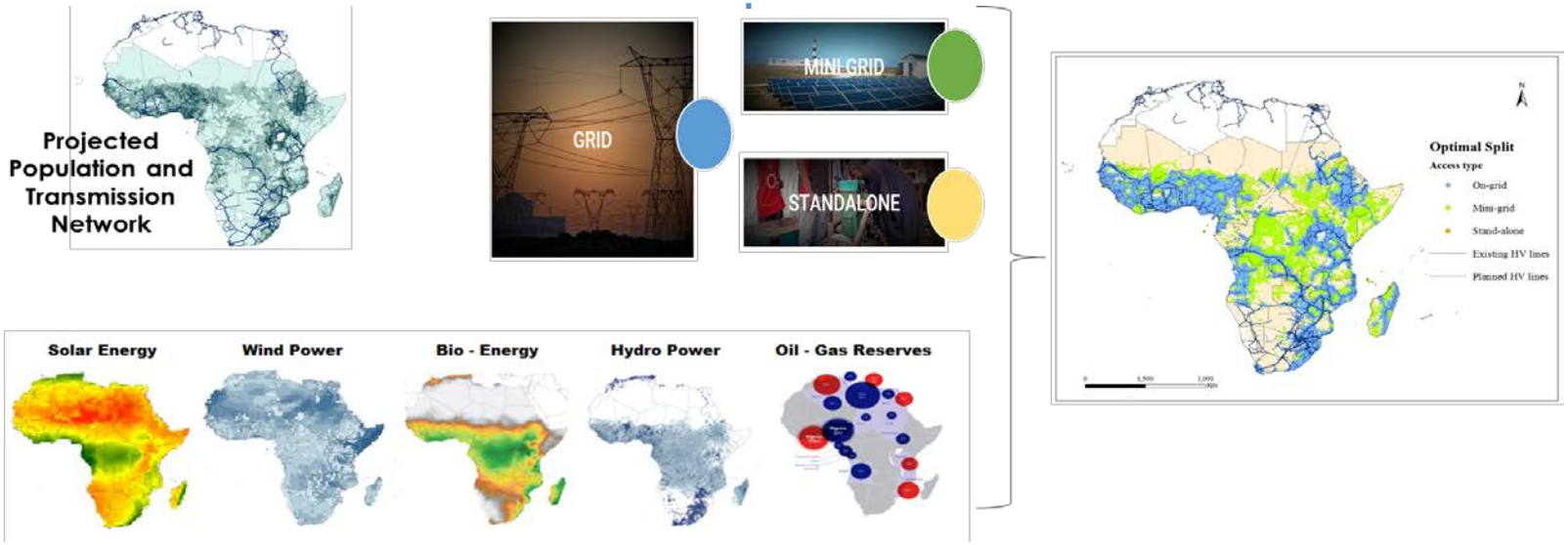
OSeMOSYS
Open Source Energy Modelling System

Part of pTIMUS www.optimus.community Practice 3

OnSSET
Open Source Spatial Electrification Tool

Analytical tools to quantify selected nexus issues

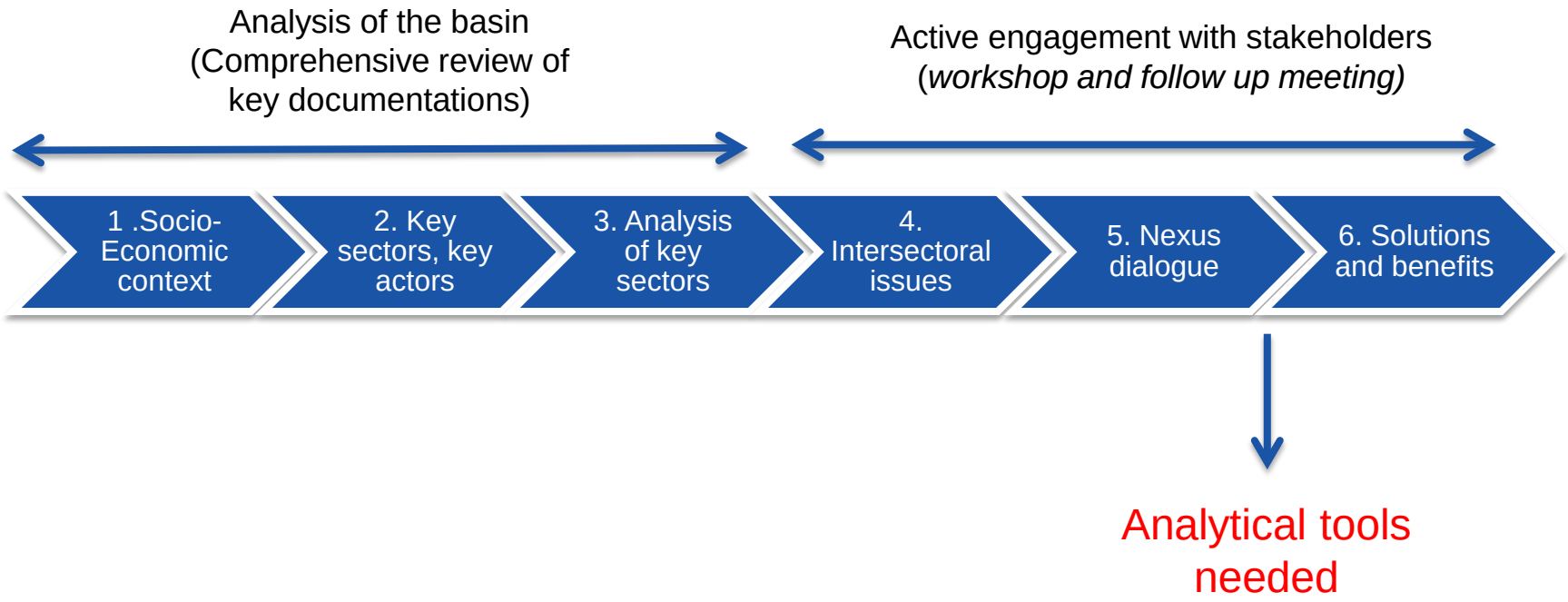


Prof. Mark Howells

Youssef Almulla, *Francesco Gardumi, Dimitris Mentis and Alexandros Korkovelos*

Division of Energy Systems Analysis, The Royal Institute of Technology (KTH-dESA)

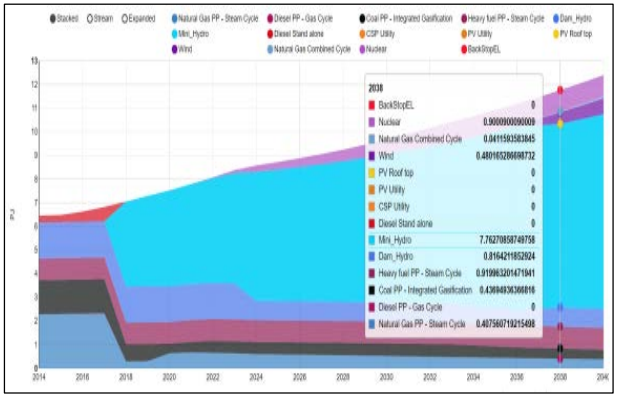
Methodology of The Nexus Assessment of a Transboundary Basin



Analytical tools developed by KTH-dESA:

OSeMOSYS

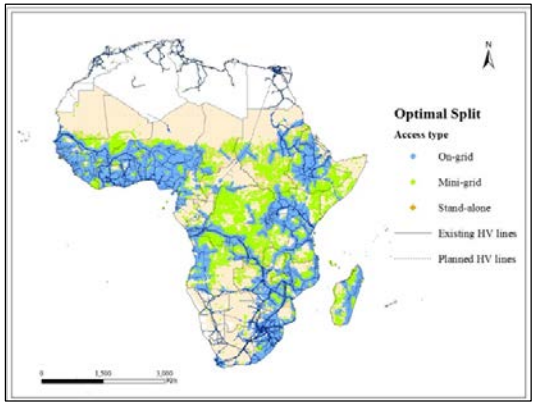
Open Source Energy Modelling System



www.osemosys.org

OnSSET

Open Source Spatial Electrification Tool



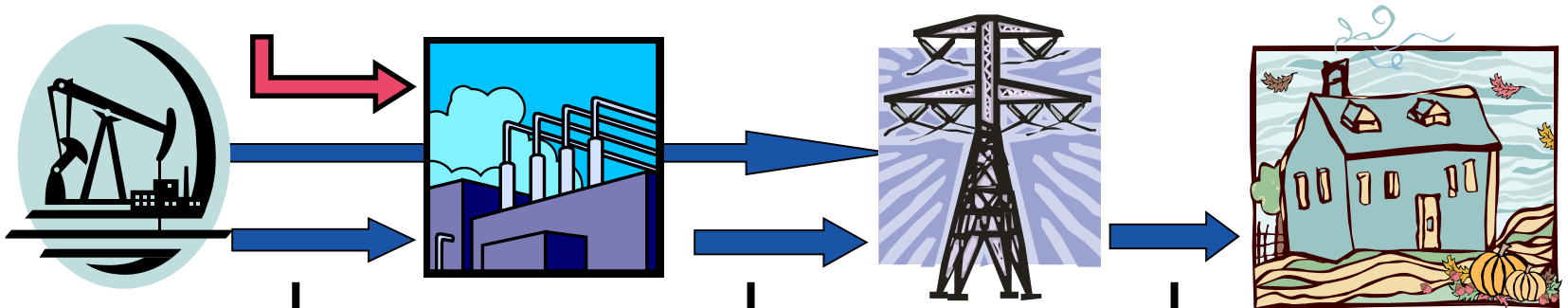
www.onsset.org

Open Source energy MOdelling SYStem

(OSeMOSYS)

- **Model generator converting the energy system structure represented by equations into a matrix to be solved by specific solvers**
  - Open source
  - Dynamic
  - ***Linear optimisation***

What we mean by Energy System



Extraction or Import

Conversion

Transmission & Distribution

Conversion

PRIMARY
-Oil
-Gas
-Coal
-water
-***Wind***
-***Solar***

SECONDARY
- Diesel
- Kerosene
- Gas
- Electricity
- Coal

FINAL
- Diesel
- Kerosene
- Gas
- Electricity
- Coal

USEFUL
- Heat
- Lighting
- Mechanical energy

What does OSeMOSYS do?

It determines the energy system configuration with the **minimum total discounted cost** for a time domain of decades, constrained by:

- **Demand for energy** (e.g. electricity, heating, cooling, km-passengers, etc.) that needs to be met
- **Available technologies** and their techno-economic characteristics (Levelised Cost of Electricity, efficiency, lifetime, etc.)
- **Emission taxations**, generation targets (e.g. renewables)
- **Other constraints** (e.g. ramping capability, availability of resources, investment decisions, etc.)

OSeMOSYS in the nexus framework

Aims at:

- providing stakeholders with policy relevant insights about key **inter-linkages and dynamics** of the energy-food-water nexus
- **identifying robust relationships** (i.e. impacts/relationships that are true for a wide range of conditions/assumptions)

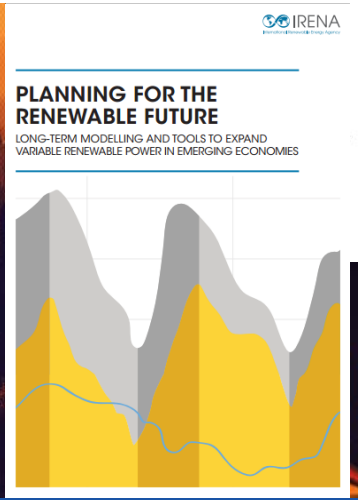
Nexus case studies under UNECE framework:

✓ Sava River Basin (2014 – 2016)

✓ Drina River Basin (2016 – 2017)

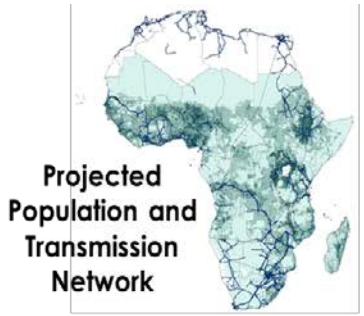
Other contributions of OSeMOSYS

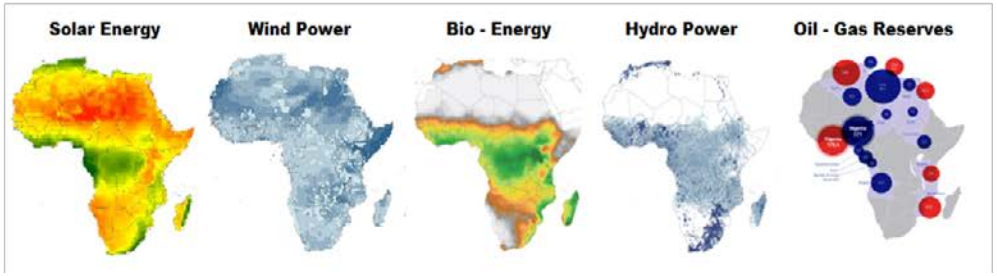
- *Continental electricity system models of **South America** and **Sub-Saharan** Africa, developed in collaboration with **World Bank***
- *Country models of **Nicaragua**, **Bolivia** and **Uganda** developed in collaboration with **UNDESA** and employed for capacity building to the **Governments***
- *Detailed country model of **Cyprus**, providing insights for the natural gas outlook to the **Ministry of Energy, Commerce, Industry and Tourism.***
- Among the United Nations ***"Modelling Tools for Sustainable Development Policies", in collaboration with UNDESA and UNDP.***

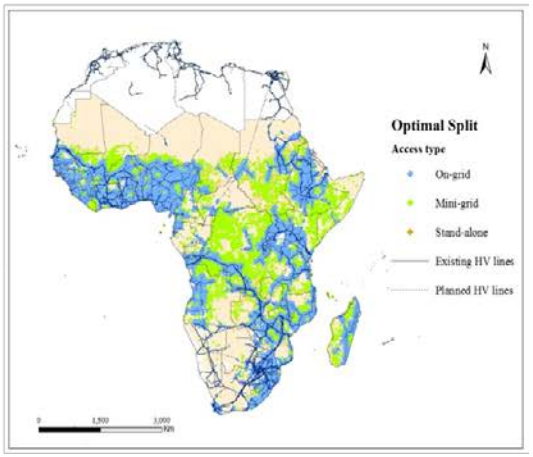


Open Source Spatial Electrification Tool

(OnSSET)







GIS and Energy System Models

Medium to long-term national energy system models such as OSeMOSYS, TIMES, MESSAGE etc. typically do not to take into account the spatial fluctuations of energy resources and demand side.

- Intermittent energy resources (such as wind, solar, hydro, diesel supply) vary in time and space.
- Power infrastructure and energy demand differ from one area to another.

Without GIS models, these details, which are essential in energy planning, cannot be captured.

GIS and energy planning

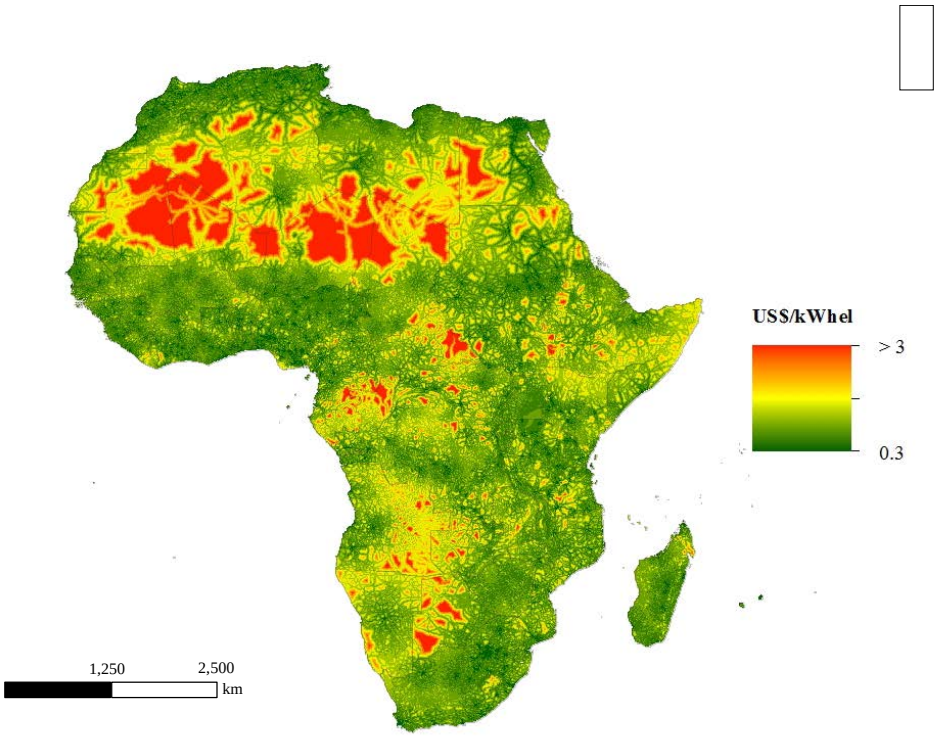
Spatial datasets for an electrification planning analysis:

Categories	Datasets
Resources	Wind Solar Hydro Oil
Infrastructure	Road network Transmission network Power plants Night-time lights

Categories	Datasets
Demand side	Population density Population growth Administrative boundaries Urban/rural split
Economic activities	Mining and Quarrying sites

The role of GIS in energy planning and energy access

- Administrative boundaries
- Road network
- Nighttime light
- Power plants
- Mines
- Existing Grid Network
- Current population
- Projected population and Grid Network
- Wind power capacity factor
- Global Horizontal Irrandiance
- Mini and small hydropower potential
- Spatial cost of Diesel gensets



The role of GIS in energy planning and energy access

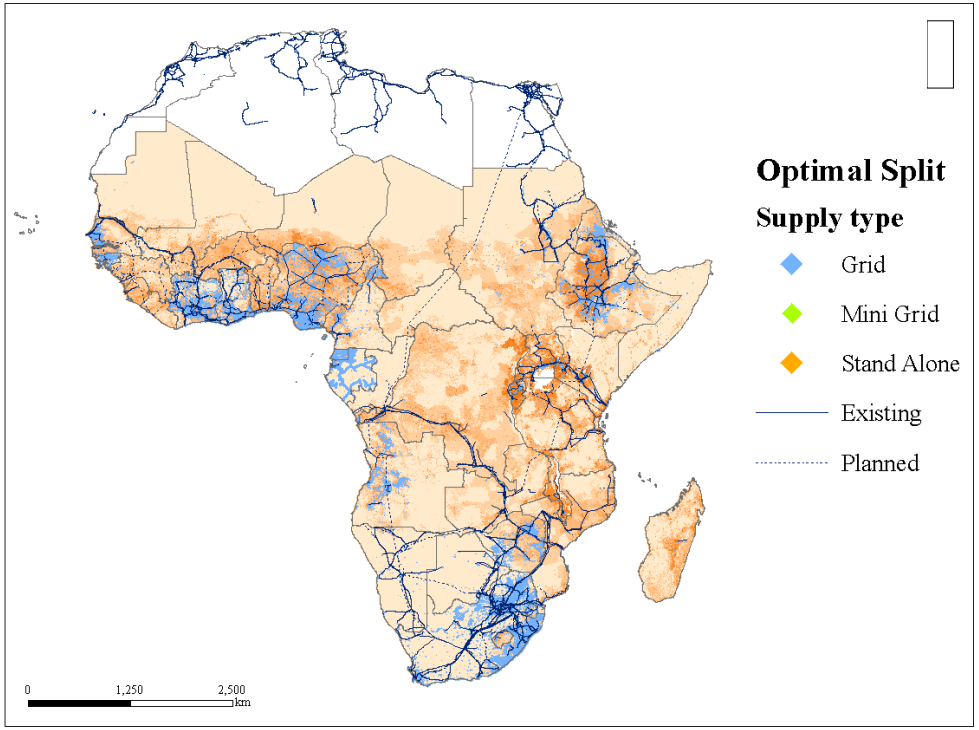
	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Indicative appliances powered	Task lightning + phone charging or radio	Tier 1 + General lightning + air circulation + television	Tier 2 + Light appliances	Tier 3 + Medium or continuous applicances	Tier 4 + Heavy or continuous applicances
Level of Access					
Consumption per capita per year for a certain efficiency level	8 kWh	44 kWh	160 kWh	423 kWh	598 kWh

Results - Electrification Analysis in Sub Saharan Africa

Tier 1 (lighting)

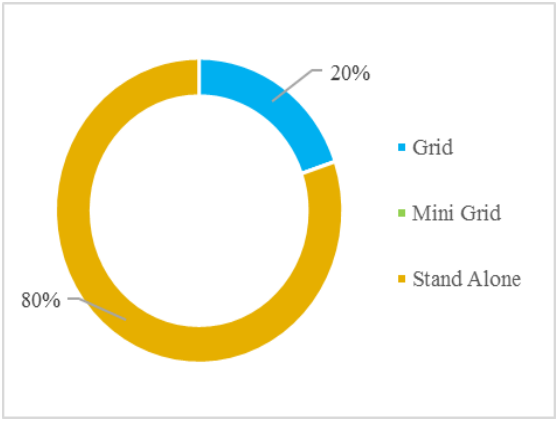
Electricity access kWh/capita/year

8	
44	
160	
423	
598	



Technology split

Grid extension:	**20%**
Mini-grid:	**0%**
PV	
Diesel	
Wind	
Hydro	
Stand-alone:	**80%**
PV	49%
Diesel	51%

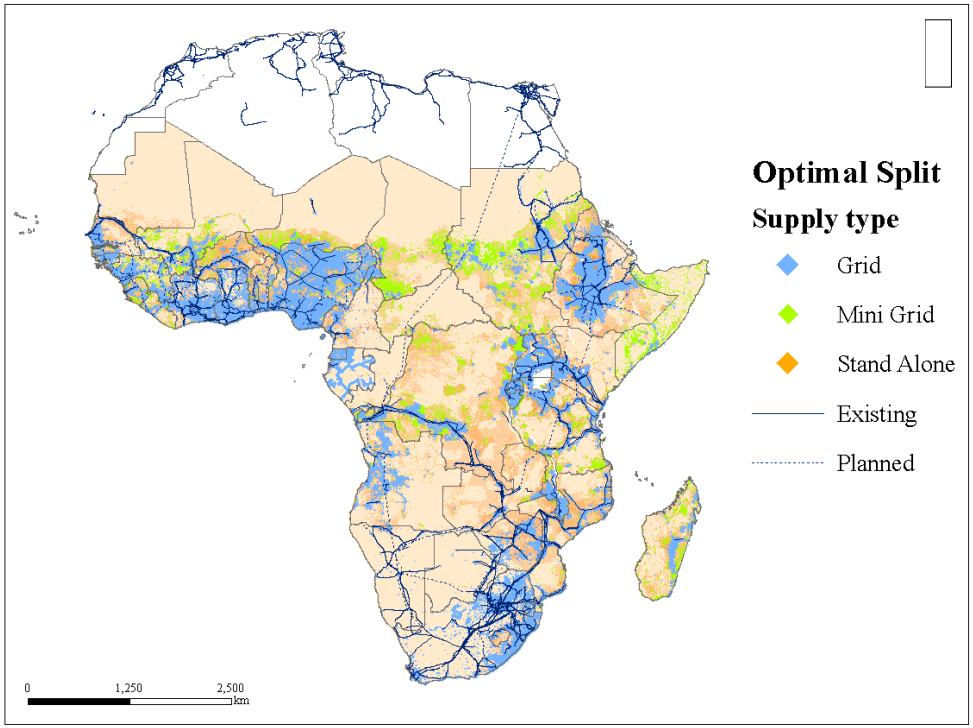


Results - Electrification Analysis in Sub Saharan Africa

Tier 3 (light appliances)

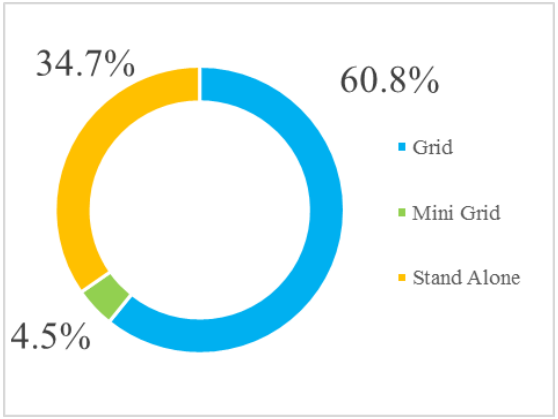
Electricity access kWh/capita/year

- 8
- 44
- **160**
- 423
- 598



Technology split

Grid extension:	**60.8%**
Mini-grid:	**4.5%**
PV	0%
Diesel	99%
Wind	0%
Hydro	1%
Stand-alone:	**34.7%**
PV	60%
Diesel	40%

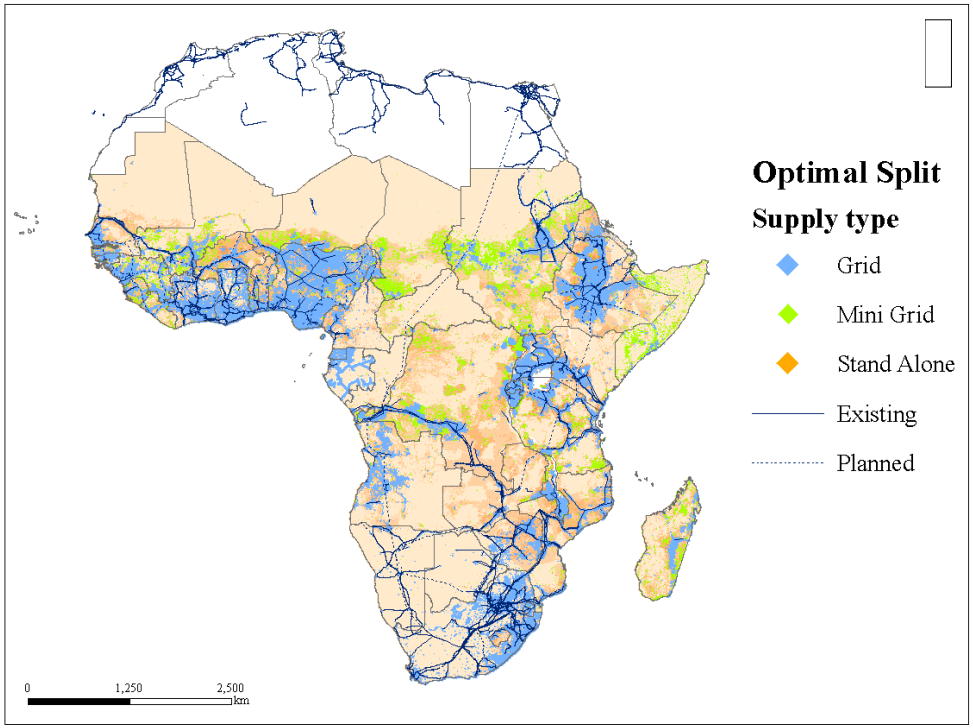


Results - Electrification Analysis in Sub Saharan Africa

Tier 5 (heavy appliances)

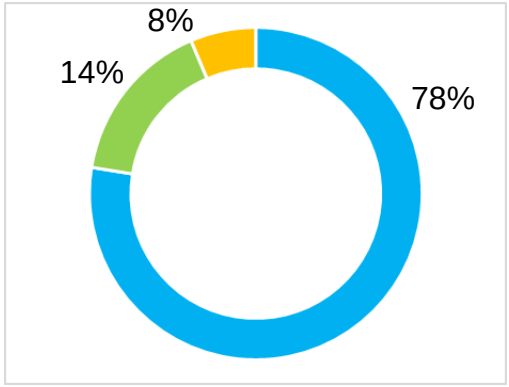
Electricity access kWh/capita/year

	8
	44
	160
	423
	598

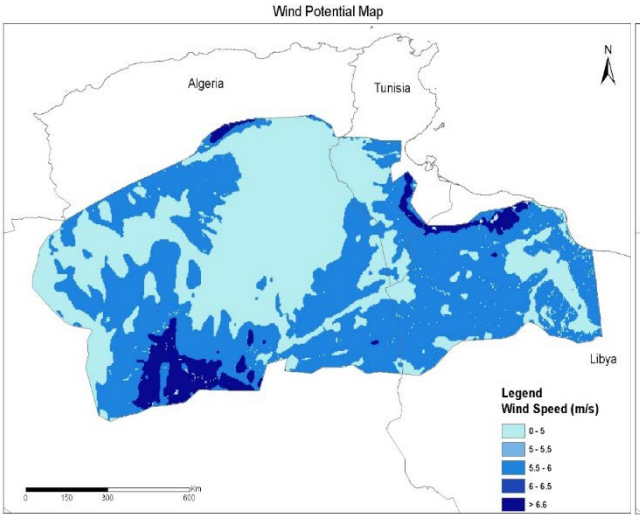


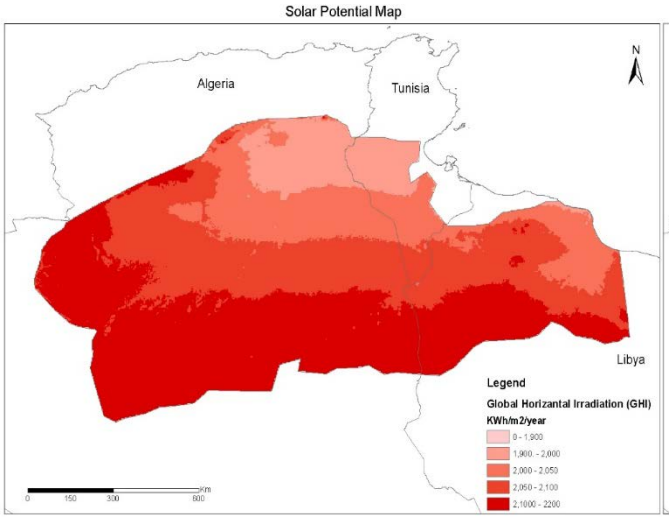
Technology split

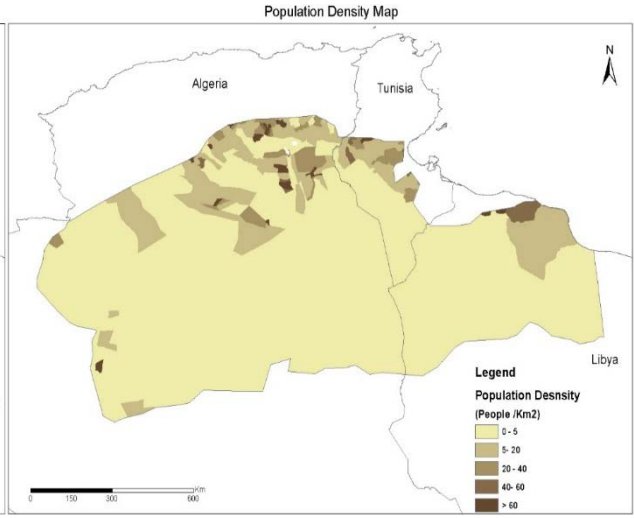
Grid extension:	**78.0%**
Mini-grid:	**14.0%**
PV	0%
Diesel	99%
Wind	0%
Hydro	1%
Stand-alone:	**8%**
PV	70%
Diesel	30%



New Application: The North Western Sahara Aquifer System (NWSAS)







OnSSET

Open Source Spatial Electrification Tool

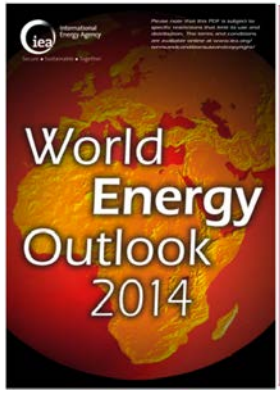
Energy for improve rural electrification

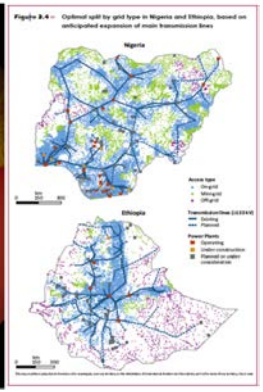
Energy for irrigation

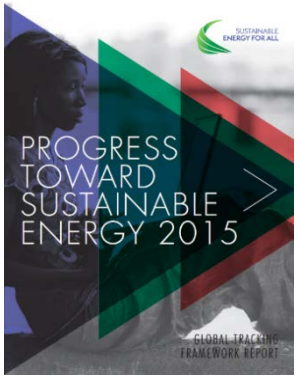
Energy for demineralization

Other contributions of OnSSET

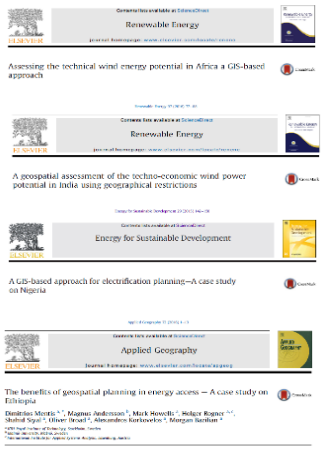
International reports







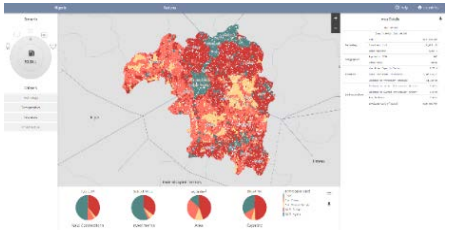
Peer Reviewd Publications



Capacity building activities

Introduction to Modelling tools for Sustainable Development at UNDP, Addis, Ethiopia, August, 2016

Open source platforms and applications



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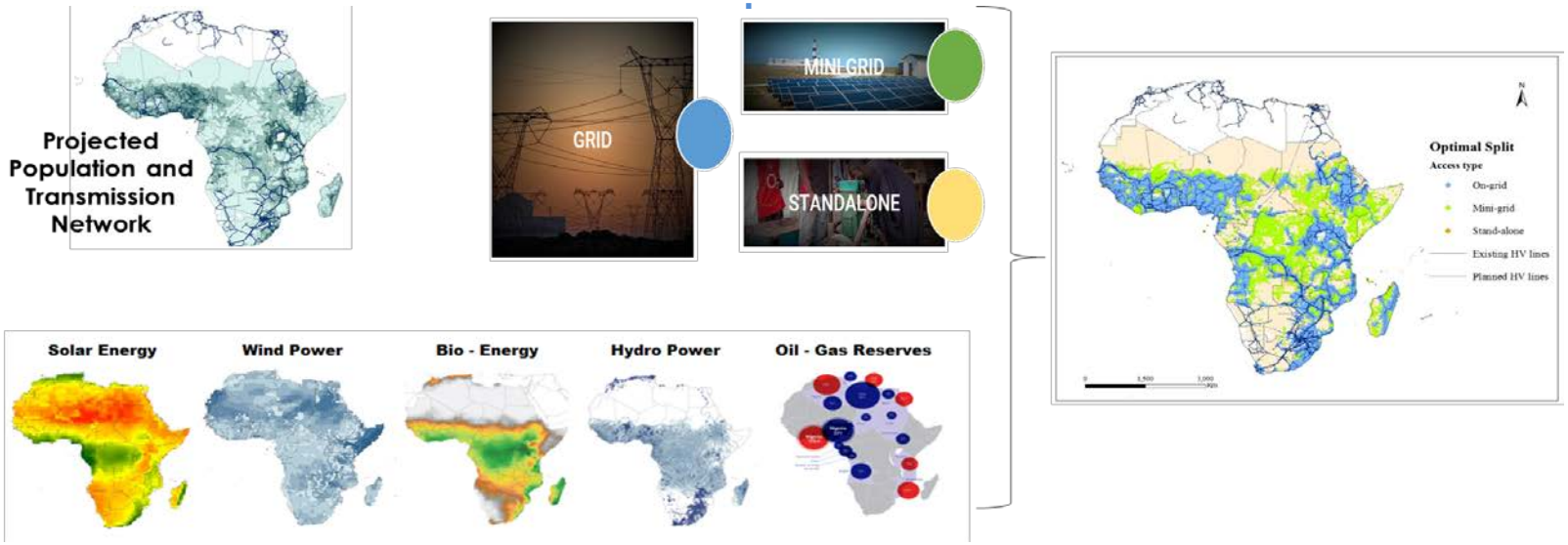

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