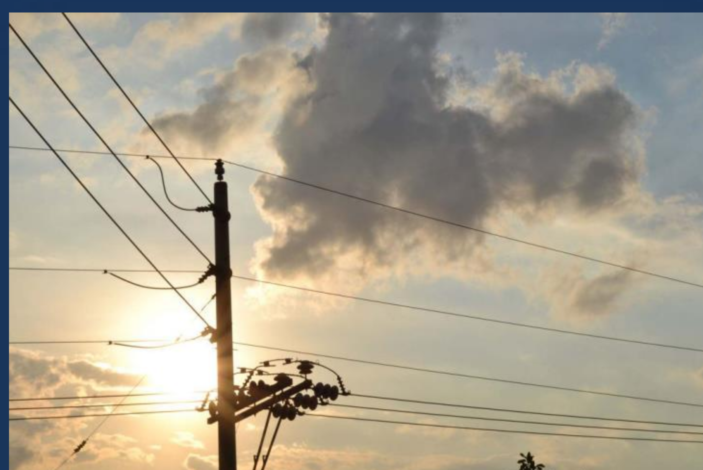
GEOSIM SOFTWARE

GEOSPATIAL RURAL ELECTRIFICATION PLANNING



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Innovation
Energie
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CONTENTS

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iEDinvest

WHY A NEW APPROACH OF RURAL ELECTRIFICATION PLANNING ?

Historical situation

- Rural electrification: a “loss making activity” for national Utilities
- Existing planning tools: technico-economic optimisation for grid extension

New context:

- Access to modern energy access: a pre-requisite for poverty alleviation (WSSD, 2002) and to achieve the MDG (Millennium Development Goals) and universal access
- End of monopoly situation: multiplication of Rural Electrification operators (REE) required coordination of investment
- Availability of georeferenced datasets for rural areas (GIS database)

1- INTRODUCTION

Lot of countries adopted policies to develop rural areas focusing on renewable energy which raises the issue of how to implement such policies ?

- Rural electrification planning is often a difficult task which require lot of skills and lot of time
- A change of strategy or parameters require most of time new studies (new project, new investments...). Often results need to be actualised based on new parameters.
- How to evaluate the real project impact as the development of energy services within a locality can also benefit to its surrounding population ?
- How to optimize mini-grids project (Biomass, Hydroelectric, Diesel) regarding its investment and kWh cost to offer real opportunities to investors ?

➢Specialized RE planning software GEOSIM

1- INTRODUCTION

GEOSIM© is a rural electrification geospatial planning tool developed by IED in 2006, pioneer tool in the geospatial approach of rural electrification.

Dedicated to Ministries of Energy, Rural electrification agencies and utilities, GEOSIM can be customized according to various environments and country policies. The software offers realistic, detailed and powerful analysis and has already been applied and deployed in many countries (Burkina Faso, Mali, Niger, Cameroon, Ethiopia, Madagascar, Benin, Lao PDR, Cambodia, Tanzania, Ivory Coast, Congo, Namibia, Peru ...).

1- INTRODUCTION

A powerful and enhanced approach of geospatial rural electrification planning based on the new paradigm for rural electrification: ***Maximising the potential Direct and Indirect Impact of rural electrification***

- ✓ A complete and innovative tool for planning rural electrification dedicated to planners and decision-makers.
- ✓ A Software based on a Geographic Information System with a user friendly interface
- ✓ An improved methodology using physical and geographical characteristics of land and spatial planning

02 PREPARATORY PHASE AND INPUT DATA

PART 02

- Territory GIS database
- Load forecasting
- Technical options and costs

1. Data collection
   - Mandatory layers
     - Localities & demography (coordinates, population, electrical status, socio economic characteristics….),
     - Existing and planned Grid network (HV, MV, powerplants, substations, minigrids…)
     - Renewable energy assessment (biomass, hydro, solar…)
   - Optional layers
     - Administrative boundaries
     - Roads and trails
     - Protected areas
     - Socio economic infrastructures (health, education , access to water…)
   - Background layers
     - Rivers
     - Land use and land cover…

2. GIS database consolidation (Manifold software)
   - Construction of Data layers compatible with GEOSIM

3. Load forecast model
   - Energy field surveys targeting households and socio economic infrastructures

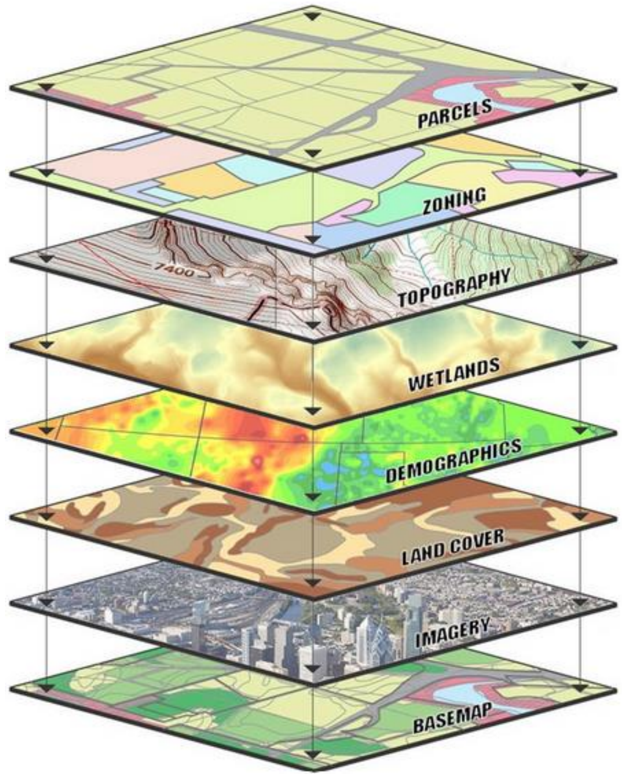
4. Technical parameters
   - Technical hypothesis
   - Cost of technologies

2.1 GIS DATABASE CONSOLIDATION

PART 2

What is a GIS?

A **geographic information system** (**GIS**) is a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data. GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data in maps, and present the results of all these operations



GIS DATA LAYERS

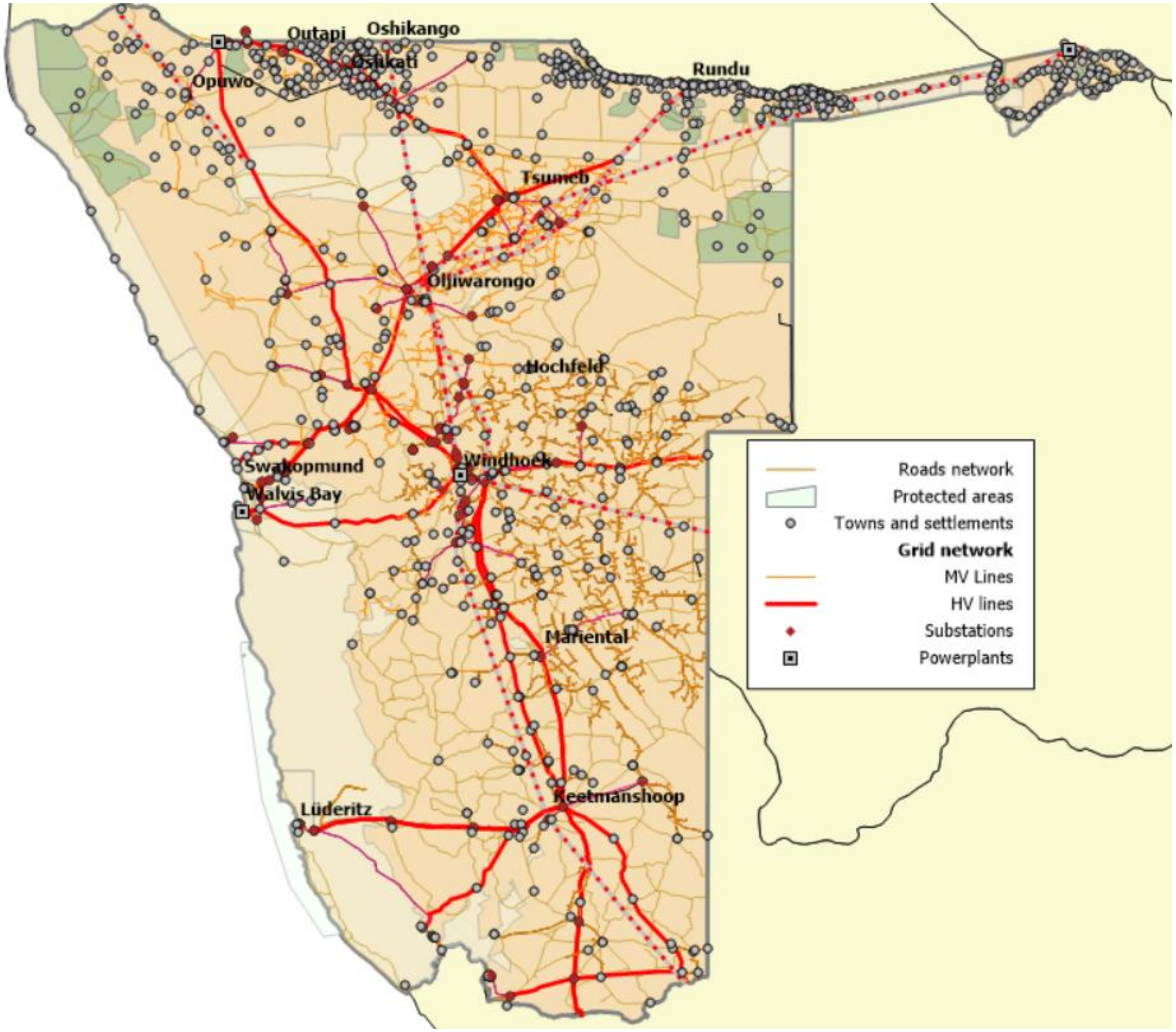
Many different types of data can be integrated into a GIS and represented as a map layer.

Examples can include: streets, parcels, zoning, flood zones, client locations, competition, shopping centers, office parks, demographics, etc.

When these layers are drawn on top of one another, undetected spatial trends and relationships often emerge. This allows us to gain insight about relevant characteristics of a location.

PART 2

Example of GIS database – Namibia (IED database)



2.2 LOAD FORECASTING

The Load forecasting model is used to record the load curves of various types of consumers identified in the study area.

This model is based on field surveys aimed at addressing local clients and estimating the consumption of customers according to the type of client and based on interviews and questionnaires filled in the field.

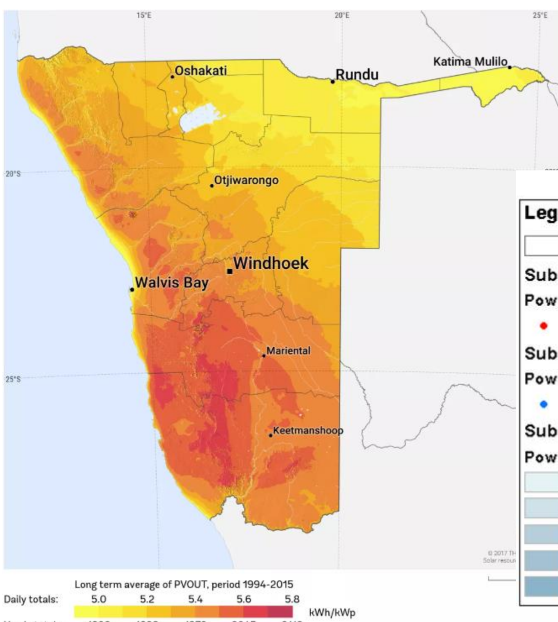
This model also estimates growth in demand over 20 years horizon, taking into account population growth, connection rate and local economic development.

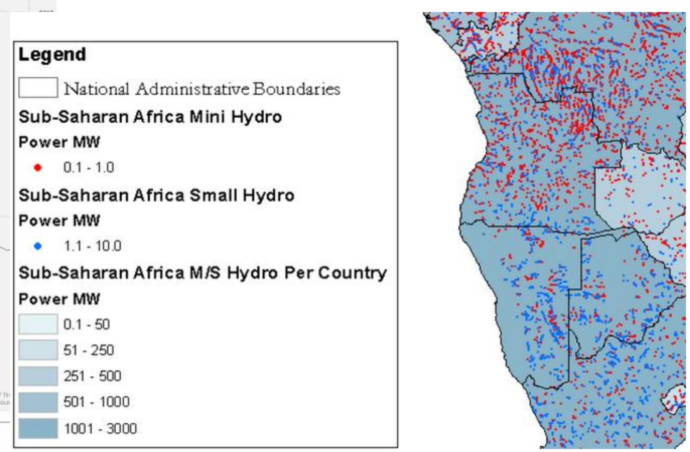
This model is completely integrated with GEOSIM and does not require any additional software.

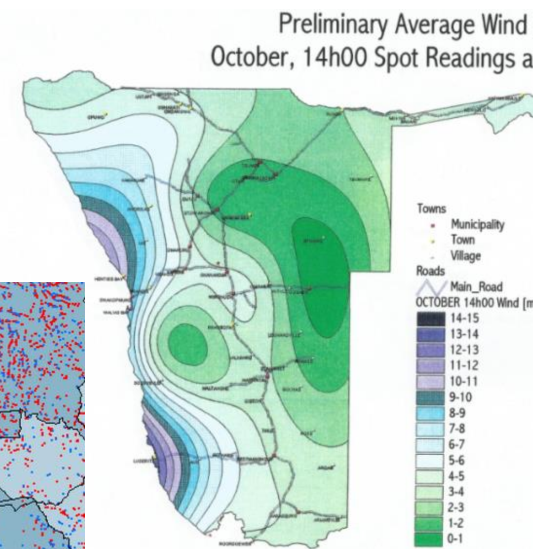
2.3 RENEWABLE ENERGY ASSESSMENT

PART 2

- Hydro potentials
  - Atlas of small hydro potential for rural electrification (< 2MW)
- Biomass resources assessments
  - Location and production of residues (rice mills, sawmills, plantations…)
- PV insolation map
- Wind resources assessment







2.4 TECHNICAL OPTIONS

- Technical Parameters
  - Economical hypothesis (discount ratio, echange rate…)
  - Thermal parameters (diesel cost, specific consumption, Diesel maximum capacity, hours of services, genset cost..)
  - PV cost (panel, structures, battery, solar penetration
  - Hydro (diesel backup, O&M cost…)
  - Biomass (diesel backup, dual fuel cost O&M cost…)
  - Distribution Network (MV and LV cost, customers per km, meters cost, equipment O&M costs, transformers…)
  - Connection cost
  - Wind turbine catalogues

- Scenario parameters
  - Grid expansion limitations
  - Energy / budget / electrification constraints

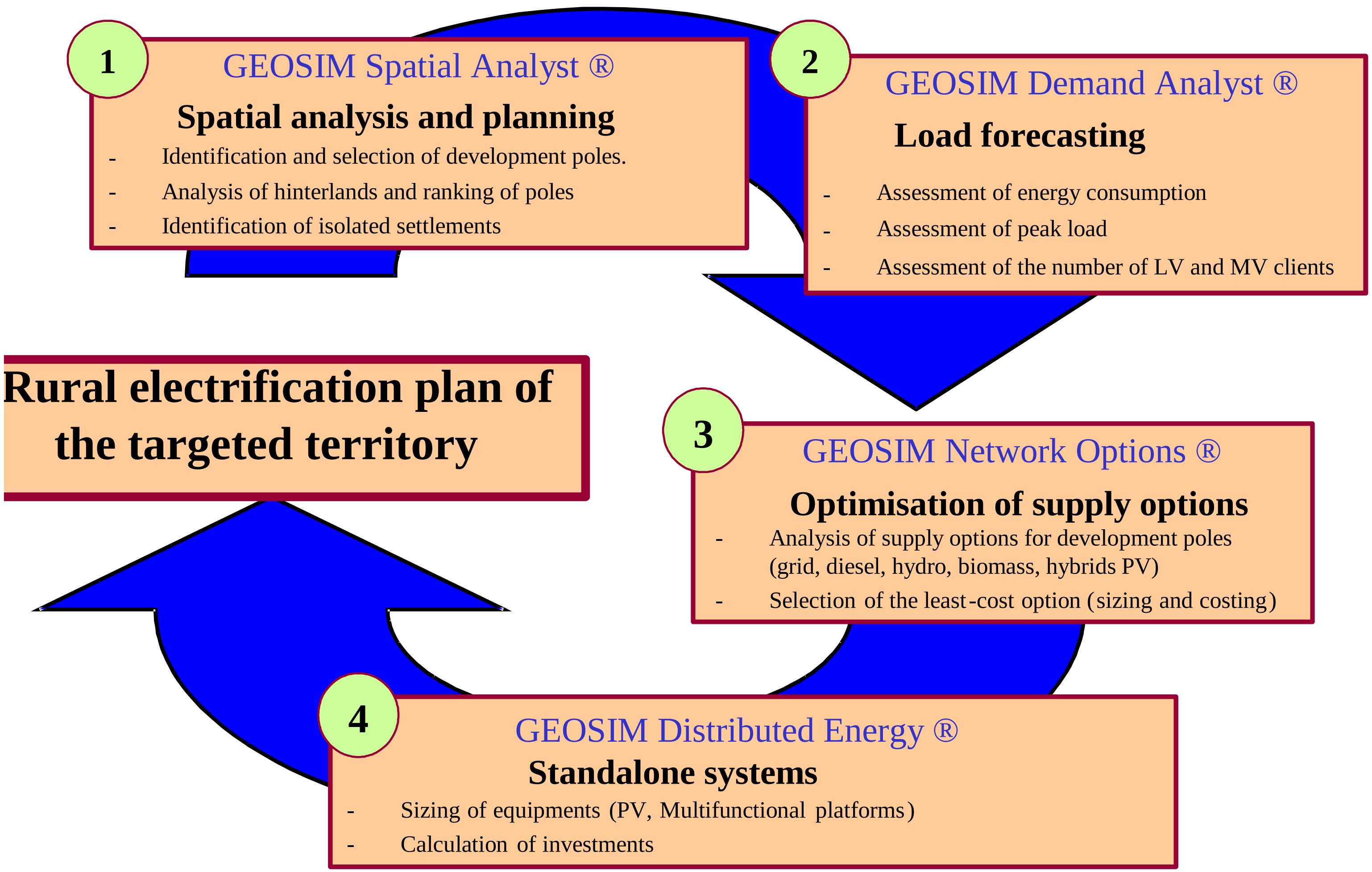
03 METHODOLOGY AND SCENARIOS

PART 03

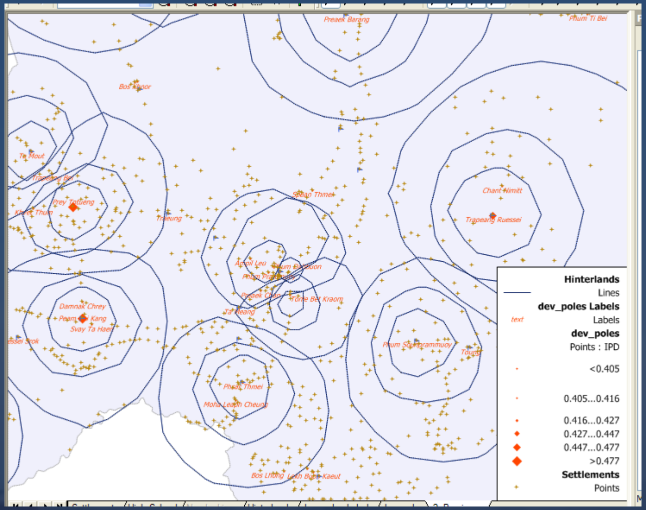
- Spatial analyst
- Load forecasting
- Network options
- Distributed energy

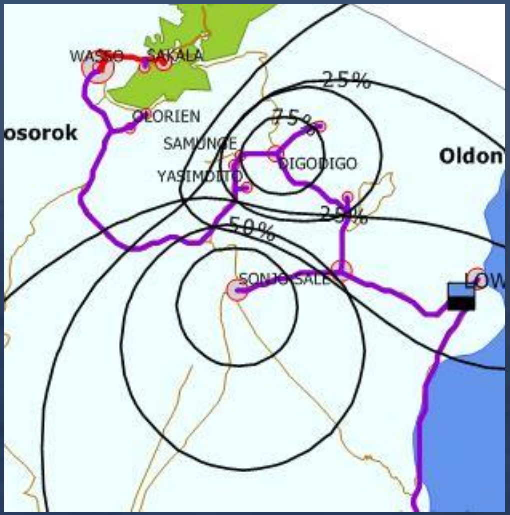
PART 3

- The GEOSIM methodology is developed through 4 modules that can operate independently. Each of its modules is a key step in a rural electrification plan.



1- SPATIAL ANALYST





As far as the impact of rural electrification is concerned, the main focus is thus the « PLACES » of electrification

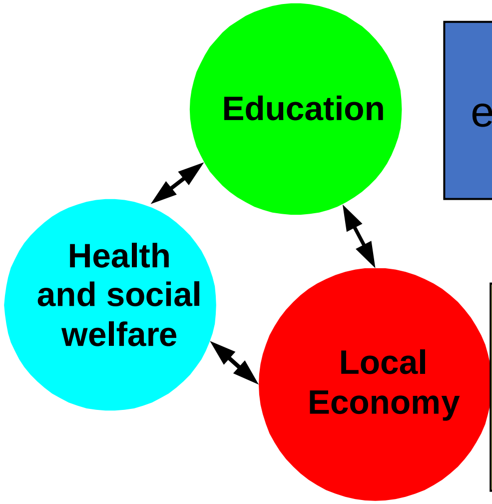
The methodology follows 3 steps

1. **Selection of settlements** to electrify first
2. **Ranking of these settlements**, so as to maximize impacts of rural electrification on the targeted territory
3. Identification of potentially **isolated settlements**

New Concepts

- IPD ranking
- Development Pole
- Hinterlands
- Isolation

METHODOLOGY – SPATIAL ANALYST



HDI (UNEP) combines 3 indexes of equal weight: (1) life expectancy, (2) knowledge (literacy rate and gross enrolment ratio), and (3) GDP per capita in purchase power parity

IPD is defined by 3 indexes of equal weight
- Health
- Education
- Local economy

INDEX	Weight	Examples of CRITERIA	WEIGHT [0,1]
HEALTH	1/3	Health posts	1/2
		Access to drinking water	1/2
EDUCATION	1/3	Adult literacy	2/3
		Enrolment ratio	1/3
LOCAL ECONOMY	1/3	Population of the settlement	1/4
		Market	1/4
		Savings and credit organization	1/4
		Distance to the nearest road	1/4

EXAMPLE OF SUBCRITERIA	VALUE [0,1]
None	0
Dispensary	0,2
Health centre	0,5
HC with surgery unit	0,8
Hospital	1

$$IPD_{index} = \sum_{criteria} (weight * value)$$

$$\mathbf{IPD = 1/3\,(IPD_{health}) + 1/3\,(IPD_{education}) + 1/3\,(IPD_{local\ economy})}$$

18

List of selected poles

Mathematical models (Gravitational model)

Assessment of attraction capacity of poles

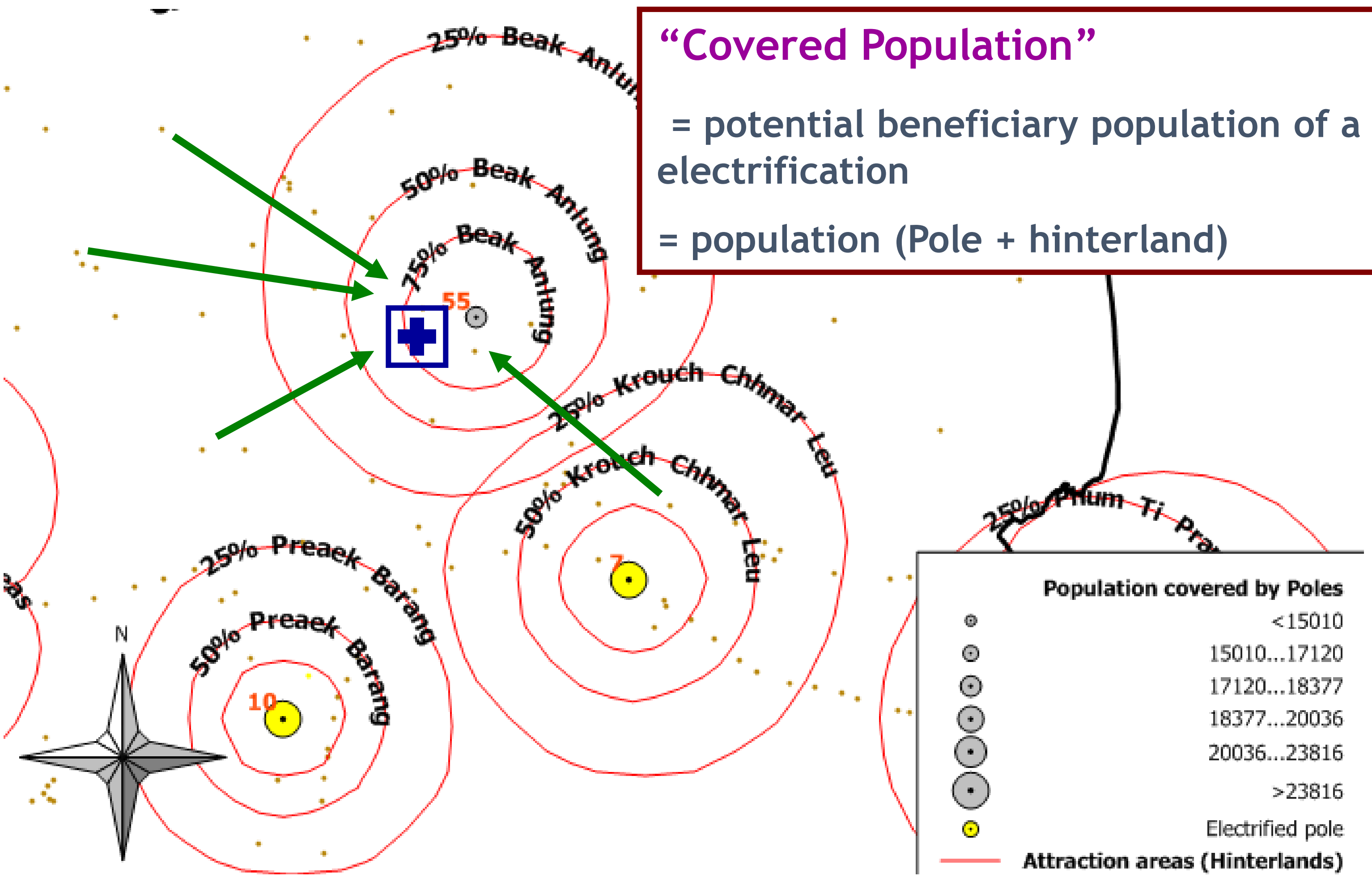
Demarcation of attraction areas of poles

Probability of attraction of all settlements towards each pole

Ranking based on total population potentially benefiting directly or indirectly from the electrification of a development pole

METHODOLOGY – SPATIAL ANALYST

Map representation of the attraction area of a cluster :



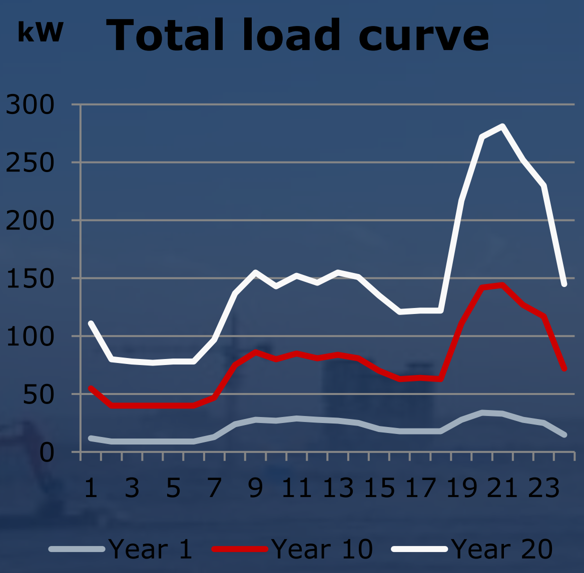
"Covered Population"

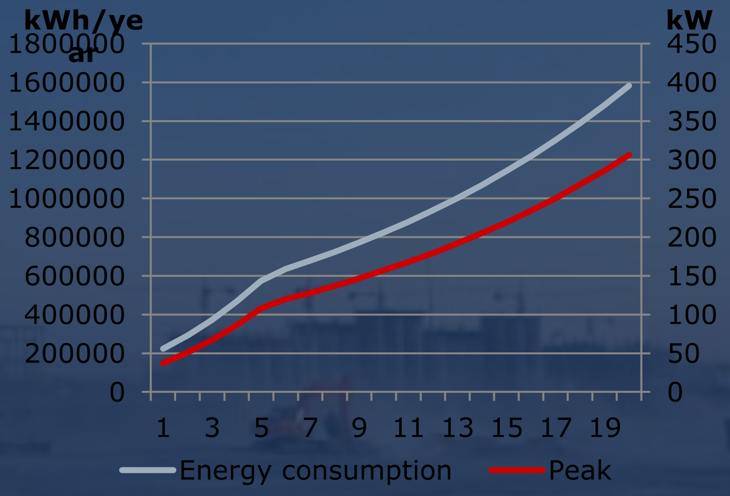
= potential beneficiary population of a Pole electrification

= population (Pole + hinterland)

2- DEMAND ANALYST

METHODOLOGY





Load forecasting is a crucial step of any power planning process

- Provides consumption and peak demand

→ inputs for least-cost sizing of supply options (hydro, diesel, biomass, PV etc.)

- Assesses how many clients can be expected

- Client needs which can be matched with willingness and capability to pay

→ input for financial and economic viability

METHODOLOGY – DEMAND ANALYST

GEOSIM model uses a bottom-up approach (rather than a formula) more detailed and which can be customized for various modes of consumption which can be found across a territory

This method requires detailed data on consumption patterns of all categories of clients

- Different categories of households
- Different types of infrastructures and services

Field surveys and demand studies usually provide necessary inputs

- Various types de clients can be set into the model:

Domestic uses

households low/mediul/high revenues

- Lights
- TV
- Radio
- Iron
- Mobile phone
- ...

Community uses

Infrastructures

- Schools
- Health centers
- Mills
- Places of worship
- ...

Services

- Water
- Public lighting
- Administrative buildings
- ...

Specific demands

Industries

- Plants
- Mines
- ...

OBJECTIVES

To characterize the demand for each settlement of the study area in terms of

- ✓ Peak demand (kW)
- ✓ Total consumption (kWh per year)
- ✓ Number of clients (LV & MV)
- ✓ Load duration curves (for hydro)

These outputs will be provided for

Each year of the planning period

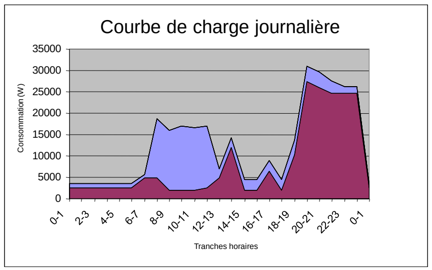
Three types of supply scenarios

(e.g. 24h, 10h and 5h)

METHODOLOGY – DEMAND ANALYST

Number of clients for each type

Specific consumption for each type of client

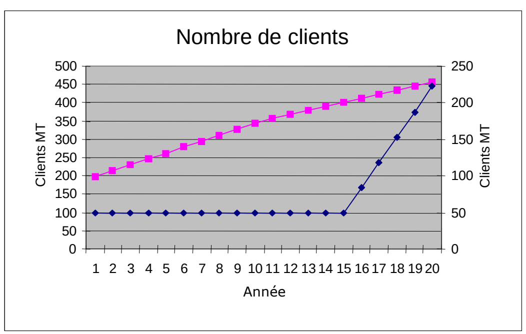


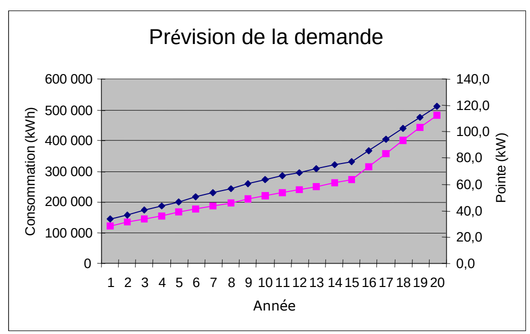
Average daily load curves

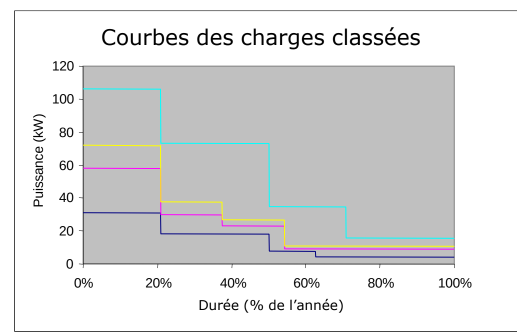
Annual consumption et peak demand

Classified load curves

Parameters calculated in year 1 for each scenario and extrapolated







METHODOLOGY – DEMAND ANALYST

Model

- Appliance Load curve
- Consumer segmentation

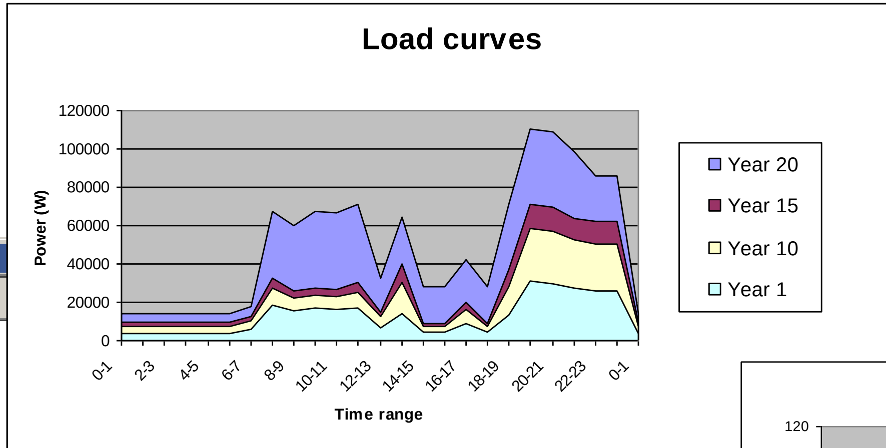
Forecast

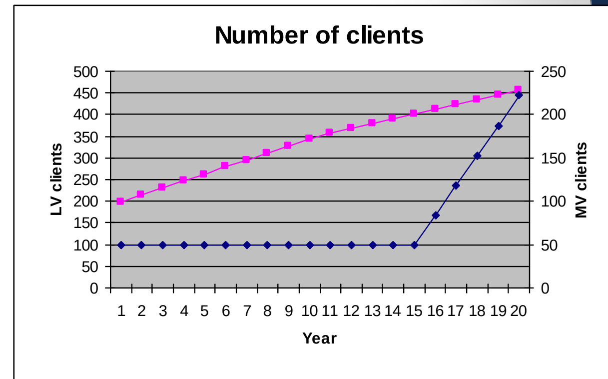
- Population growth
- Energy consumption growth
- Connections growth
- Evolution de la segmentation

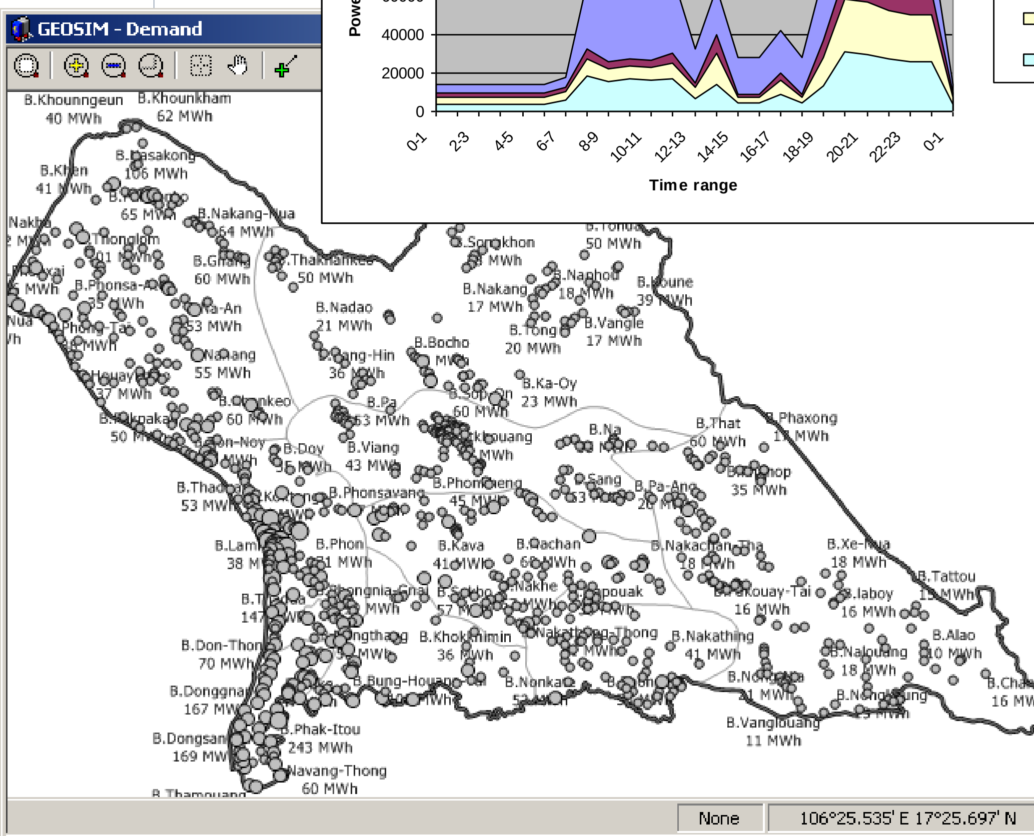
Results

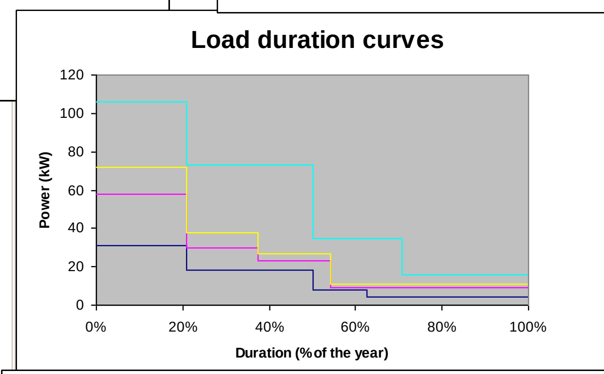
- Number of clients
- Peak (kW)
- Energy consumption (kWh)

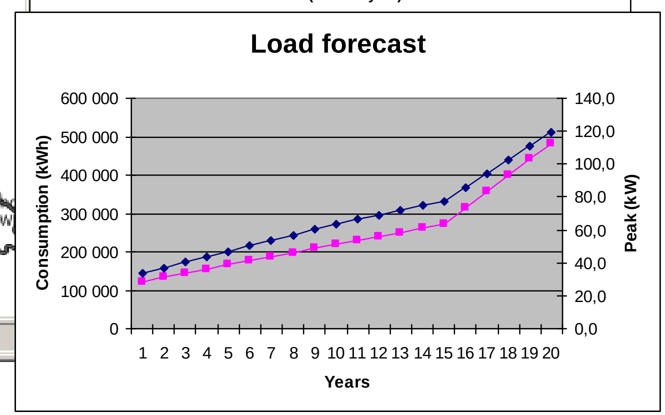
RESULTS


Load curves
Power (W)
120000
100000
80000
60000
40000
20000
0
0-1
2-3
4-5
6-7
8-9
10-11
12-13
14-15
16-17
18-19
20-21
22-23
0-1
Time range
Year 20
Year 15
Year 10
Year 1

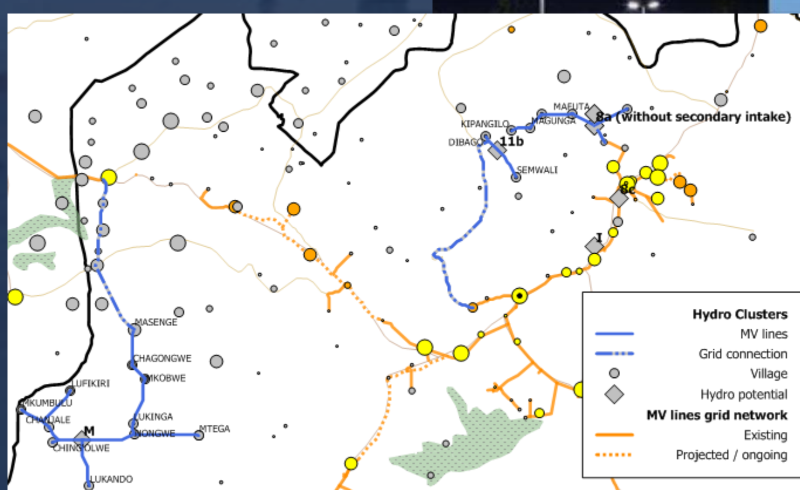

Number of clients
LV clients
MV clients
500
450
400
350
300
250
200
150
100
50
0
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Year


GEOSIM - Demand
B.Khounngeun
40 MWh
B.Khounkham
62 MWh
B.Nakang-Nua
B.Thakhankee
50 MWh
B.Nadao
21 MWh
B.Nakang
17 MWh
B.Naphou
18 MWh
B.Vangle
17 MWh
B.Bocho
B.Ka-Oy
23 MWh
B.That
60 MWh
B.Phaxong
17 MWh
B.Viang
43 MWh
B.Phonsavang
B.Kava
B.Xe-Nua
18 MWh
B.Tattou
B.Alao
B.Nakathing
41 MWh
B.Khokmimin
36 MWh
B.Vangbuang
11 MWh
B.Phak-Itou
243 MWh
B.Dongsan
169 MWh
B.Dongnai
167 MWh
B.Don-Thong
70 MWh
Navang-Thong
60 MWh
None
106°25.535' E 17°25.697' N


Load duration curves
Power (kW)
120
100
80
60
40
20
0
0%
20%
40%
60%
80%
100%
Duration (% of the year)


Load forecast
Consumption (kWh)
Peak (kW)
600 000
500 000
400 000
300 000
200 000
100 000
0
140,0
120,0
100,0
80,0
60,0
40,0
20,0
0,0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Years

3- NETWORK OPTIONS



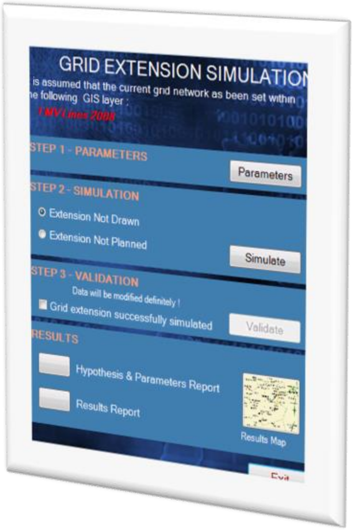
Grid Extension

Grid extension must be forecasted prior to studying decentralised options, to make sure identified projects will remain in off-grid areas in the next few years

If this exercise has not been done yet, the model is able to roughly simulate the extension using a cost-benefit analysis and several constraints

Possible constraints

- ❑ Distance to existing substations
- ❑ Distance to the MV grid
- ❑ Investment budget
- ❑ Available energy on the grid
- ❑ Maximum number of settlements to electrify per year



Grid Extension

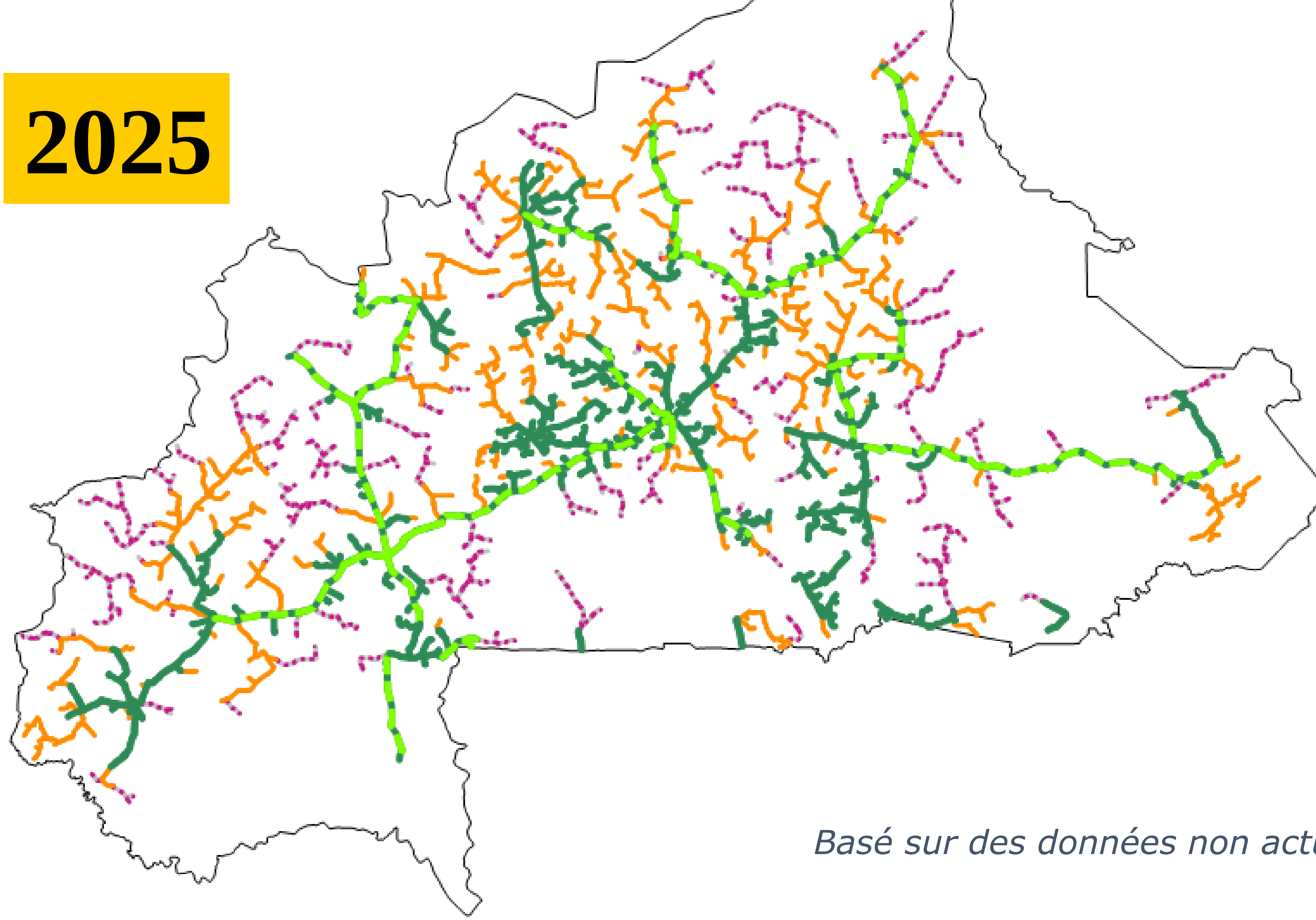
Grid extension is done using

- Least cost path algorithm
  - Geographic optimization of network design (following roads, avoiding lake, forbidden areas…)
- Electrical validation
  - Technical viability of extensions with voltage drop and losses calculation
- Benefit selection criteria
  - Economic approach with Actualized Net Value

$$ANV = \sum_{i=1}^{horizon} \frac{Benefits(i) - Costs(i)}{(1+r)^i}$$

Exemple: extension du réseau 33kV Burkina Faso

2025



Basé sur des données non actualisées

Localités > 7000 pour SWER < 40 km | Réseau 33kV 2014 densifié Forecast SWER | Réseau 33kV 2021 | 1 Réseau 33kV 2025 | Buffer SWER 30 km | Zone d'étude_BURKINA FASO

IREP study results : Morogoro

KEY FIGURES

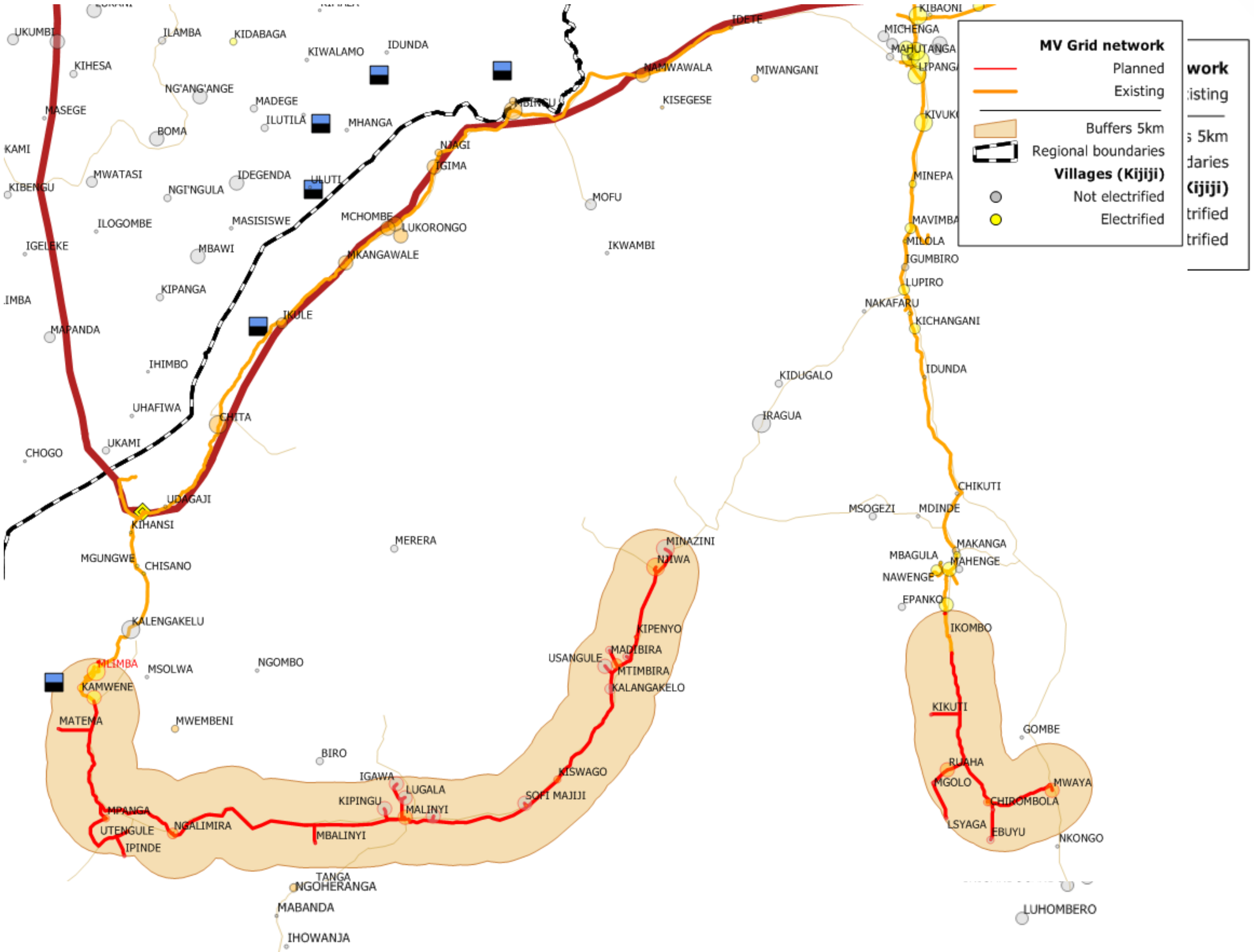
Population	**1, 759,809**
Number of villages	**595**
non-electrified	*374*
electrified	*221*
Coverage rate	**47.6%**
Access rate	**10.4%**

Planned projects

- Viwanja towards Njiwa
- Ikombo towards Mwaya
- Mikumi towards Kilosa
- Msowero towards Magole
- Kwambe towards Mtumbatu

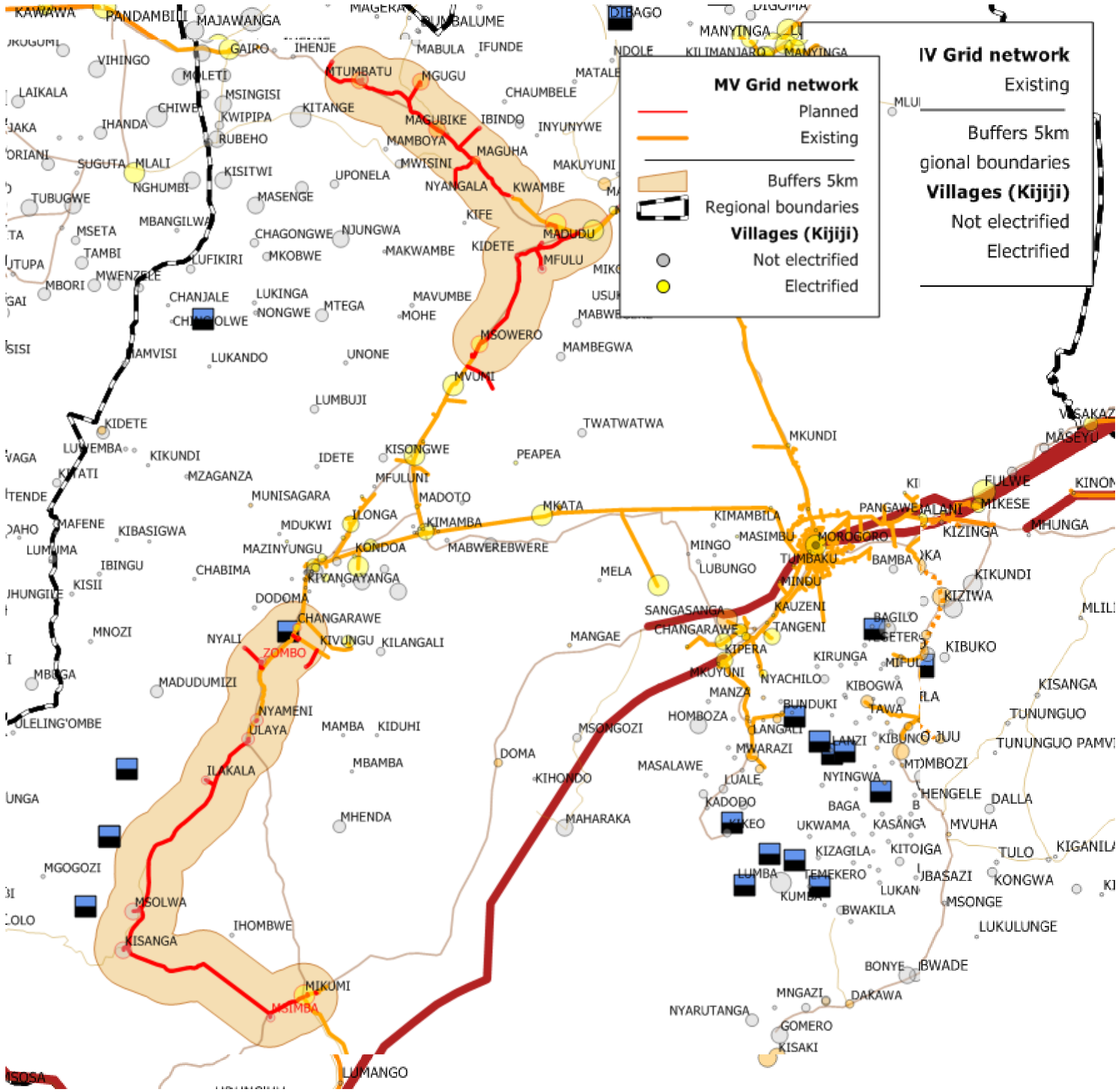
[1] % of the regional population leaving in electrified settlements
[2] % of people electrified calculated with 5.7 people per household (see REA's surveys)

Morogoro planned projects (South)



METHODOLOGY – NETWORK OPTIONS

Morogoro planned projects (North)



Morogoro Results (1/2)

Grid extension Towards...	Localities connected	MV lines length (km)	Population 2012	Power demand 2012 GWh	Km / village	Cost / HH	Cost / MWh
Viwanja to Njiwa	22	137	71744	9.421	6.2	560,6	420.0
Ikombo to Mwaya	10	45	24259	2.696	4.5	555,9	503.4
Mikumi to Kilosa	10	81.848	26024	3.739	8.2	707,9	479.7
Msowero to Magole	3	28.3	5286	2.546	9.4	975,2	198.6
Kwambe to Mtumbatu	9	49.7	22805	2.433	5.5	595,2	556.0
TOTAL	**54**	**341.8**	**150118**	**20.84**			

[1] Considering 5,1 people per household, and the population for the first year
[2] Equal to the total investment / Power demand in 2017

Morogoro Results (2/2)

Grid extension Towards...	Investment for transmission (MUS$)	Investment for distribution (MUS$)	Total investment (MUS$)
Viwanja to Njiwa	3,5998	5.24	8.83
Ikombo to Mwaya	1,172	1.792	2.964
Mikumi to Kilosa	2,1286	1.92	4.0486
Msowero to Magole	0,736	0.397	1.133
Kwambe to Mtumbatu	1,294	1.689	2.983
TOTAL	**8.93**	**11.038**	**19.06**

Morogoro Results

Grid extension Towards...	Localities connected	MV lines length (km)	Population 2012	Power demand 2017 GWh	Km / village	Cost / HH	Cost / MWh
Densification	126	210.7	400,024	80.661	1.7	262	125
Extension	254	1931	459,784	148	7.6	842	256

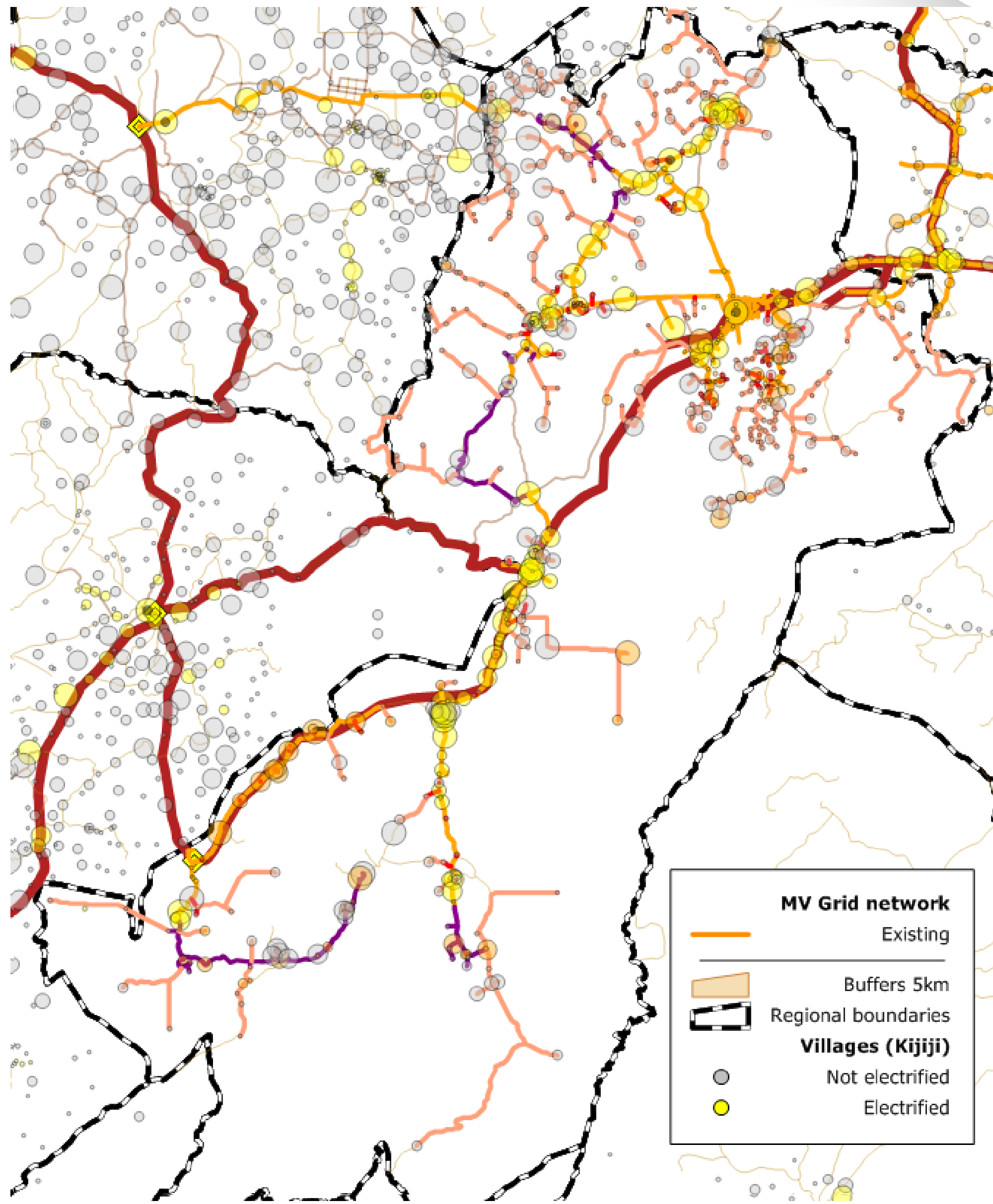
Grid extension Towards...	Investment for transmission (MUS$)	Investment for distribution (MUS$)	Total investment (MUS$)
Densification	5.178	17.4	22.5
Extension	50.1	33.6	83.7

[1] Considering 4.55 people per household

Morogoro Electrification – Scenario 1 – Total Grid electrification

- Planned projects
  - Budget: 19 M$
  - MV lines: 342 km
  - Demand: 46 GWh
- Densification
  - Budget: 22.5 M$
  - MV lines: 211 km
  - Demand: 185 GWh
- Total Electrification
  - Budget: 85.5 M$
  - MV lines: 1931km
  - Demand: 333 GWh

TOTAL : 127 M$



METHODOLOGY – NETWORK OPTIONS

Decentralized projects

Regarding off-grid areas, GEOSIM will identify, compare, optimize and propose renewable energy mini-grids based on

- Renewable energy assessments and location of potentials
- Location of loads (localities and settlements)

- ❑ Preparation of rural electrification plan at the scale of a country or region Identification of the least-cost power option to meet the demand of non-electrified localities, with a focus on development poles
- ❑ Project's economic analysis (estimated yearly investment and maintenance costs)
- ❑ Technico-economic optimization is carried out to reach the lowest cost / kWh

❑ 5 options considered:

Hybrid PV/ Wind

Diesel

Solar

Hydro

Biomass

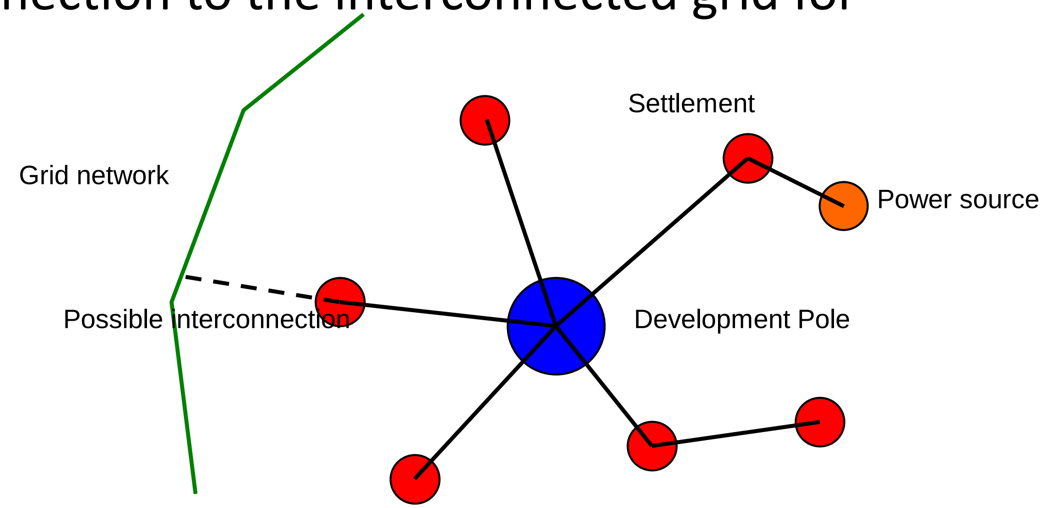
METHODOLOGY – NETWORK OPTIONS

Decentralized projects

DEFINITION FOR "DECENTRALIZED PROJECT"

Once off-grid areas are defined, the model will identify possible mini-grids projects, consisting of

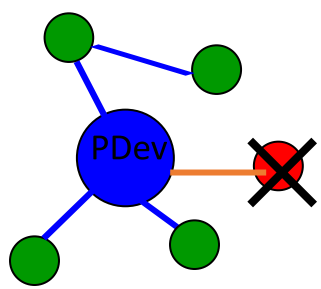
- A settlement or a list of settlements (usually including at least one Development Pole)
- A mini-grid connecting these settlements if there are more than one
- A power source (diesel genset, hydro, biomass, solar, wind hybrid systems…)
- Possibly an interconnection to the interconnected grid for energy injection



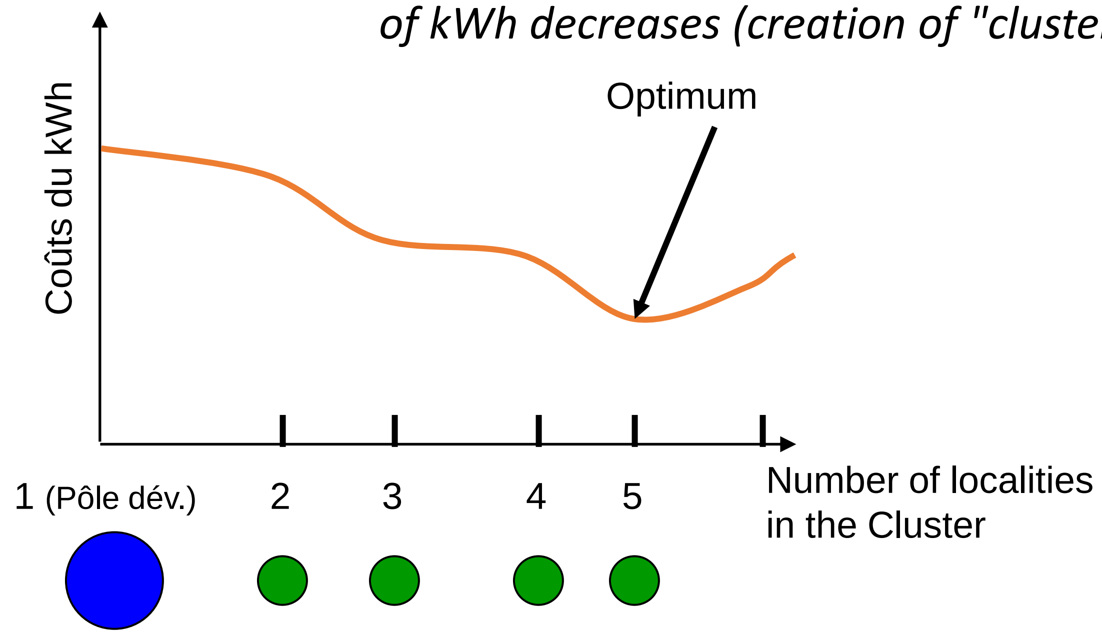
Decentralized projects

LEAST COST OPTIMIZATION

The system (generation powerplant, domestic lines at localities or between localities, transformers) are resized each time a locality is added to the cluster in order to satisfy the demand



To minimize the supply cost of a development pole, and on the basis of demand, neighboring localities are connected as long as the discounted cost of kWh decreases (creation of "clusters")



Decentralized projects

- At this stage, only economic analysis from the point of view of society as a whole is performed for all projects (no profitability assessment for a possible public or private investor)

- Because
  - Rural electrification is by nature not profitable and planning should therefore focus mainly on optimisation of public subsidies
  - The level of detail of analyses and data required for financial analysis are much beyond the scope of planning

METHODOLOGY – NETWORK OPTIONS

Decentralized projects

Least cost mini grids

Economic analysis

Supply Options module

Cashflow Report for Hydro Projects

Mode : Isolated

Project # 1 Pole name : DJOUNGO
Area : MOUNGO

Settlements number in the cluster : 6

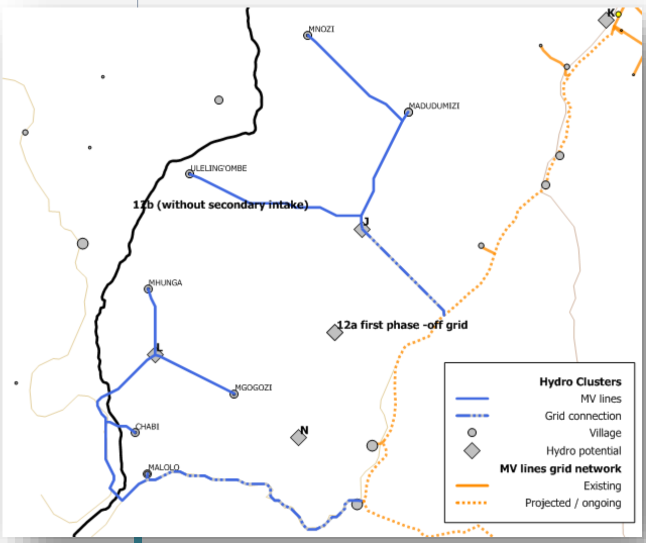
Levelized Cost : 7 FCFA/kWh

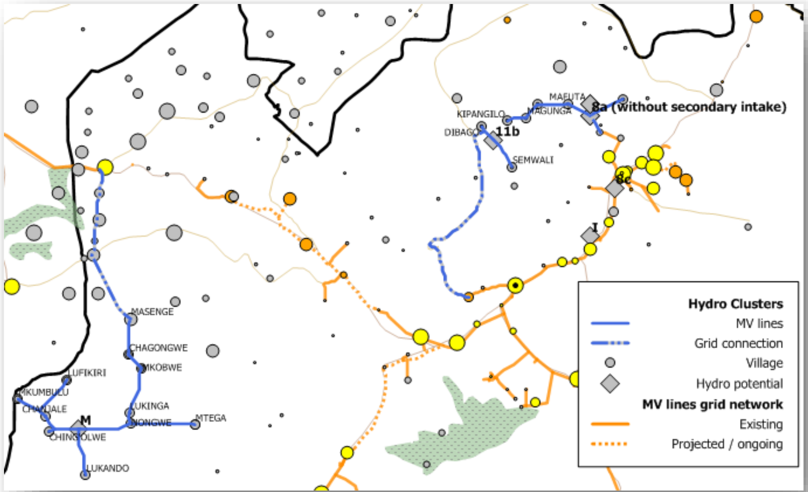
SHP Capacity : 2500 kWh Hydro residual value : 12 232 990

Residual Values			15 067 880		
Transformers	LV lines	MV lines	Genset	Power House	Grid connection
172 181	715 843	1 379 618	467 250	100 000	0

Year					Cluster investments				Cluster O&M	
Year	1	Genset energy produced :	0	kWh						
		Hydro energy produced	0	kWh	Small Hydro :	16 681 350	Meters MV :	0	O&M Fuel :	0
		Demand	469025	kWh	Genset :	0	Meters LV :	0	O&M Maintenance :	0
		Peak	281	kW	MV lines :	1 799094	Transformers LV :	341 118	O&M Personnel :	0
		Customers LV :	400		MV internal lines :	270 333	Transformers MV :	175 424	O&M Others :	0
		Customers MV :	32		LV lines :	778 512	Grid connection :	0	Total O&M :	0
		MV length :	27175	m	Power house :	300 000	Total Investments :	20 345 831		
Year	2	Genset energy produced :	31767	kWh						
		Hydro energy produced	478194	kWh	Small Hydro :	16 681 350	Meters MV :	6 784	O&M Fuel :	128 145
		Demand	506784	kWh	Genset :	448 000	Meters LV :	26 400	O&M Maintenance :	809 422
		Peak	306	kW	MV lines :	1 799094	Transformers LV :	341 118	O&M Personnel :	30 000
		Customers LV :	430		MV internal lines :	270 333	Transformers MV :	175 424	O&M Others :	15 000
		Customers MV :	32		LV lines :	778 512	Grid connection :	0	Total O&M :	982 567
		MV length :	27175	m	Power house :	0	Total Investments :	20 527015		
Year	3	Genset energy produced :	39861	kWh						
		Hydro energy produced	508664	kWh	Small Hydro :	0	Meters MV :	424	O&M Fuel :	163 788
		Demand	544539	kWh	Genset :	0	Meters LV :	3 960	O&M Maintenance :	809 422
		Peak	327	kW	MV lines :	0	Transformers LV :	0	O&M Personnel :	30 000
		Customers LV :	460		MV internal lines :	0	Transformers MV :	0	O&M Others :	15 000
		Customers MV :	33		LV lines :	0	Grid connection :	0	Total O&M :	1 018210
		MV length :	27175	m	Power house :	0	Total Investments :	4 384		
Year	4	Genset energy produced :	48363	kWh						
		Hydro energy produced	538771	kWh	Small Hydro :	0	Meters MV :	0	O&M Fuel :	202 426
		Demand	582298	kWh	Genset :	0	Meters LV :	4 224	O&M Maintenance :	809 422
		Peak	352	kW	MV lines :	0	Transformers LV :	0	O&M Personnel :	30 000
		Customers LV :	492		MV internal lines :	0	Transformers MV :	0	O&M Others :	15 000
		Customers MV :	33		LV lines :	0	Grid connection :	0	Total O&M :	1 056848
		MV length :	27175	m	Power house :	0	Total Investments :	4 224		

Mini Hydro projects



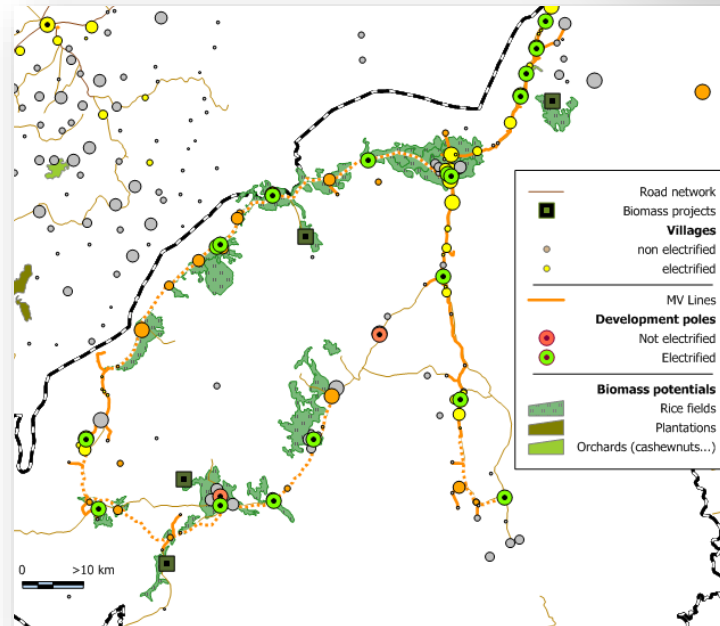


Project #	Pole Name	Grid Connected	Levelized Cost (kWh)	Starting Investment ($ US)	Investment/ Customer	Cluster Population (Y1)	Nb Localities impacted	LV Customers First year	LV Customers LastYear	Energy Demand (kWh) First Year	Energy Demand (kWh) Last Year
HYDRO CLUSTERS				75 635 048	8 981	111 688	67	8 422	39 965	0	114 873 769
1	A	Yes	0.10	4 911 610	8 269	7 771	6	594	2 784	0	6 591 091
2	B	Yes	0.06	8 241 058	7 166	15 343	7	1 150	5 469	0	13 963 713
4	E	Yes	0.07	4 108 768	8 234	6 662	3	499	2 386	0	6 224 452
6	G	Yes	0.07	4 599 560	6 804	8 944	6	676	3 202	0	7 823 318
9	J	Yes	0.10	6 982 932	14 078	6 672	3	496	2 388	0	6 576 778
11	L	Yes	0.06	6 502 144	13 379	6 391	4	486	2 306	0	8 626 905
12	M	Yes	0.04	14 393 982	9 174	21 008	11	1 569	7 494	0	28 437 934
17	P	Yes	0.10	7 454 230	7 154	13 925	6	1 042	4 956	0	11 258 814
20	9a1	Yes	0.08	3 036 832	8 230	4 882	4	369	1 755	0	4 481 009
23	8a (without secondary	Yes	0.06	3 222 204	7 357	5 658	5	438	2 034	0	5 743 410
28	11b	Yes	0.09	3 027 166	12 256	3 278	2	247	1 177	0	3 303 265
44	C	Yes	0.07	9 154 562	10 695	11 154	10	856	4 014	0	11 843 080

Biomass projects

- Residue : Rice husk
- Technology : Gasifier
- Nb Projects : 4

Site	MOFU	IHOWANJA	BIRO	KAMBALA
Installed capacity at the site	107 kW	103 kW	470 kW	330 kW
Cluster settlements number	1	1	2	1
2012 Population covered	2 887	1 756	3 299	2 641



Project #	Pole Name	Grid Connected	Levelized Cost (kWh)	Starting Investment ($ US)	Investment/ Customer	Cluster Population (Y1)	Nb Localities impacted	LV Customers First year	LV Customers LastYear	Energy Demand (kWh) First Year	Energy Demand (kWh) Last Year
BIOMASS CLUSTERS				4 224 736	5 314	10 583	5	795	3 797	0	5 659 954
4	MOFU	Yes	0.18	829 254	3 857	2 887	1	215	1 038	0	1 487 142
6	KAMBALA	Yes	0.10	1 209 214	6 107	2 641	1	198	954	0	1 405 125
7	IHOWANJA	Yes	0.14	499 580	3 756	1 756	1	133	628	0	852 167
8	BIRO	Yes	0.10	1 686 688	6 774	3 299	2	249	1 177	0	1 915 520

Morogoro - Scenario 2

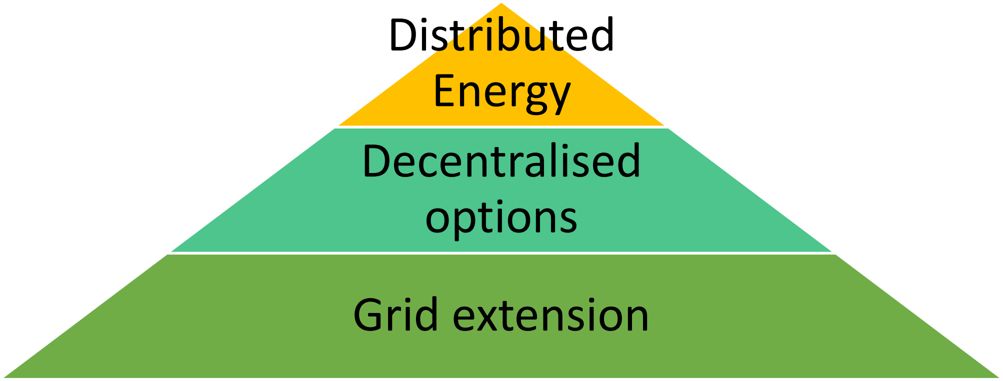
- Planned projects 19 M$
  - MV lines: 342 km
  - Demand: 46 GWh
- Densification 22.5 M$
  - MV lines: 211 km
  - Demand: 185 GWh
- Decentralised options 81.3 M$
  - Hydro: (16 MW) 75.6 M$
  - Biomass: (1 MW) 4.2 M$
  - Diesel hybrid PV: (0.6 MW) 1.5 M$
- Distributed Energy 7.7 M$

	Nb Villages
Projects extension	46
Grid extension	126
Hydro projects	67
Biomass project	5
Diesel hybrid PV projects	4
Remote settlements	126

TOTAL : 130.5 M$

4- DISTRIBUTED ENERGY

Distributed Energy strategies generally aim at improving access to modern forms of energy (electricity but also mechanical power for productive uses) in areas where accessibility, lack of available financing and other socio-economic constraints render electrification through grid extension or isolated mini-grids impossible in the near future



Such standalone solutions may involve :

- Domestic equipments such as solar home systems (SHS)
- Community equipments (PV for schools and hospitals, multifunctional platforms).

CONSTRAINTS

By default, all settlements already electrified at the beginning of the planning period, as well as those included in the rural electrification plan, are considered not eligible for Distributed energy strategies. Therefore, only settlements with no suitable electrification option by the end of the planning period will be considered.

The user then has the choice of

- Focusing only on “isolated” settlements. These isolated settlements are as defined in the Spatial Analyst® module.
- Limiting the available budget
- Limiting the population coverage (percentage of population living in villages served by Distributed Energy options compared to the total population of studied areas)

DOMESTIC EQUIPEMENTS

Up to two different domestic distributed generation equipments can be set up.

For each domestic equipment, the following information should be provided:

- **Penetration rate**: percentage of households in the village, which will have access to this equipment.
- **Equipment type**: A list of several equipment is suggested (PV, Pico-hydro and batteries).
- **Unit cost**: investment cost to supply <u>one</u> household.

Pico hydroelectric turbines (less than 1kW), <u>to be used only if all eligible villages are located near small waterways.</u>

COMMUNITY EQUIPEMENTS

Several technologies have been pre-configured, but other types and combinations can be used:

- PV panels for education and health infrastructures
- Multifunctional Platforms): mechanical power provided by a diesel engine for several productive uses at the same time (grinding, battery charging, sawing, hulling etc.).
- Platform with small grid (micro-grids): same as above with the addition of an inverter and a mini-grid to supply a few households or public services.

RESULTS

Detailed results are provided per settlements benefiting from DE options or aggregated at administrative levels :

Report including

- ✓ List of targeted villages
- ✓ Number of equipments required
- ✓ Budget required per equipment et per village

Map of investment

➡ Program definition for access to modern forms of energy

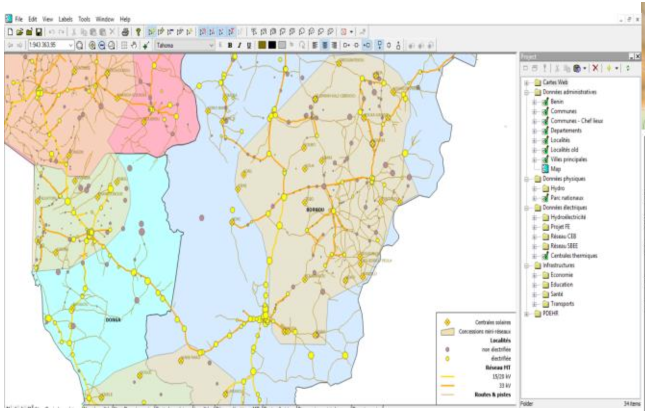
PART 04

04 CONCLUSION & REFERENCES

- Outputs
- Clients and references

GEOSIM produce the following outputs:

- Modules reports
- Results mapping
- Grid expansion investment plan (financial investment breakdown)
- Least cost decentralized projects portfolio (economic analysis and mapping)



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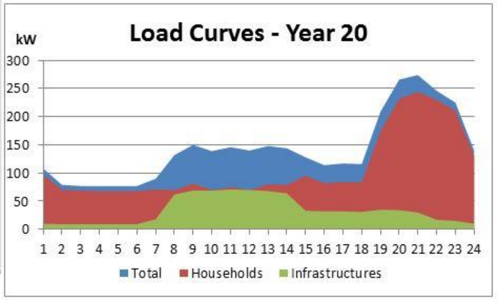

Ranking of Development Poles GeoSim

Code	Pole Name	Pole IPD score	Pole Population (Census : 2012)	Total population covered from the pole
Area :	Morogoro	Number of poles : 60	585 531	1 785 157
011637	MOROGORO	0.92	227 921	246 151
001152	GAIRO	0.54	16 982	76 275
003596	IFAKARA	0.90	12 382	65 128
010813	IRAGUA	0.49	45 130	54 649
007655	KILOSA	0.71	3 219	51 540
004383	MZUMBE	0.59	2 097	45 797
007595	MKAMBA	0.53	16 757	45 662
003420	BEREGA	0.50	4 458	40 582
002808	LANGALI	0.48	2 634	39 737
003726	MLIMBA	0.51	13 977	38 111
007587	MLABANI	0.53	7 704	36 908
002783	MKUYUNI	0.48	4 141	36 488
002789	MTOMBOZI	0.44	1 470	35 620
012341	MAHENGE	0.72	4 556	35 499
012410	TURIANI	0.63	1 000	32 893
003591	MWAYA	0.47	5 823	30 005
007878	MTIMBIRA	0.47	3 271	28 902
007675	KIMAMBA	0.50	5 753	28 257
007636	CHANZURU	0.48	3 010	28 176
002794	MANYINGA	0.49	5 838	27 286

Multiple benefits of using the GIS planning tool

- ✓ Ease of use: Wide and advanced expertise now available to planners.
- ✓ Many scenarios can be easily simulated with various parameters (sensitivity studies) or strategies to determine the best possible solution
- ✓ Spatial and temporal dimensions added to standard studies (investment programming).
- ✓ Mapping of the results
- ✓ Maximized impact on population

Use of rural electrification plans

- Aid-decision tool for policy makers
  - Estimate budgets for rural electrification funds with a focus on social and economic development
  - Undertake subsidy and tariff studies focused on particular technologies or business models (public-private partnerships, interconnection with the grid…)
  - Assess the potential for rural electrification from renewable resources in a particular area
  - Assess the potential impact of Demand Side Management strategies (through different demand scenarios)
  - …

Use of rural electrification plans

- Planning is a complex exercise, based on broad assumptions and often inaccurate data
- Therefore, it should remain a cautious and dynamic process
  - Sensitivity analyses should be done on major assumptions for demand forecast, fuel prices, capacities of renewable sources…
  - The plan and database should be regularly updated (~every 5 years), taking into account evolutions in prices, grid extension, local development…

Results update and sensitivity analyses

Project identification

- All projects listed in the plan are in theory suitable for deeper investigations (pre-feasibility and feasibility studies)
- These in-depth studies should include finer technico-economic analyses as well as organisational, regulatory and financial issues, which have not been treated in the rural electrification plan
- …

CONCLUSION AND REFERENCES

REFERENCES

- **Few key references…**
  - Tanzania :
    - Integrated rural electrification planning (2012)
    - National Electrification program prospectus (2015)
    - Rural Energy Master Plan (2021)
  - Congo: High Level Least Cost Geospatial Electrification Options Analysis for Grid and Off-Grid Rollout (2019)
  - Cameroon : Rural Electrification Master plan (2018)
  - Benin: Distribution Master plan (2016)
  - Ethiopia : Rural Electrification Master plan (2006)
  - Namibia : Least cost geospatial Electrification Planning (2020)
  - Peru : Least cost geospatial Electrification for 10 regions (2021)
  - Madagascar:
    - Regional Rural Electrification planning (2014)
    - Geospatial Least Cost Electrification Planning (2021)
  - Others projects
    - ECOWAS: GIS-Based electrification study for the ECOWAS Regional Access Project (Mali, Guinea Bissau, Gambia (2018), Mauritania (2019) and Niger (2021))
    - Cambodia : Sustainable rural electrification Planning (2008)
    - Uganda : National Electrification Strategy (2021)
    - Ghana (2019),
    - Lao PDR (2007)…

CONCLUSION AND REFERENCES

REFERENCES

- **Clients**
  - Institutionnel (Ministries, Rural Electrification Agencies)
    - ➢ MEM, REA (Tanzania), MINEE, AER (Cameroon), MIME (Cambodia) ADER, MEH (Madagascar)…
  - Utilities
    - ➢ CI-ENERGIES, TANESCO, SBEE, JIRAMA, EEPCO …

- **Donors**

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ROYAL NORWEGIAN EMBASSY

THANKS FOR YOUR ATTENTION

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