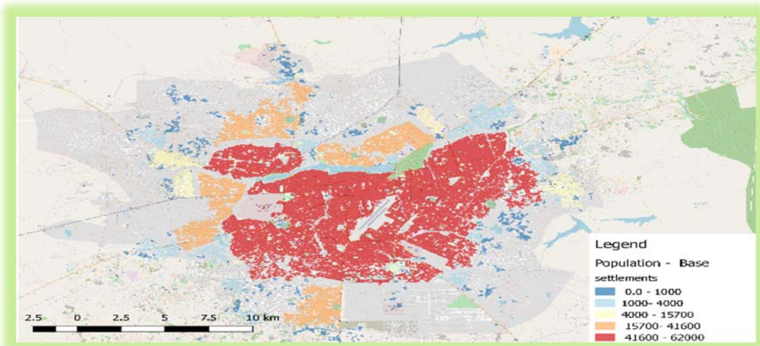
Methodology used to disaggregate the population by built-up areas – a key input for the Least Coast Option model

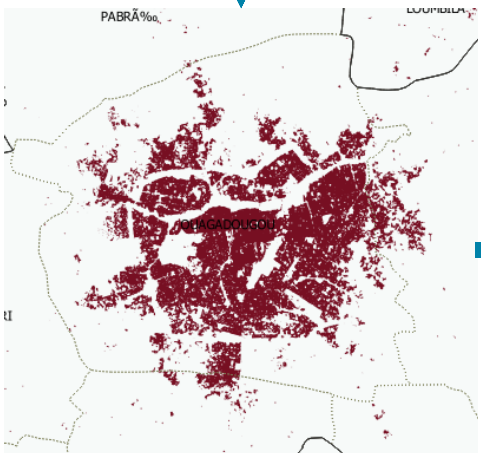
Population data from FDE (ABER)





Satellite image from ESA 20m resolution

Built-up areas



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Geospatial model for rural electrification

Population distribution

↓

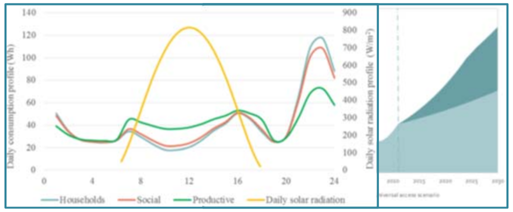
Electricity Access

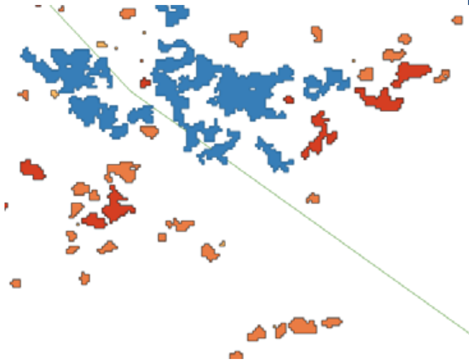
↓

Energy Consumption

↓

Least-cost technology per village





Model agglomeration

Electrified / Non-electrified villages

Energy Consumption (Household / Projection)

Identification of costs (generation, distribution, etc.)

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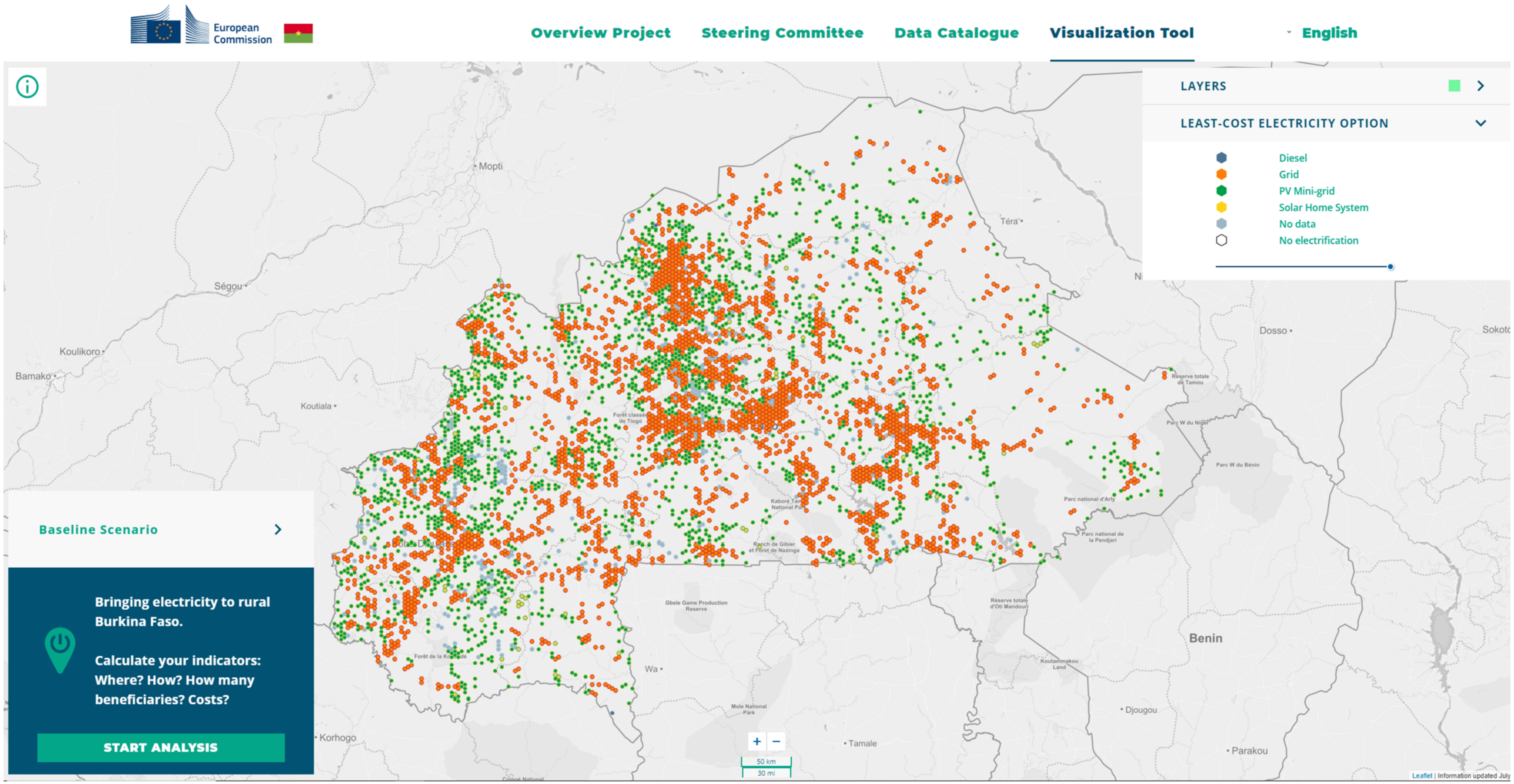

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6. Recommendations

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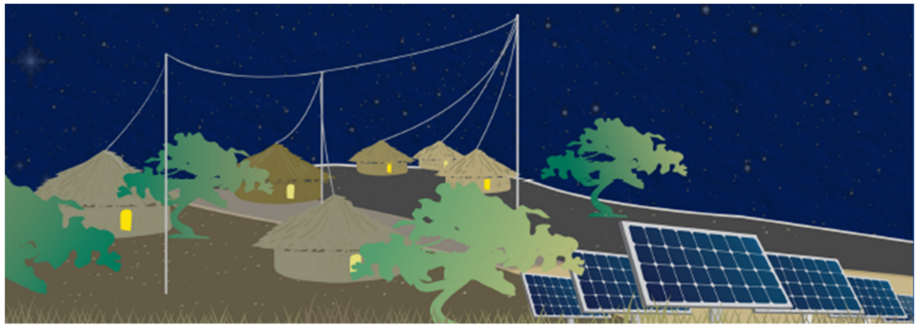
Recommendations

✓ Application of digital technologies is recommended for:

- Site data collection
- Design and sizing the energy system
- Intelligent energy management system
- Revenue collection system
- Operation monitoring system

✓ Regulatory frameworks need to facilitate innovation.



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7. Resources

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Digital Energy Facility

- **Why:** Digital + Energy = increased efficiency, energy access for development, climate mitigation
- **What:** 1 million people with new/improved access to renewable energy
  - Digitisation of power utilities
  - Support to the Energy-Digital community through an Energy-Digital Innovation Platform
  - Up to EUR 10 million as:
    - Early stage financing for digital-energy start-ups, up to 50 000 EUR (annual challenges)
    - Contingent debt financing for innovation in energy access companies up to 300 000 EUR (FI)
    - Innovative public-private partnerships (call for projects)
- **How:** 2 Contracts with Agence Française de Développement (AFD), EC Contribution EUR 23.5 million
- **Where:** worldwide, with a focus on Africa
- **When:** signature December 2019, duration 15 years

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Technical Assistance Facility - Energy

- **Why:** ad hoc assessment of energy – related opportunities
- **What**: on-demand expert missions
- **How:** send request to DEVCO C6 (Climate Change and Sustainable Energy), draft Terms of Reference (help available)
- **Where:** worldwide
- **When:** from January 2020

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Thank you for your attention!

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Background slides

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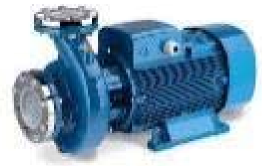
Definitions

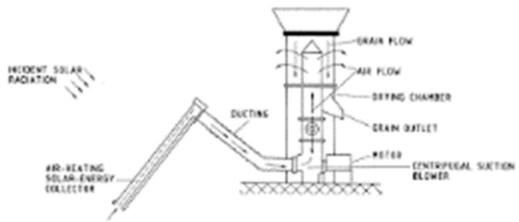
- **Off-grid:** Any technical approach providing electricity in a location that is not served by the main national electricity grid.
- **Autonomous:** Any technical approach that can operate fully without the need of any external infrastructure.
- **Stand alone system:** A system that can provide electricity (either AC or DC) autonomously.
- **Solar Home System:** A stand alone system consisting of PVs, a battery and a charge controller which provides either Alternating Current or Direct Current to a single household.
- **Microgrid:** A group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both connected or island-mode.
- **Mini-grid:** An autonomous electrical grid. The main difference usually found in literature in comparison to microgrids is that a mini-grid doesn't have to be able to operate connected to a larger grid (although many mini-grids in literature comply fully with the definition of a microgrid).

Productive Uses of Energy

- Autonomous microgrids can power effectively a vast array of appliances related to economic development such as :
  - ✓ Water pumping
  - ✓ Water desalination
  - ✓ Refrigeration
  - ✓ Space heating and cooling
  - ✓ Incubators for poultry farming
  - ✓ Milking machines
  - ✓ Rice and maize hullers, polishers, threshers, graters etc.
  - ✓ Grain mills
  - ✓ Oil presses
  - ✓ Tailoring
  - ✓ Workshop machinery (e.g. drills, chainsaws, rotary jigsaws, routers, etc.)
  - ✓ Hairdressers equipment



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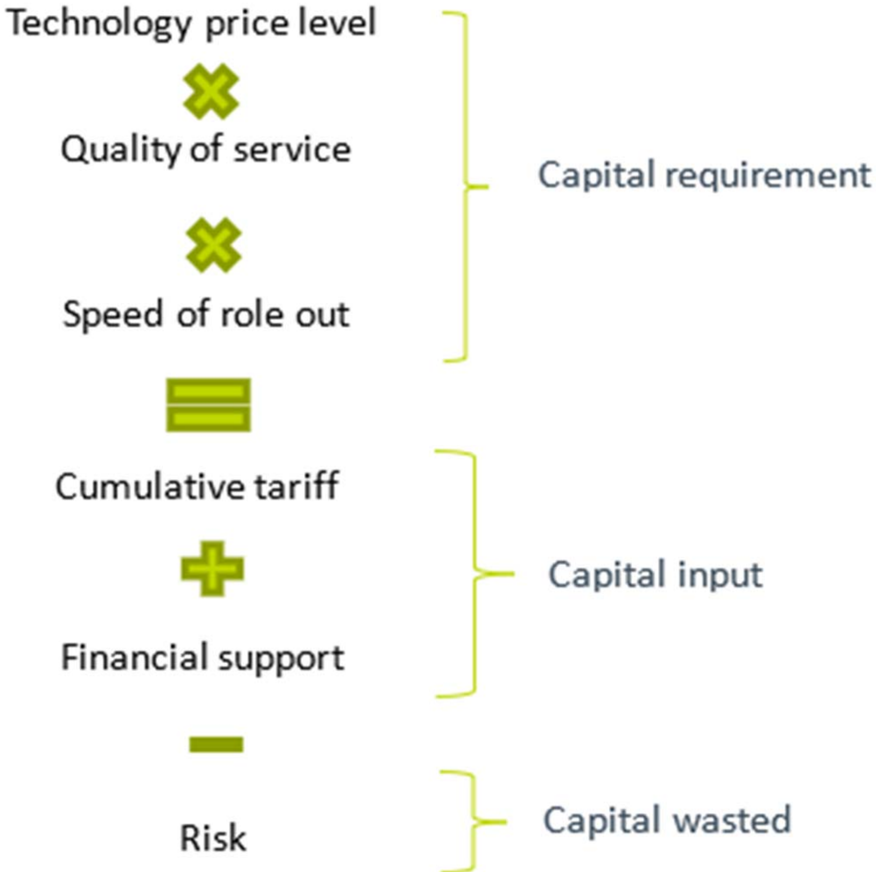
The mini-grid finance equilibrium



- Quality of service: Tier 1 – 5
- Speed of roll out: The amount of villages / people that need to get access per year
- Cumulative tariff: The total revenues generated by the mini-grid
- Financial support: Grants or other capital for the project
- Risk: Risks for the developer like non-payment, exchange rates, country risks, policy changes, grid encroachment

- Not possible to have a high role out with a high level of service, with at the same time low tariffs and little grant money available. Politicians need to choose what they find important, but cannot have it all.

Stages of Rural Electrification project implementation

A. Project development and Pre-Installation
B. Design, Procurement, Installation and Commissioning
C. Post-commissioning and sustaining of the project