Renewables for African Agriculture:
Integrating Modelling Excellence and Robust Business Models

ONSSET
(OPEN SOURCE SPATIAL ELECTRIFICATION TOOLKIT)

www.re4afagri.africa

LEAP-RE

Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy

RE4AFAGRI

Renewable Energy for African Agriculture

The LEAP-RE project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 963530.

The challenge...

Sub-Saharan African agricultural sector presents challenges

- In sub-Saharan Africa (SSA) about **80% of the agricultural production comes from smallholder farmers**
- **More than half** of the population depends directly or indirectly on **agriculture as their labour and income source**
- Most farmers practice **rainfed agriculture (covering >90% of cropland)**

Rainfed agriculture and **no electricity** in the community

Low **productivity** and **raw crops sold** to wholesale **(lack of cold storage and crop processing)**

Poverty and **inequality** traps, **food** insecurity

Solutions exist with opportunity for development!

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Sustainable **irrigation** and **community-wide renewable electricity**

Increased **productivity** & local **crop processing**

Agriculture as **leverage** for reduction of poverty and inequality

…but *which* solutions are best? *where*? and what will it *cost*?

THE RE4AFAGRI modelling platform

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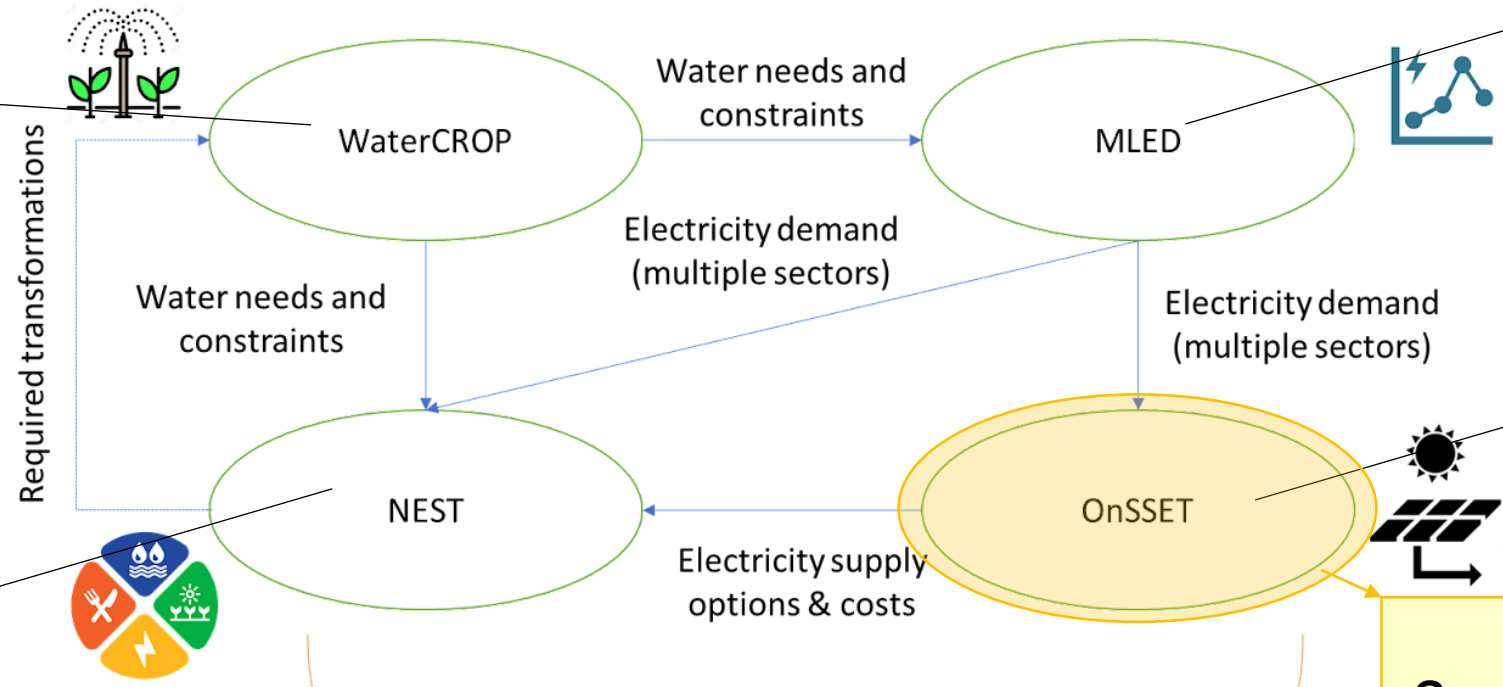
The **RE4AFAGRI platform is a multi-model integrated framework** to analyse deficits, requirements, and optimal solutions for integrated land-water-agriculture-energy-development nexus interlinkages in developing countries. **Four models** representing land-water-crop-food-energy requirements and dynamics *(WaterCROP, M-LED, OnSSET and MESSAGE-NEST)* are calibrated and soft-linked through **the RE4AFAGRI platform.**

Tuninetti et al. (2015)

Falchetta et al. (2021)



Mentis et al. (2017)

Vinca et al. (2020)

10.1016/j.esr.2022.100922

Infrastructure and investment requirements estimated and impact analysis

OnSSET
Ope**n**-**S**ource **S**patial
Electrification **T**oolkit
Focus of this video

Geospatial energy access planning:
data and modelling challenges and opportunities

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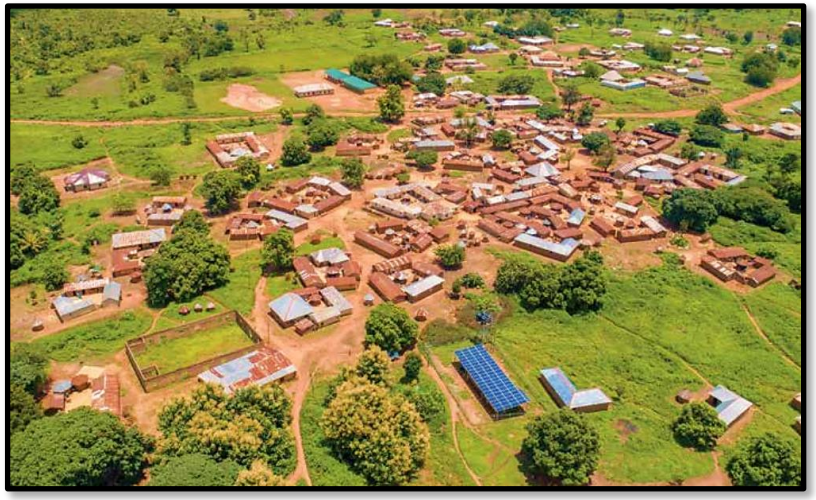


Several supply technology options available:

- Centralized grid extension and generation capacity expansion
- Mini grids with local generation and distribution (various types)
- Standalone systems (various types and sizes)

Multiple data sources and scenarios needed:

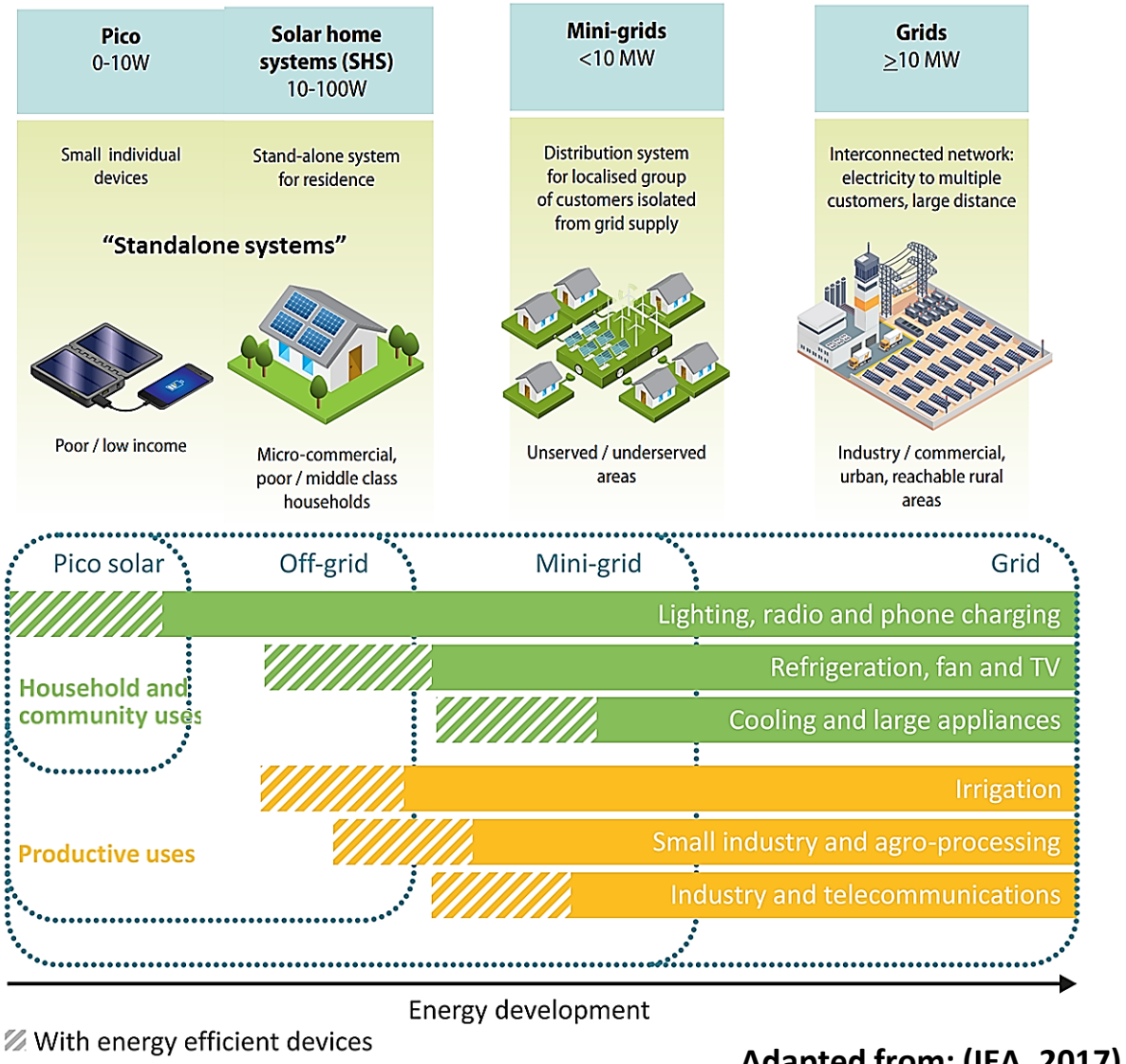
- Population, resources, infrastructure, demand, costs
- In a data-scarce environment
- While planning for scenarios of an uncertain future

New modelling techniques and data:

- Satellite image processing and machine learning have revolutionized possibilities and data availability
- Multi-scale multi-model integrated modelling platforms like **RE4AFAGRI with OnSSET and other soft-linked models**

Options for Electricity Access

- **Centralized grid extension:** and supporting generation capacity expansion
- **Standalone systems:** eg. Solar Home Systems or solar lanterns
- **Mini grids** with local generation and distribution (typically solar, hydro, diesel, wind and hybrids)



Adapted from: (IEA, 2017)

which solution is best? where? How much will it cost?

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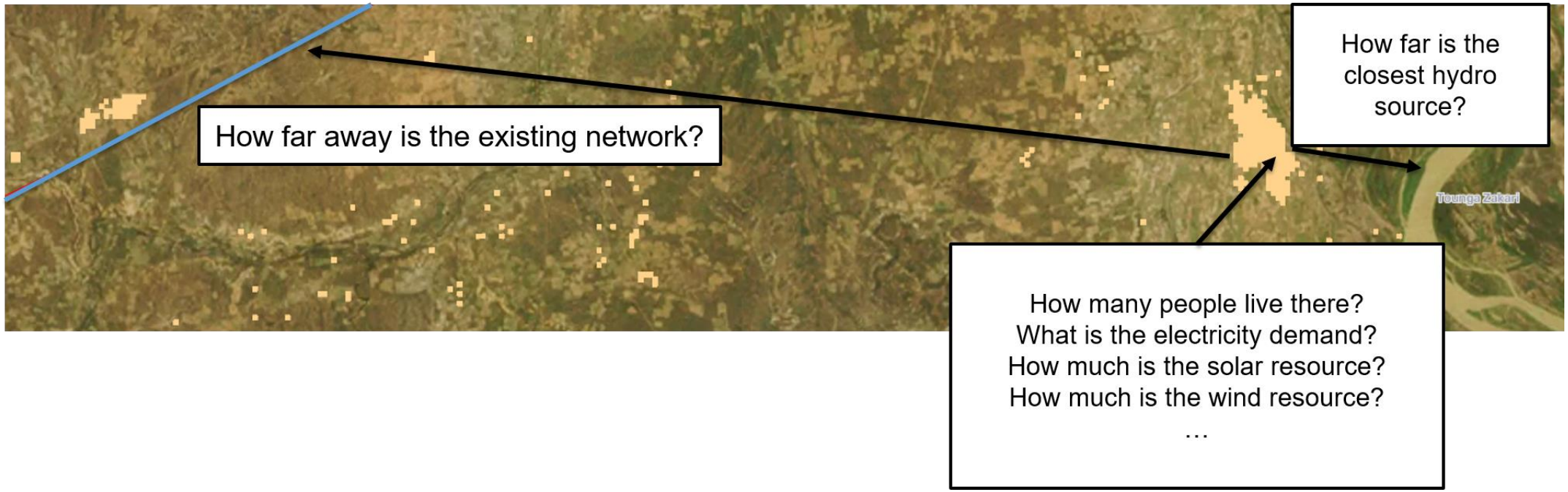
Which technology can produce electricity at the lowest cost?

- Connection to a centralized grid?
- Mini-grid?
- Stand-alone solar systems?

We need to know geospatial information!



KTH VETENSKAP OCH KONST

UNDESA

UNDP
Empowered lives.
Resilient nations.

WORLD BANK GROUP

ABB

iea International Energy Agency

NASA

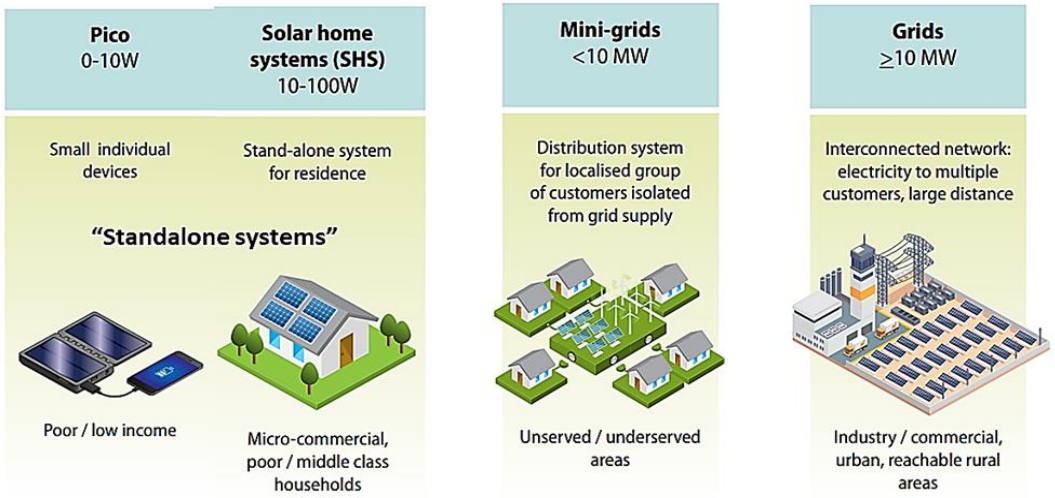
Vetenskapsrådet

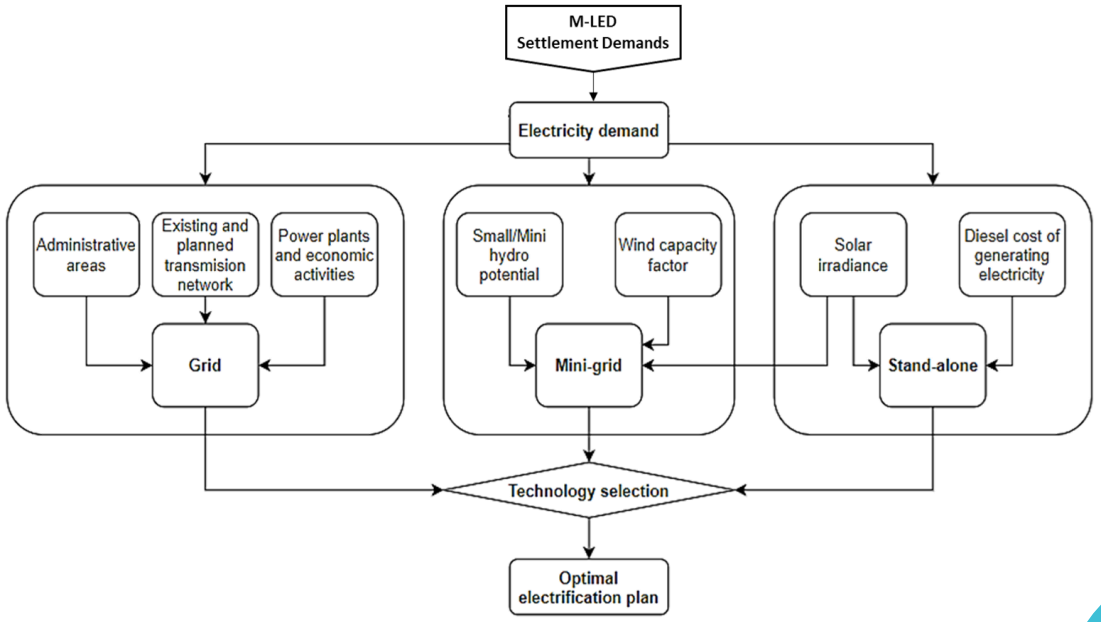
Sida

ESMAP
Energy Sector Management Assistance Program

OnSSET – Open-Source Spatial Electrification Toolkit

OnSSET (the Open Source Spatial Electrification Toolkit) is a GIS-based optimization tool that supports electrification planning and decision making for the achievement of energy access goals. It uses many different geospatial datasets to provide energy access investment insights at the settlement level, including: energy demand, population distribution, energy resources, proximity to energy and transport infrastructure, and all costs and performance parameters of energy technologies.





Different energy technology options for electricity access and their typical end-users

OnSSET is also used by many other organisations including:
World Bank ESMAP – Global Electrification Platform
International Energy Agency – Africa Energy Outlooks & World Energy Outlooks
Many others…

OnSSET used by several major institutions to model energy access options for the future in Africa

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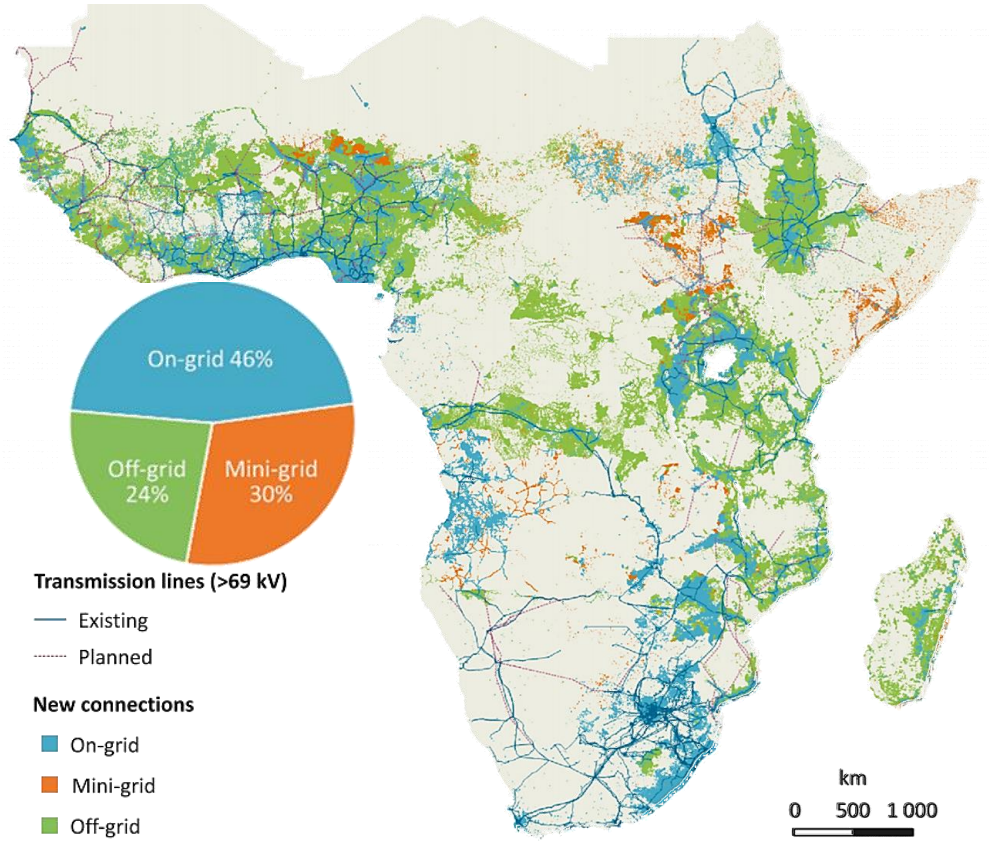
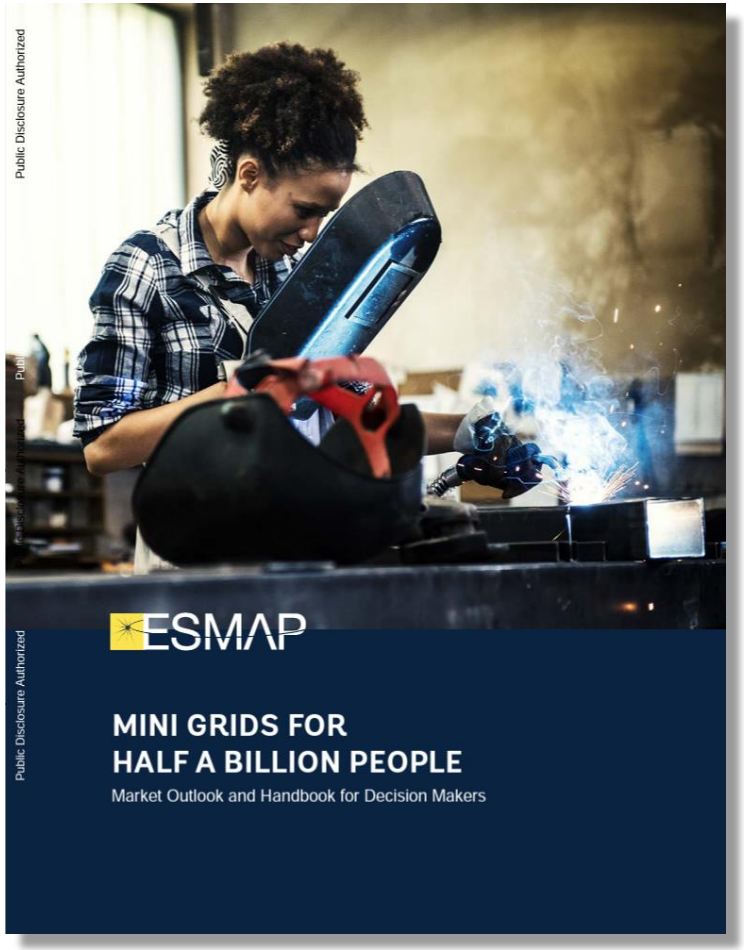
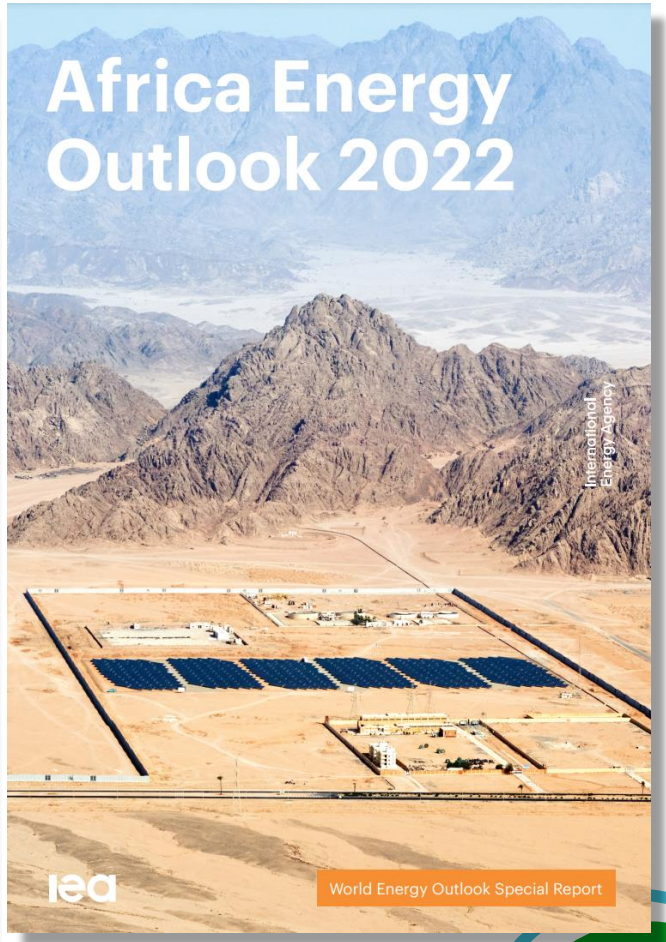
IEA - "Energy for All Scenario" (100% Electrification)







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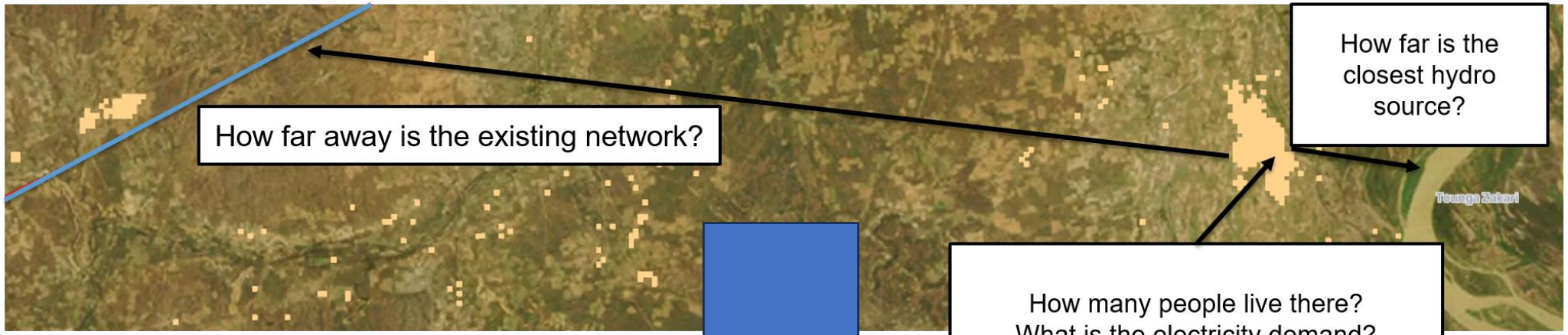
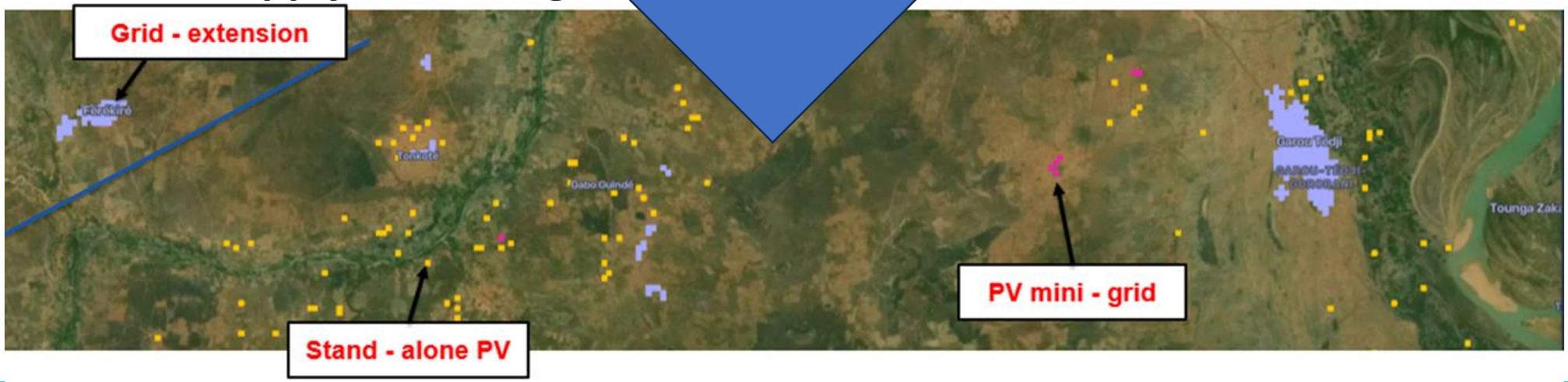
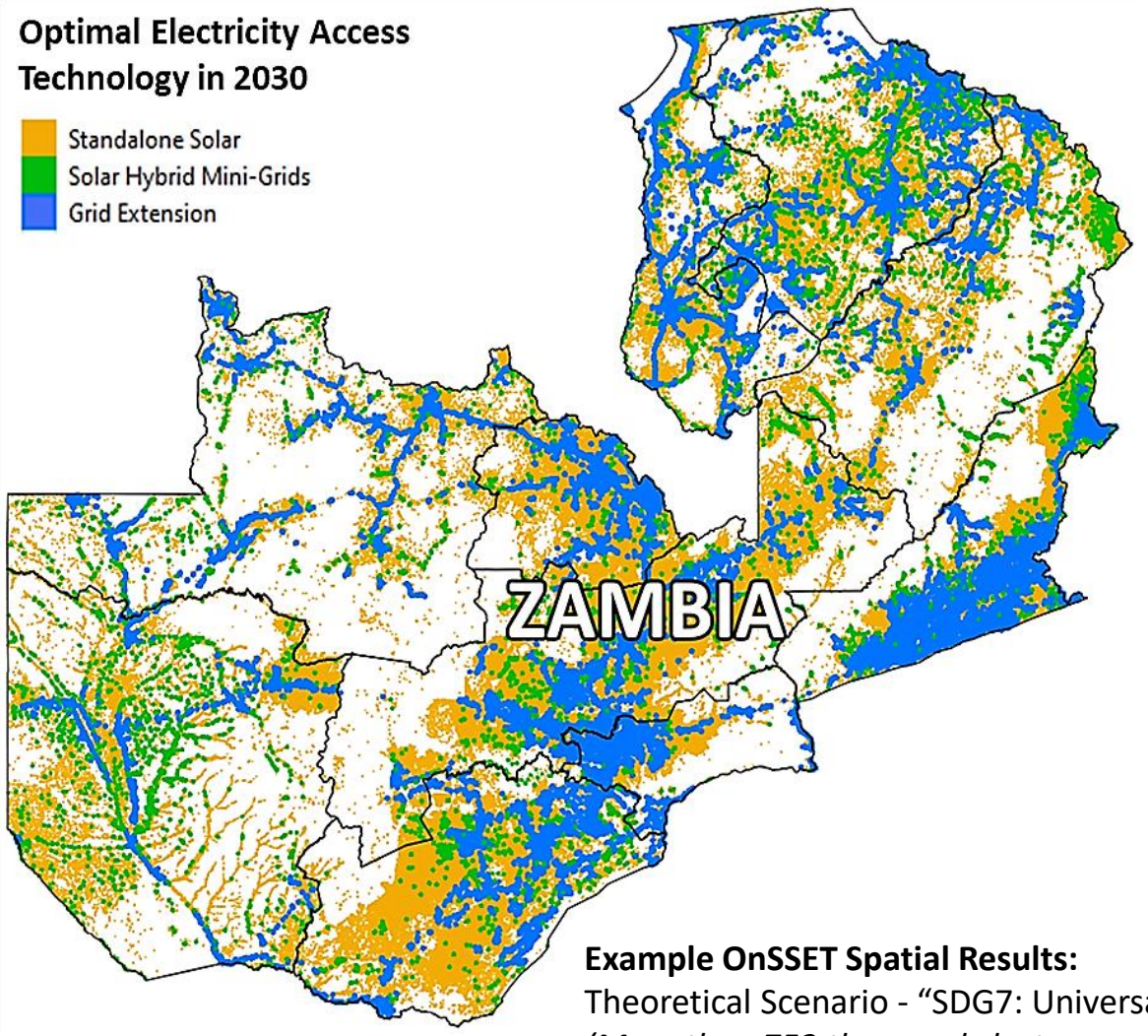


OnSSET Optimization

Geospatial Processing and Least-Cost Supply Modelling…



Mapping and Visualizing OnSSET Results



Example OnSSET Spatial Results:
Theoretical Scenario - "SDG7: Universal Access by 2030"
(More than 752 thousand clusters modelled)

Example Output Mapping - Zambia:

Optimal technology options are mapped for hundreds of thousands of individual population settlement clusters in Zambia. Every cluster has full data of calculated model results.

Blue shows where **grid extension** is found as the cheapest option *per settlement*, **orange** showing **standalone solar systems**, and **green** showing **solar hybrid mini grids**.

Key Model Outputs from OnSSET

Table: Summarized OnSSET modelling calculated output statistics and values available for each location specific population settlement cluster and each technology option

Variable	Description	Unit
Population	The population served by each technology in each cluster, in each year.	people
Electricity Demand	Total electricity demand in the settlement combined from all sectors in MLED. This includes the total theoretical "latent" demand, and demand served if electrified.	kWh
Start year electrification status	OnSSET estimates the percentage of a population cluster that is likely to have electricity access in the start year based primarily on nightlight data coverage of population, but also distances to existing electricity infrastructure or roads if nightlight data is insufficient. These values are calibrated to match national statistics, and for rural and urban areas separately.	% electricity access
New Connections	The number of newly electrified population by each technology in each year.	people
Installed Capacity	The additional capacity required to fully cover the targeted demand in each year.	kW
Investment Requirement	The capital upfront investment required by each technology to reach the electrification target in each year. (Excludes operational costs)	USD
LCOE- Levelized Cost of Energy	The total "all-in" Levelized Cost of Energy expected in each location, for each technology, as calculated by the OnSSET analysis. (Includes operational costs)	USD/kWh

RE4AFAGRI OnSSET - Software and data requirements

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- The **RE4AFAGRI implementation of OnSSET** has been developed and tested on **64-bit Windows 11** connected to the **internet**.
- It is written in the **Python** programming language.
- Detailed **installation instructions are included in the next videos**

Software and Data requirements:

- **Anaconda** as the Python package and environment manager: https://www.anaconda.com/download
- **Install the RE4AFAGRI implementation of OnSSET** by carefully following the installation instructions from **GitHub** at: https://github.com/iiasa/RE4AFAGRI_platform
- **Download** the required **model input data** from **Zenodo** at: https://zenodo.org/communities/leapre_re4afagri
- **More info and help** can be found on the **RE4AFAGRI platform Wiki** at: https://github.com/iiasa/RE4AFAGRI_platform/wiki

*Today in Africa - “The **dark** continent”…*

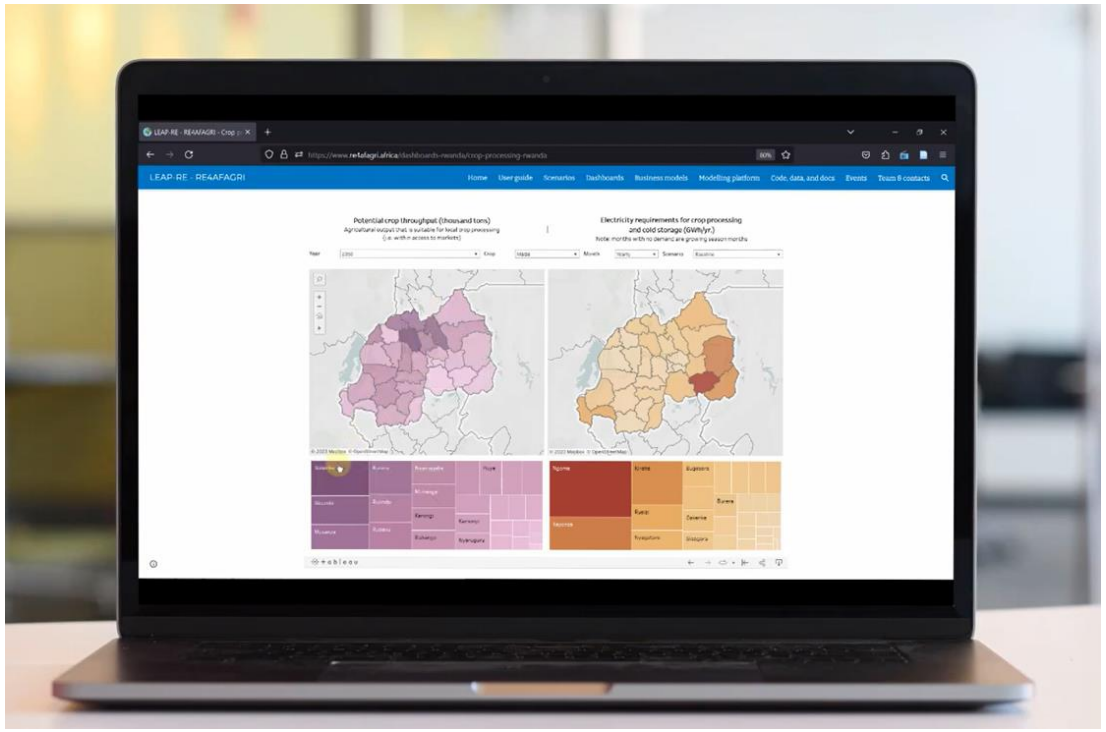
Africa in the future…

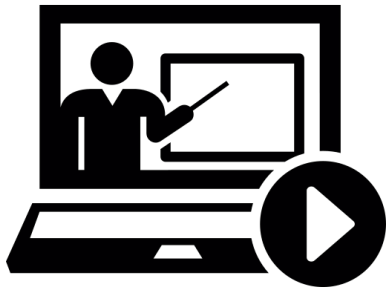
Leading 21st century sustainable *development continent*

source (IEA, 2018) - using OnSSET modelled settlements

OnSSET: extended training videos

Coming up next…





Check out the **extended training videos**:

1. **OnSSET** Software installation procedure video
2. **OnSSET** Model introduction, running and tailoring