Combining Geospatial and Mathematical methods to support Electrification in rural areas.

Tractebel’s Geospatial Electrification Tools

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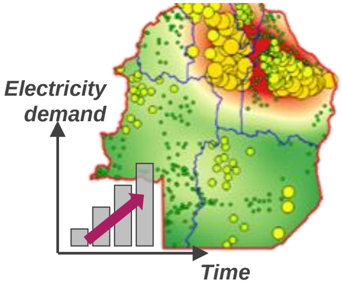
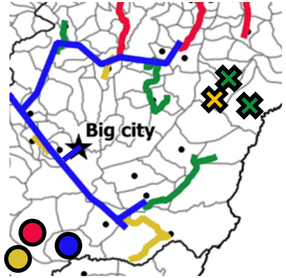
Extensive electrification planning

GIS database preparation → Agriculture power & water needs → Demand forecast & RES potential → Staged electrification planning

GIS content:
Renewables
Infrastructure
Population
Network
Schools
Hospitals
Marketplaces
Etc.

Crops production & post-harvesting needs



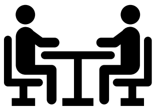


Staged investments:
★ Grid densification
— Grid extension
✖ Mini-grids
○ Stand-alone systems

Year 1 Year 3
Year 2 Year 4

Capacity building (for local autonomy)

Co-construction



Setting up local responsibilities

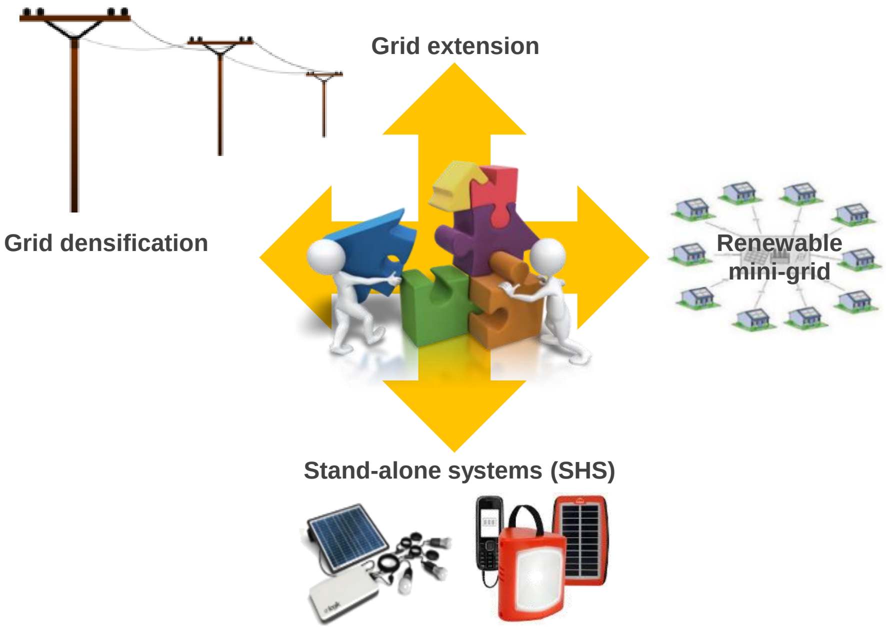
Workshop Training

The electrification planning is made quicker thank to Geospatial Rural Electrification Planning Suite (GREPS)

What: Determine the **best electrification solution** for rural areas among **grid extension, mini-grid creation and individual solutions** considering also **renewables generation.**

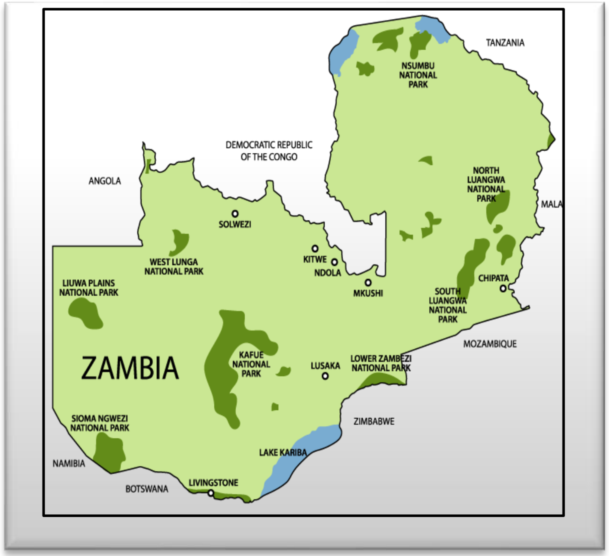
How: **Geospatial analysis** coupled with a **load forecast** to determine the **best electrification solution** between on- and off-grid based on LCOE calculation.

Output: **Detailed rollout planning** for grid densification, grid extension, renewable mini-grids and stand-alone solutions.



Successful studies in the last two years

Few examples…



Planned electricity access rate:

16% → 80% access over 15 years

6% → 30% access over 12 years

31% → 100% over 11 years

When the mini-grid option is the cheapest and when one takes a closer look at one village…

From a technical point of view to **develop a minigrid business in a new village**, we have to:

- *Select a site*
- *Count the houses in the village*
- *Estimate the energy consumption*
- *Size the generation unit*
- *Design the distribution grid*
- *Select the customers*

But from site selection to customer selection:
many tasks are manual

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TAOS.ai aims at helping the development of mini-grids by automatizing most of this process using AI and Optimization

TAOS.ai in a nutshell

A **T**ool for **A**utonomous and **O**ptimized small-size **E**lectricity **S**ystems: TAOS.ai

INPUTS

- GIS DATA
- +
- SITE VISIT DATA
- +
- HISTORICAL DATA LEARNING SET

ANALYTICS

LOAD FORECAST

- Pattern recognition
- +
- Pattern of consumption and level of the demand

+

OPTIMAL DESIGN

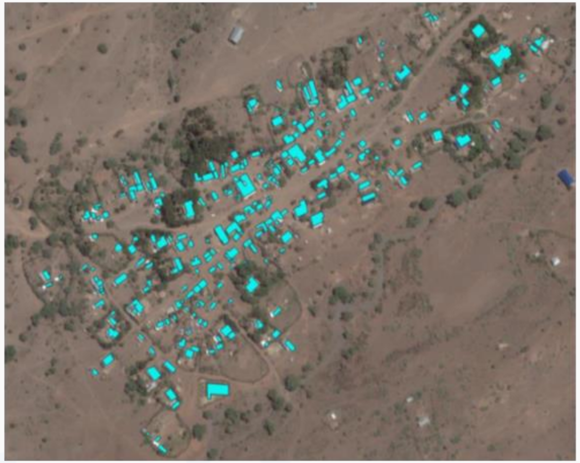
- Grid design & sizing

OUTPUTS

- Number of connections
- Consumption profile per connection
- Generation sizing Distribution design

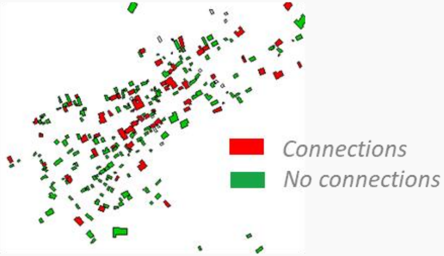
The load is forecasted at the building level, based on previous electrification projects

- **Start from a village satellite image…**

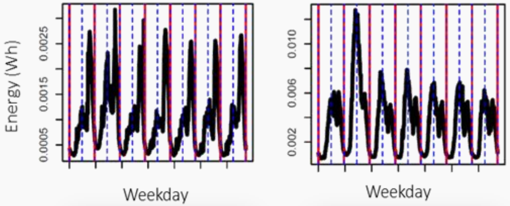


Few inputs: digitalized village map, size of houses, roof types, field data

- **… To get results via machine learning techniques:**



number of houses



63% of the consumers

27% of the consumers

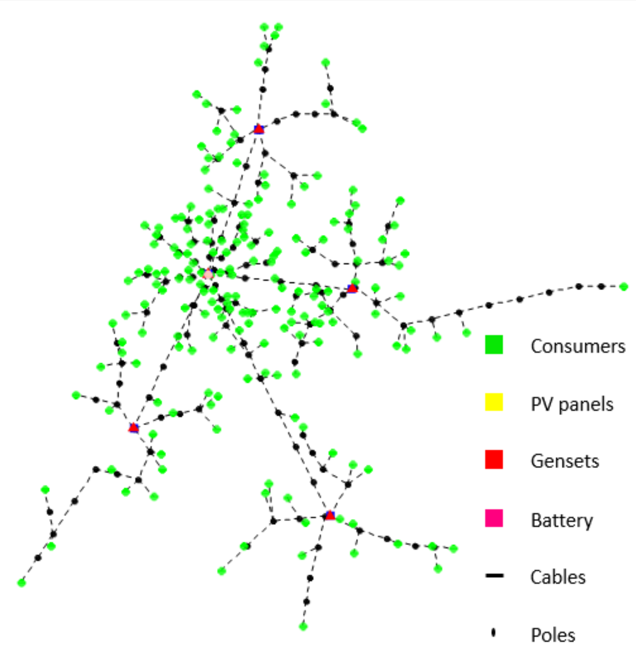
Consumption profiles prediction

Using mathematical programming techniques, TAOS.ai estimates the sizing and cost of the mini-grid project

- **Minimization of total electrification cost :** investment, installation and operating costs of grid and supply assets **simultaneously -> this is not a simulation approach**

- **Constraints**
  — Demand satisfaction
  — Technical constraints (PV, battery, diesel genset, SHS)
  — Reserve requirement
  — Power flow (linearized)

- **Outputs**
  — Optimal sizing of supply and grid reticulation
  — Total village electrification cost
  — CAPEX/connection rate



This optimization uses the demand forecast performed before.
Sensitivities with respect to the demand are also possible.

A comparison with a classical hand-made design in a test village

Consumption forecast	**TAOS.ai**	**Observed**	
Daily demand (kWh)	58,58	63,5	-
Peak demand (kW)	12	4,5	-
	TAOS.ai	**Hand made**	**CAPEX saving**
Generation sizing			
PV (kWp)	17	29,2	**42%**
Battery (kWh_{usable})	34	73,7	**46%**
Grid design			
Number of poles	225	275	**20%**
Cable distance (km)	8,3	10,2	**20%**