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Geospatial modelling and implementation plan for electrification strategies – The case of Plateau (Nigeria)

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Motivation

- Rural electrification rates are still low in many regions of Nigeria. Decentralized electricity supply with renewable energies and diesel generators and grid extension are options for providing access to electrification.
- Geospatial assessments may improve planning of electrification and implementation strategies with transparent information on different electrification options and scenarios.
- Electrification planning for the different locations is required with an analysis of topographical challenges and of the distribution of non-electrified locations in regard to existing power infrastructure and potentials of decentral systems.

Methodology

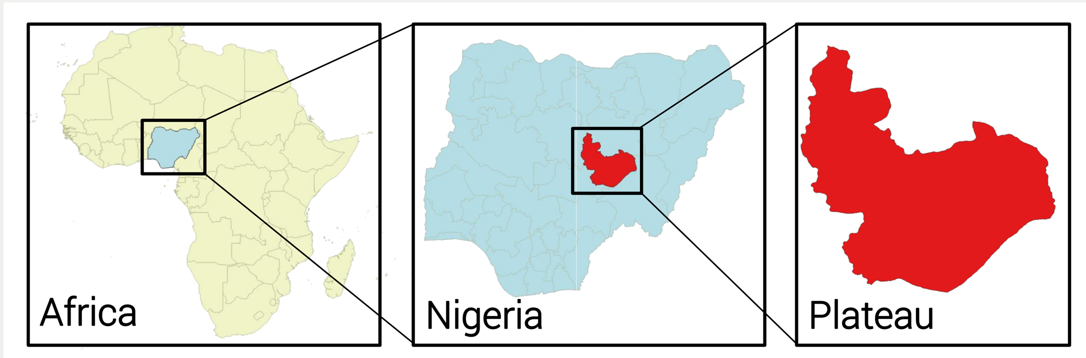
Providing electricity to remote, rural locations remains a great challenge. Focusing on infrastructure development the choice between decentralized energy systems and extension of the national or international grid system has to be carefully evaluated. The performance of **technical feasible, sustainable, reliable** and **affordable electrification** pathways can differ strongly depending on local characteristics and defined policies and regulations.

GIS analysis, simulation of energy systems and **grid extension modeling** provide an understanding of the importance of local circumstances which may help to determine optimized electrification strategies, also considering local **renewable energy resources**.

The following methodology is applied for Plateau (federal state of Nigeria):

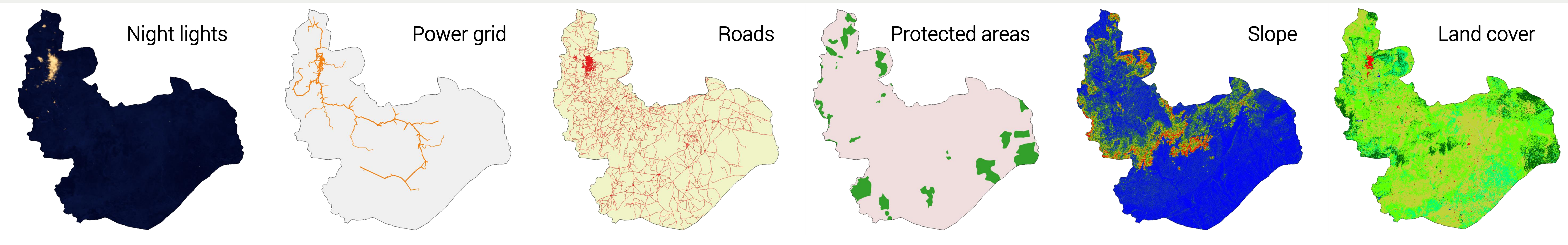
(a) Data collection
(b) Simulation of electrification options
- LCOE based mini-grid optimization
- Spatially explicit grid extension modelling

(c) Development of implementation plan



▲ Figure 1: Location of study area.

Geospatial assessment

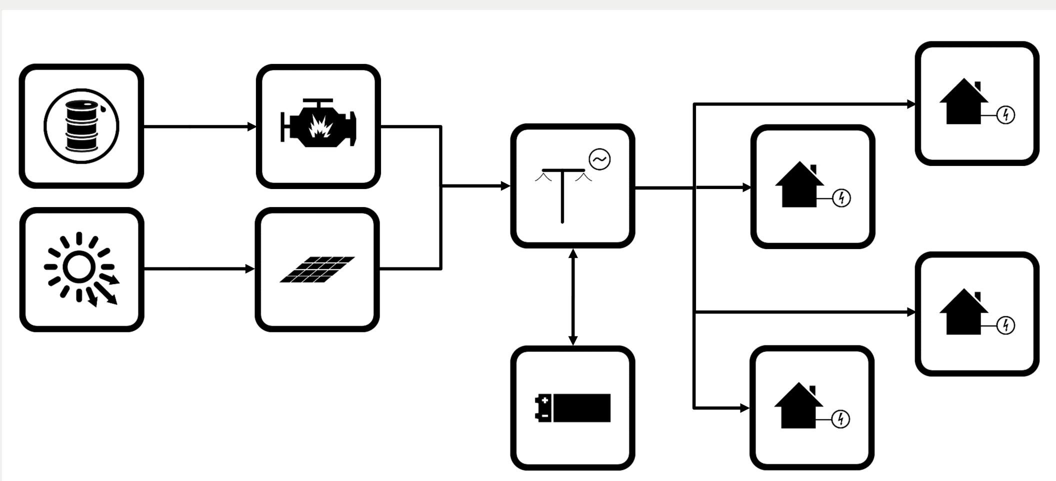


▲ Figure 2: Input data for assessing the status of electrification and to derive spatial parameters for the mini-grid simulation and grid modelling.

Mini-grid simulation

Decentralized electrification options are mini-grids and solar home systems. The following methodology was carried out to define the cost for each location:

- Detailed energy demand assessment to allow adequate system dimensioning
- LCOE-based mini-grid simulation in 1h time steps to assess costs for each location
- Solar home systems are suggested for locations with a small population and a low demand



▲ Figure 3: Schematic diagram showing possible mini-grid combinations with different renewable technologies and batteries.

Detailed outcome

Electrification planning according to political framework conditions:

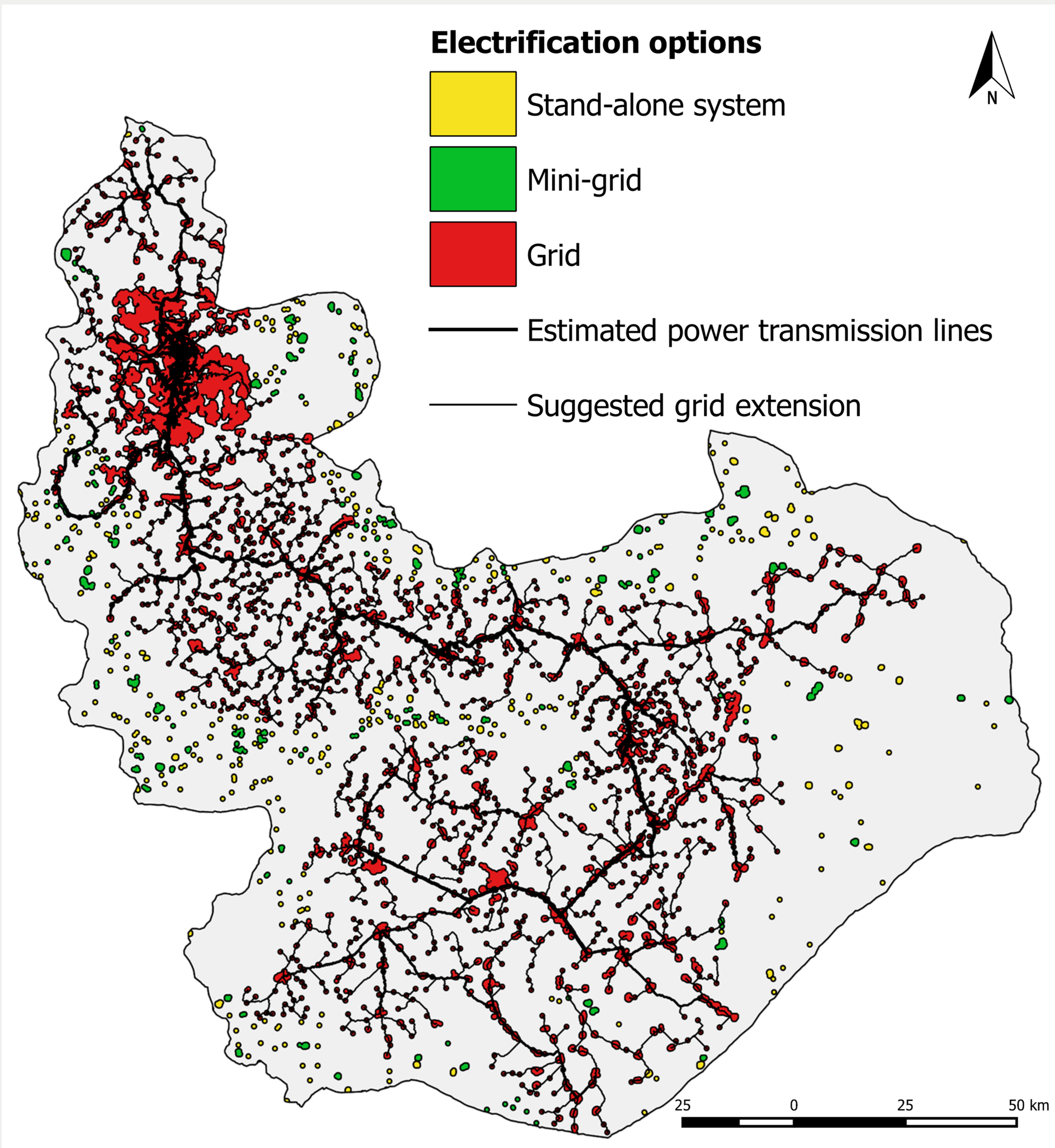
- Grid extension to all locations > 5,000 people
- 10 km radius extension around existing grid infrastructure
- Mini-grids for locations > 1,000 people

Results show that with this criteria densely populated areas are mostly suggested to be connected to the grid whereas the sparsely populated and remote regions are more often suggested for decentral electrification (Tab. 1).

▼ Table 1: Allocation of different supply types.

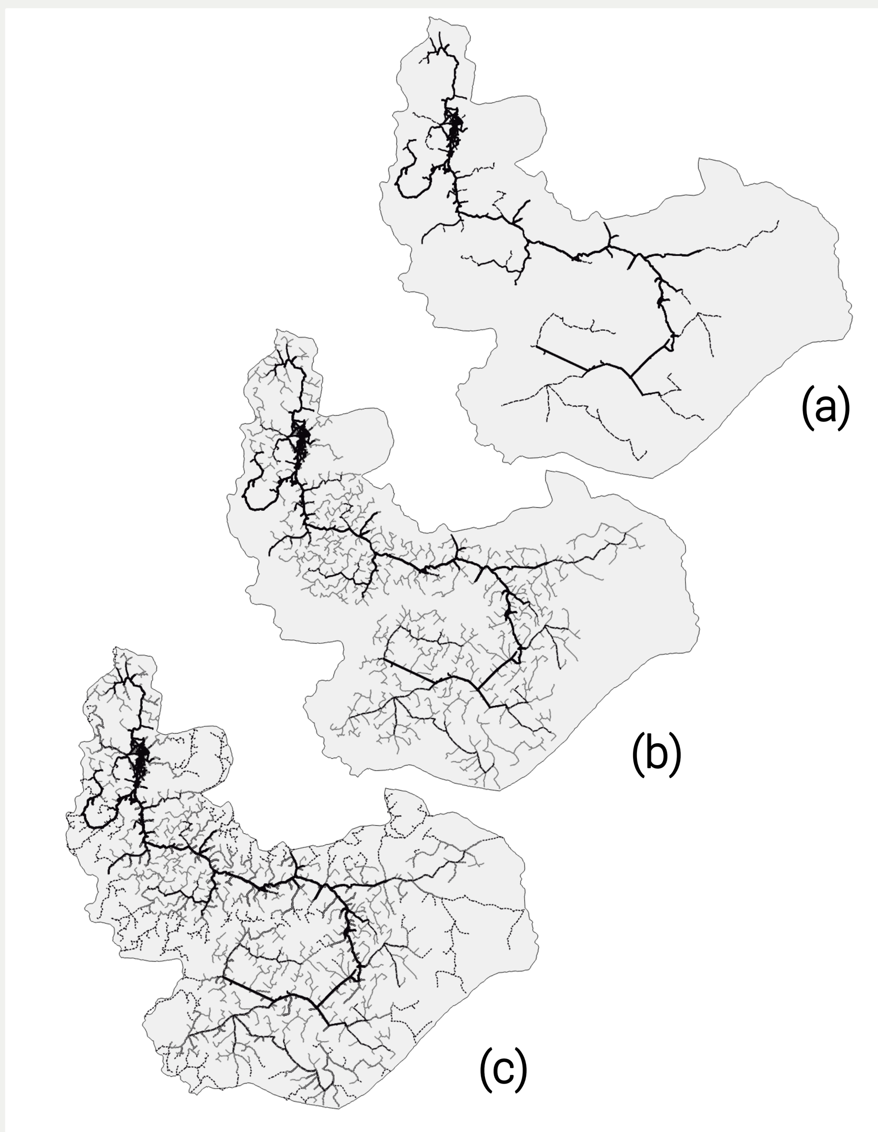
Option	Locations	Population
Grid	1,340	1,509,000
Mini-grid	132	330,000
Stand-alone	362	144,000

Result: Electrification Plan



▲ Figure 4: Electrification plan for Plateau to achieve 100 % access to electricity.

Grid modelling



▲ Figure 5: Prioritizing grid extension according to framework conditions by utilizing Dijkstra's algorithm.
(a) extension to all locations > 5,000 people
(b) 10 km radius around existing grid
(c) 100 % electrification.

Conclusion

- Spatial modelling for electrification planning adds a novel level of detail to existing planning structures.
- Individual, often non-transparent decisions in rural electrification planning can be replaced by a comprehensive evidence-based decision criteria.
- This high level planning allows governments and administrations to economically compare options and understand the overall needed interventions and a long-term roadmap to reach the goal of universal access to energy.
- Investors from public and private sectors gain a quick in-depth understanding of which opportunities exist in terms of renewable energies and respective business models and also about risks such as nearby grid infrastructure or competing least cost options.

Acknowledgement:
The author gratefully thanks the Reiner Lemoine-Stiftung for financing the research work. This work partly results from the authors' collaboration with the Nigerian Energy Support Programme (NESP) implemented by GIZ GmbH in collaboration with Federal Ministry of Power, Works and Housing, Nigeria and funded by the German Government and the European Union.
The authors gratefully acknowledge the support from GIZ-NESP and Nigerian FMPWH. Any conclusions or recommendations expressed in this article do not necessarily reflect the views of GIZ-NESP or FMPWH.