Afghanistan Energy Study: Activity 3

Power Systems Planning Using Geo-Spatial Analysis

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Afghanistan Energy Study Committee Meeting
October, 2016

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Energy & Extractives

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SE4ALL: Sustainable Energy for All group

Development and application of quantitative models in order to answer difficult policy and investment questions in the energy field.

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Importance of energy planning

- Energy planning is essential for **matching demand and supply.**
- **System cost minimization** without compromising energy security, reliability of supply and environmental integrity is a primary planning objective.
- Fundamental **energy system transformation** is key for the provision of reliable, affordable, sustainable and modern energy services to all.

However…

- Past energy planning paradigms (models and mind-sets) are largely inadequate for access analysis and planning.
- Effective electrification planning requires **geospatial** information (e.g., settlement location, distances from the grid and road infrastructure, energy resource availability).
- Usually, there is a lack of long term, reliable energy-related data.

Why **G**eographic **I**nformation **S**ystems (GIS)

The use of GIS serves multiple purposes:

Location based assessments: GIS tools enable assessments to analyse energy related geospatial information.

Remote sensing: The use of GIS tools facilitates the integration of remote sensing techniques to derive resource availability & energy potentials in cases where such data are not (publically) available.

Illustration of results: GIS is used to illustrate results in interactive maps, providing an effective science – policy interface.

ONSSET – **O**pe**N** **S**ource **S**patial **E**lectrification **T**ool

- ✓ GIS based tool developed in python
- ✓ Support electrification efforts on continental - national - subnational level
- ✓ Customized inputs according to study specifications
- ✓ Quantification of Capacity – Investment requirements for electrification
- ✓ Availability of the results in high spatial resolution (1 sq.km grid cells)
- ✓ Visualization of key outputs in maps & graphs

Process and Data

Infrastructure

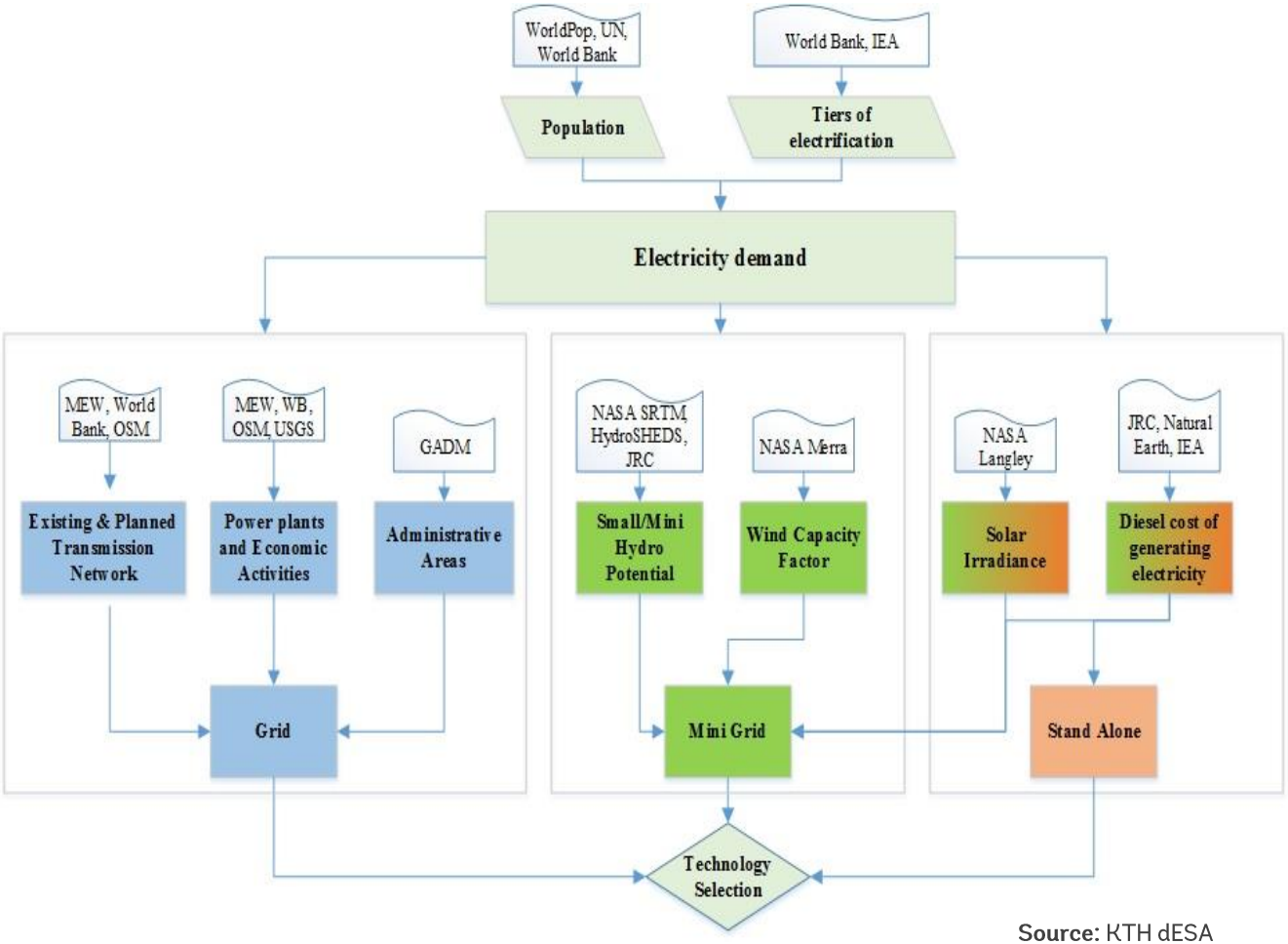
1. Administrative boundaries
2. Road network
   (existing and planned)
3. **Transmission network**
   (existing and planned)
4. **Power plants**
   (existing and planned)

5. **Population data**
   (distributions & density)

Resources

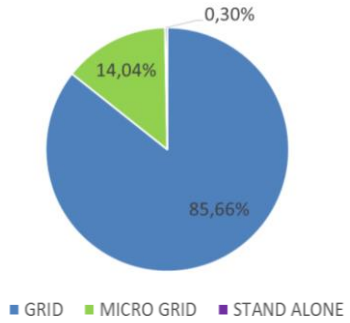
8. Solar availability
   (Photovoltaic systems)
9. Wind availability
   (Wind Capacity Factors)
10. Hydro availability
    (Mini – Small Hydropower)
11. Diesel gensets

ONSSET electrification model



Source: KTH dESA

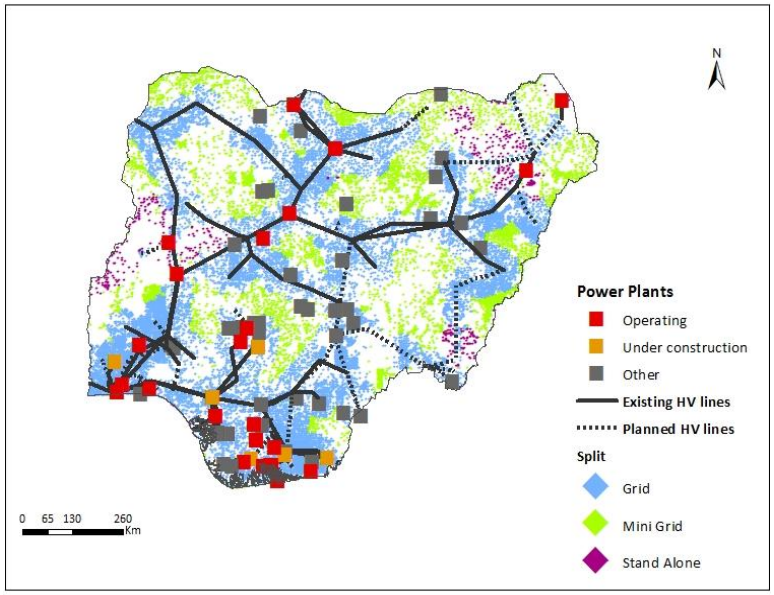
ONSSET Results – The case study of Nigeria



Estimated investment for full electrification by 2030:

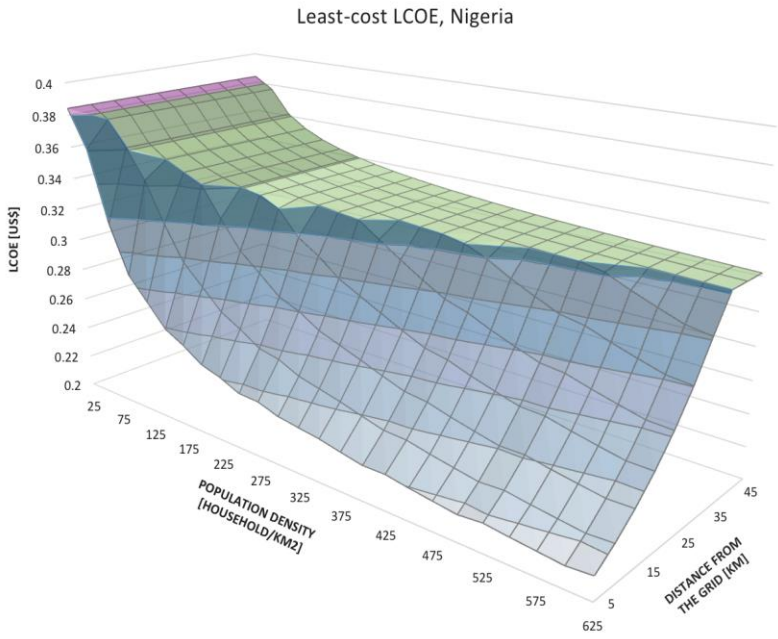
15.5 – 226.4 Billion US$

Item	Number	Unit
HV Transmission	4,300	km
MV Transmission	78,300	km
MV & LV Distribution	1,100,000	km
New Grid connections	33.8 million	Households
New Mini Grid Capacity	900	MW
New Stand Alone Capacity	15	MW



Nigeria, least cost split among Grid, Mini-grid, and Stand-alone electrification technologies

Source: Mentis, et al., KTH, Energy 94.



Least cost LCOEs in Nigeria as a function of the distance to the grid and population density

Source: Nerini, et al., KTH, Energy 94.

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What can ONSSET offer to Afghanistan?

The application of ONSSET in Afghanistan can:

- Provide a initial **overview of the least cost electrification option** per region according to certain possibilities and limitation.
- **Estimate the additional capacity** requirements (National Grid, Mini grids and Stand alone systems) in order to meet the demand.
- **Quantify the investment** required for the electrification targets to be achieved.
- **Inform decision making** in the energy field (science-policy, financing etc.) using a tool that is **open and freely available.**

Phase I - A First Cut Analysis Using ONSSET

i. Identifying, collecting, aggregating and making available via geodatabase high resolution datasets of interest that support electrification planning exercises in Afghanistan.

ii. Conducting a preliminary GIS based country-wide electrification analysis for Afghanistan, including the development of twelve (12) scenarios regarding electrification rates, levels of electricity consumption (tiers of access), spatially related fuel and technology costs, as well as relevant types of uncertainty.

iii. Post analysis and result visualization (tables, graphs, interactive “heat” maps etc.).

iv. A 16hour training workshop on the use of the open source spatial electrification tool ONSSET to inform national energy policies and identify paths for full electrification.

Phase II – Detailed Geo-Spatial Analysis

A detailed least-cost expansion plan down to Medium Voltage for 3-5 “representative” and viable (not under severe conflict) provinces in Afghanistan.

- Build on first pass estimates and see what is right and what is wrong
- To build on existing work, and be detailed and focused on next five years
- Work with a dedicated governmental working group in Afghanistan to conduct work
- To be used as a model for a country-wide rollout
- To augment work ongoing by Afghanistan Government, ADB, etc.

THANK YOU

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