



# **MODELING TOOLS FOR LOW-CARBON DEVELOPMENT**

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# CONTENT

1. **KTH-dESA INTRODUCTION**
2. **MODELING TOOLS FOR ENERGY PLANNING**
3. **WAY FORWARD**

# KTH - DIVISION OF ENERGY SYSTEMS ANALYSIS INTRODUCTION



- Ca. 20 researchers
- Outward facing division (International partnerships and capacity building)



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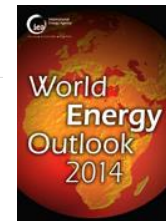
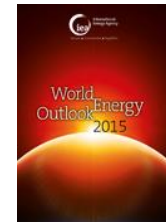
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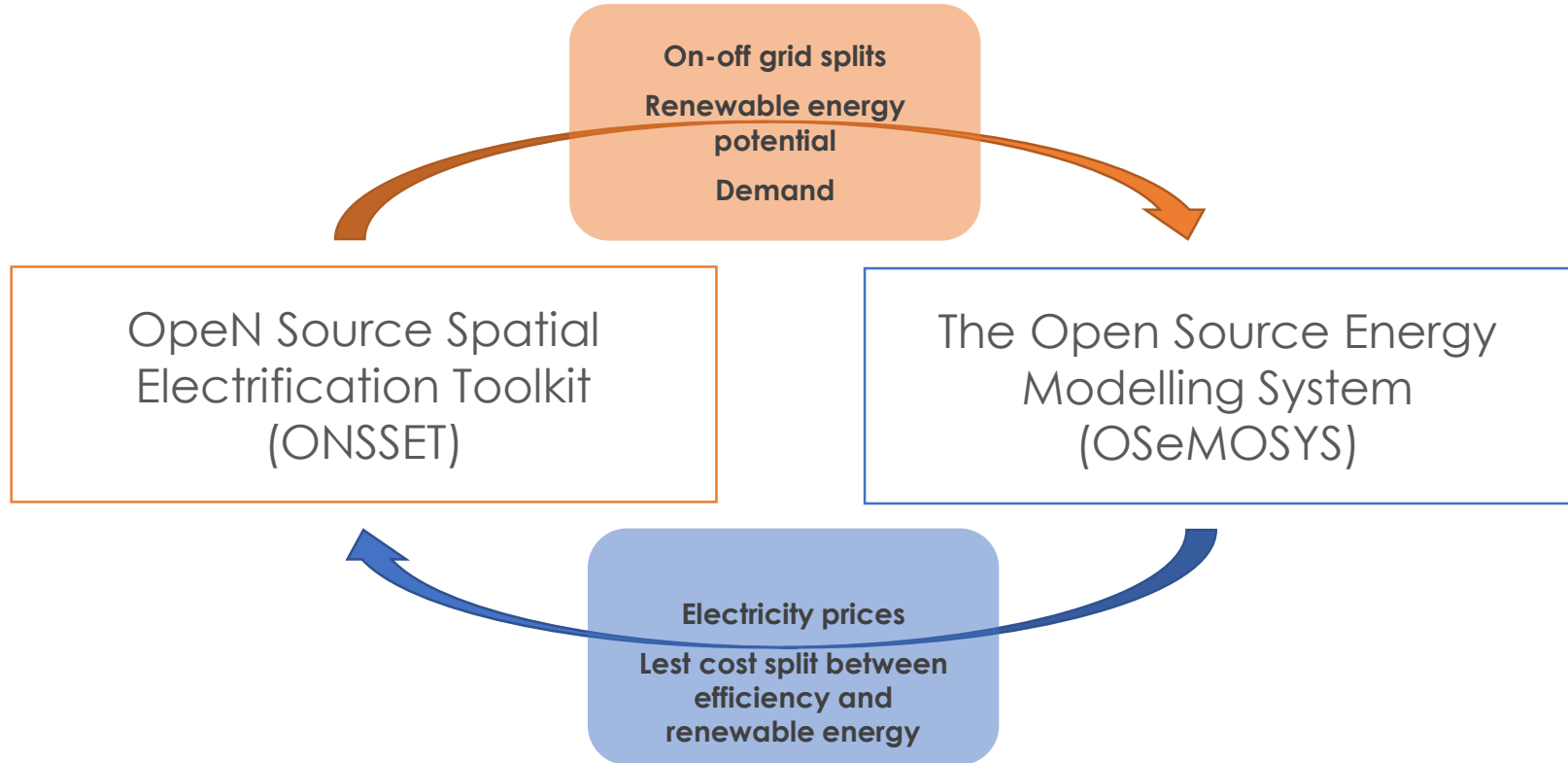
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**Holger Rogner**  
*Affiliate Professor*



# MODELLING TOOLS FOR ENERGY PLANNING







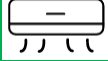
# COMPARING ON- AND OFF- GRID, RENEWABLE AND NOT OPEN SOURCE SPATIAL ELECTRIFICATION TOOLKIT - ONSSET



# DEMAND IN ONSSET THE MULTI-TIER FRAMEWORK

Service-oriented framework  
characterized by the **appliances** that can be powered with a certain tier of energy services

Scope for representation of efficient appliances

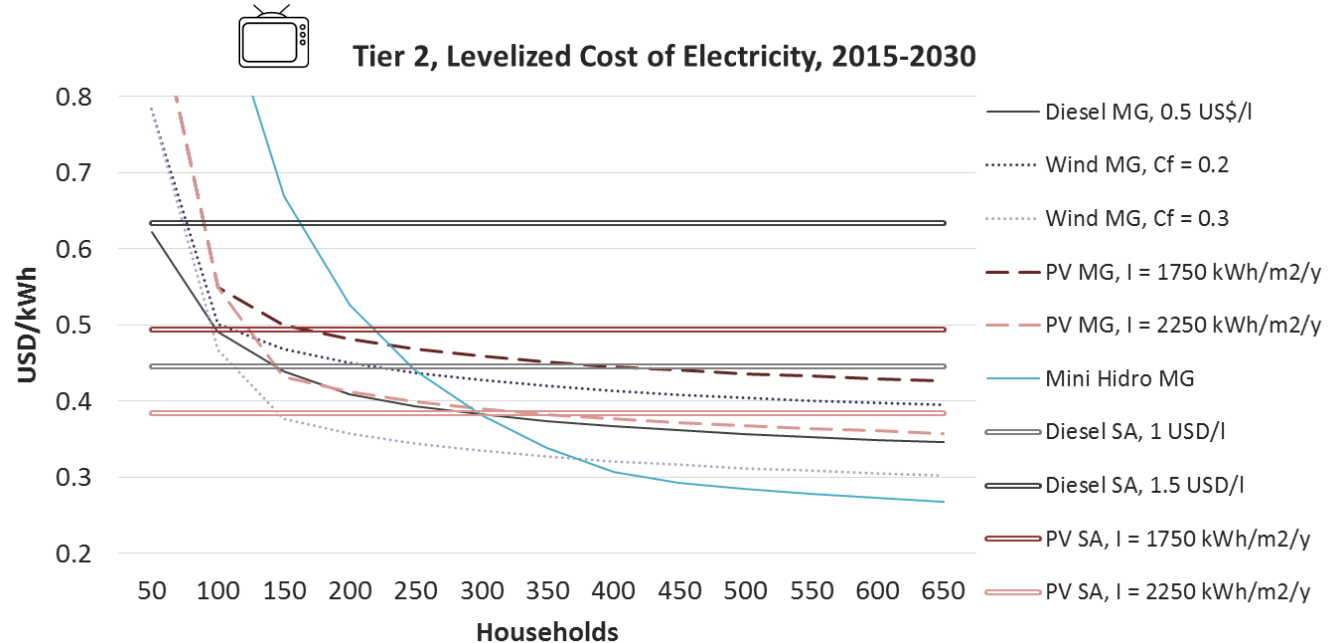
TIER	Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
<i>Indicative electricity services</i>	-	 <i>Task lighting + Phone charging or Radio</i>	 <i>Tier 1 + Fan + Television</i>	 <i>Tier 2 + light appliances</i>	 <i>Tier 3 + Medium or continuous appliances</i>	 <i>Tier 4 + heavy appliances</i>
<i>Consumption (kWh) per household per year</i>	<3	3–66	67–321	322–1,318	1,319–2,121	>2,121

*Simplified multitier matrix for measuring access to household electricity services, (IEA and the World Bank, 2015)*

# PARAMETRIZATION OF THE COST OF ELECTRICITY: LOCAL ENERGY RESOURCES AVAILABILITY

## Influence of:

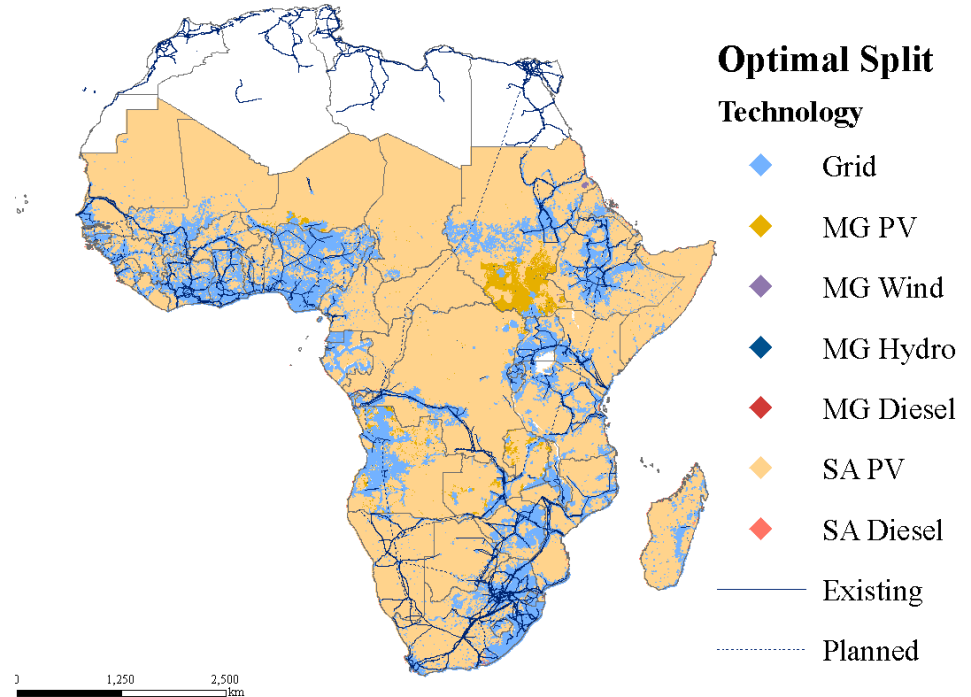
- Solar irradiation
- Wind availability
- Local diesel cost
- Availability of other sources: hydro or biomass residuals



*Cost comparison of selected stand-alone and mini-grid technologies with Tier 2 of energy access target*

# ONSSET – GIS APPLICATION, SUB SAHARAN AFRICA

- 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 Irradiance
- Mini and small hydropower potential
- Spatial cost of Diesel gensets
- Least cost Electrification option



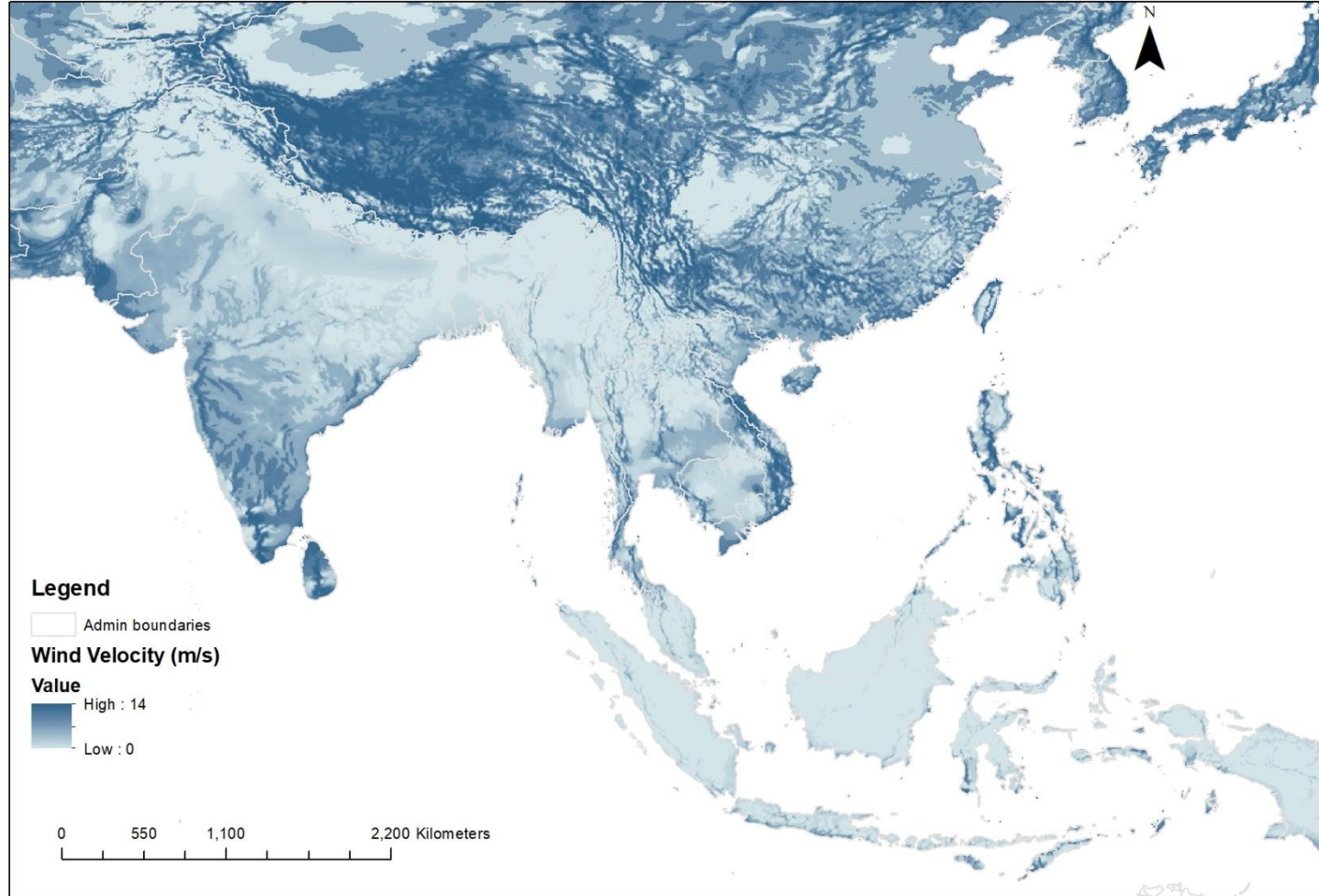
Source: Mentis, D. KTH, 2017



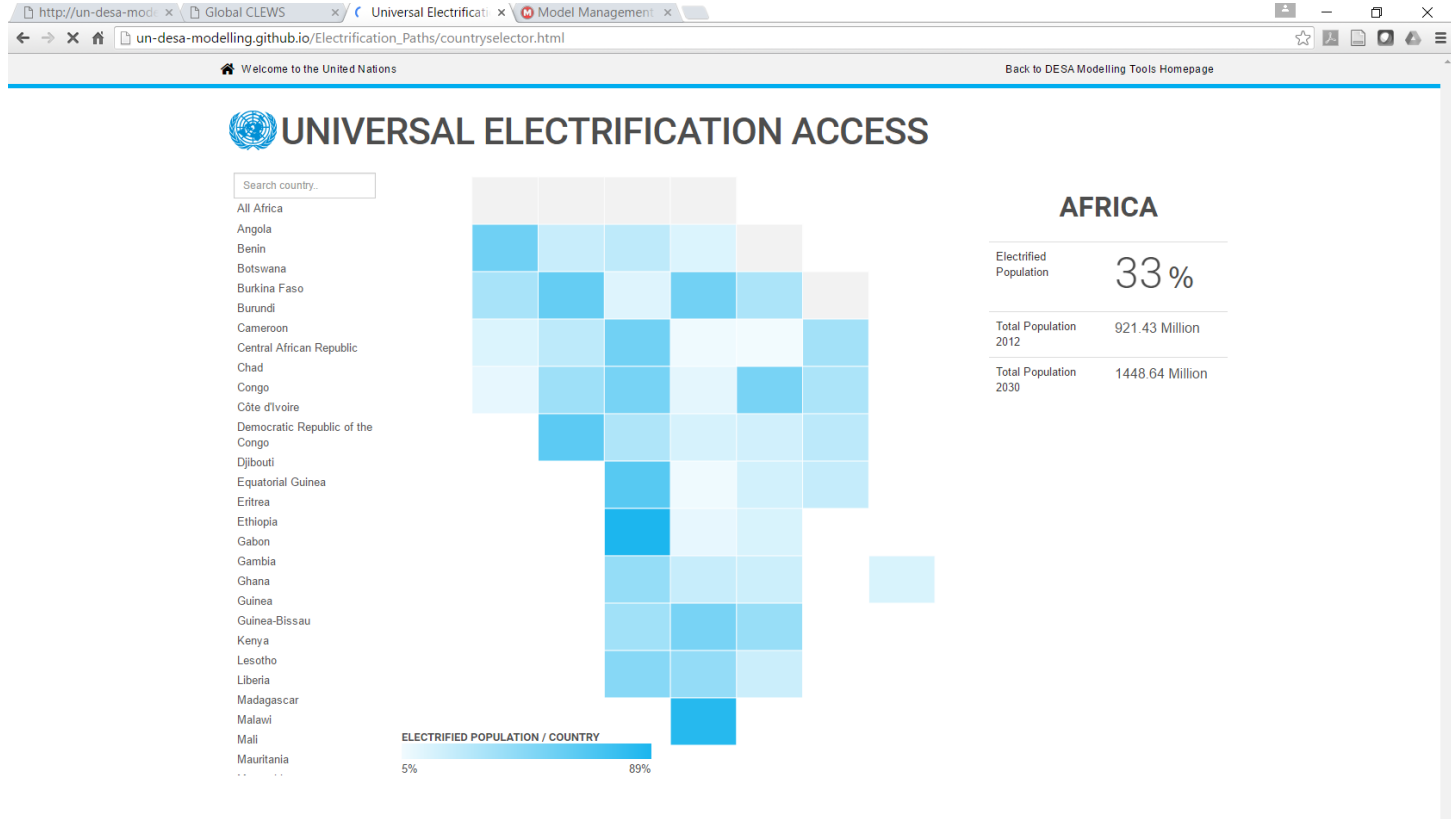
# ONSSET – GIS APPLICATION, ASIA

## Available maps:

1. Population density
2. Existing Grid Network
3. Travelling times
4. Wind power capacity factor
5. Mini and small hydropower
6. Global Horizontal Irrandiance
7. Least cost Electrification option
8. LCOEs



# ONSSET WEB INTERFACE

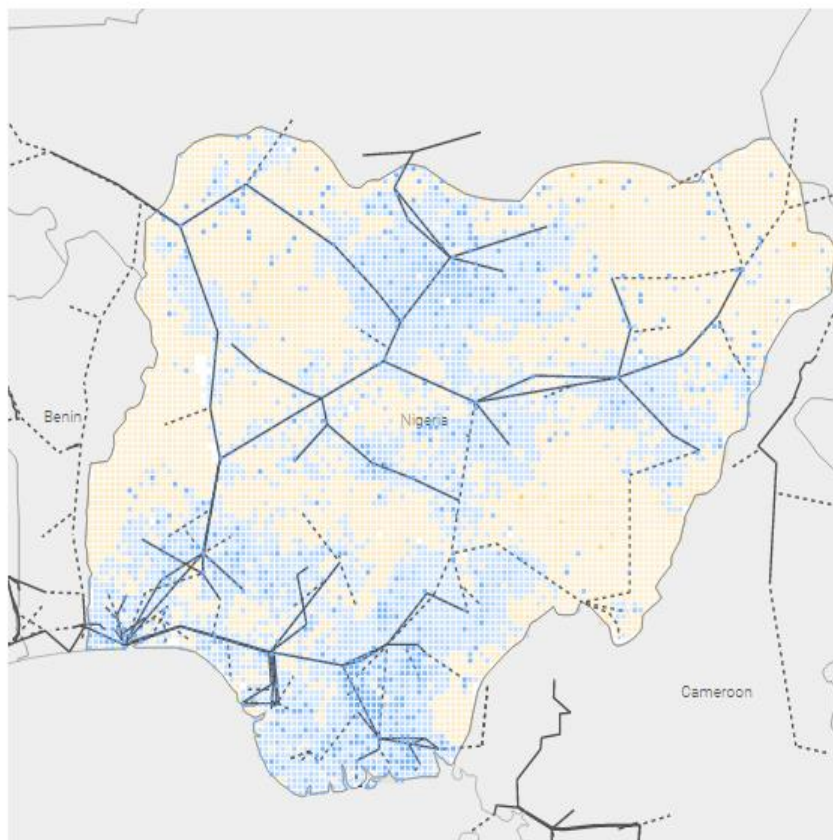


## Diesel Price



## Energy Consumption

kWh/household/year  
Tier 3



## Population / 100 km<sup>2</sup>

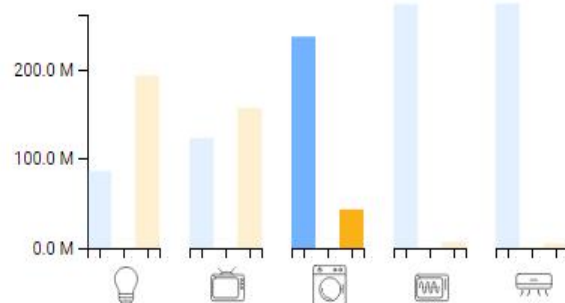


## Transmission Lines



## Population Distribution by Scenario

People to receive electricity (2012-2030) : 262.60 Million People



## Total Cost of Electrification by Scenario

Total cost by scenario (2012-2030) : 66.11 Billion US\$

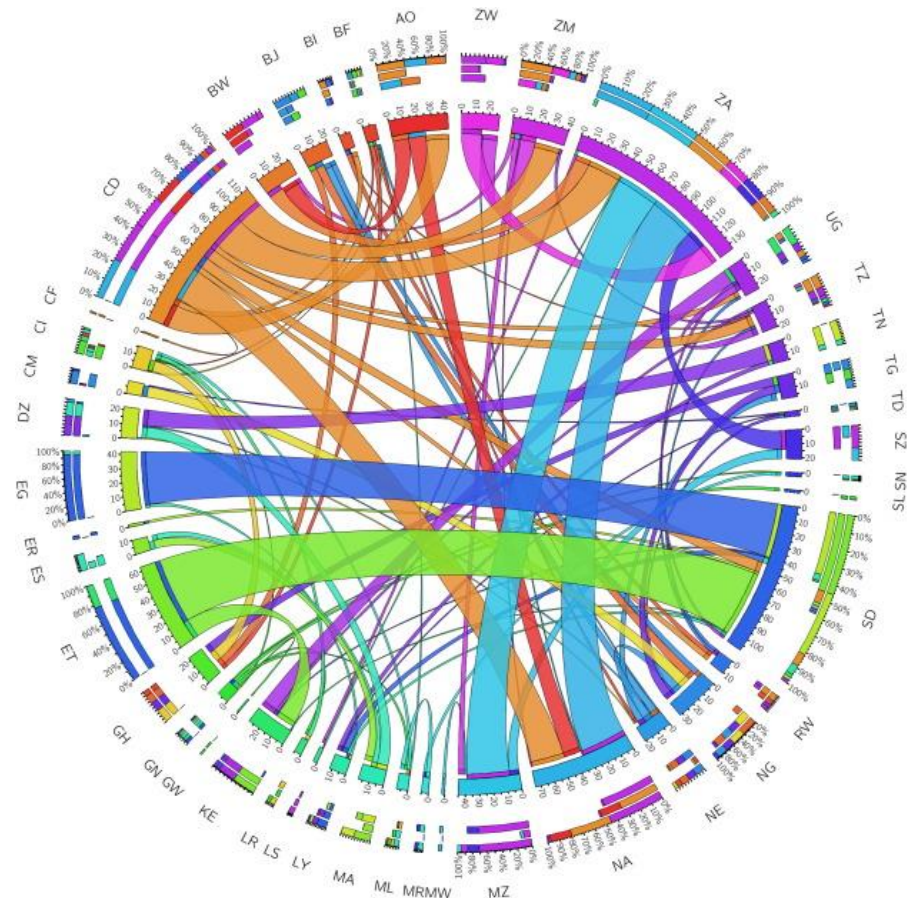


# THE OPEN SOURCE ENERGY MODELLING SYSTEM: OSEMOSYS

**Least-cost, perfect foresight optimization energy model**

**Can be used at different scales, from towns to continents, for supply-demand modelling**

Example results: Evaluation of the role of **electricity trade** across African countries



*Sample results: cross-country electricity trade in Africa in 2040, enhanced trade scenario (Taliotis et al., 2016)*

## WAY FORWARD

All our tools are **open source** and available for use

We are expanding analyses to several **Asian countries**

We can support the **contact with development banks and international organizations** for training and projects

### **Possible partnerships on:**

- Tools application
- Tools transmission

## SOURCES / FURTHER READING

- Fuso Nerini, F. et al., A Cost Comparison Of Technology Approaches for Improving Access to Electricity Services. Energy, 2016
- Mentis, D. Spatially explicit electrification Modelling Insights. PhD thesis, KTH, 2017
- KTH-UNDESA ONSSET online model at: <http://un-desa-modelling.github.io/electrification-paths-presentation/>
- Taliotis, C. et al., An indicative analysis of investment opportunities in the African electricity supply sector using TEMBA (The Electricity Model Base for Africa). Energy for Sustainable Development, 2016