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

M-LED

(A «MULTI-SECTORAL LATENT ELECTRICITY DEMAND» ASSESSMENT PLATFORM)

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.

Why assessing electricity demand?

Electricity is a **key condition** to enable socio-economic and human development

A function of:

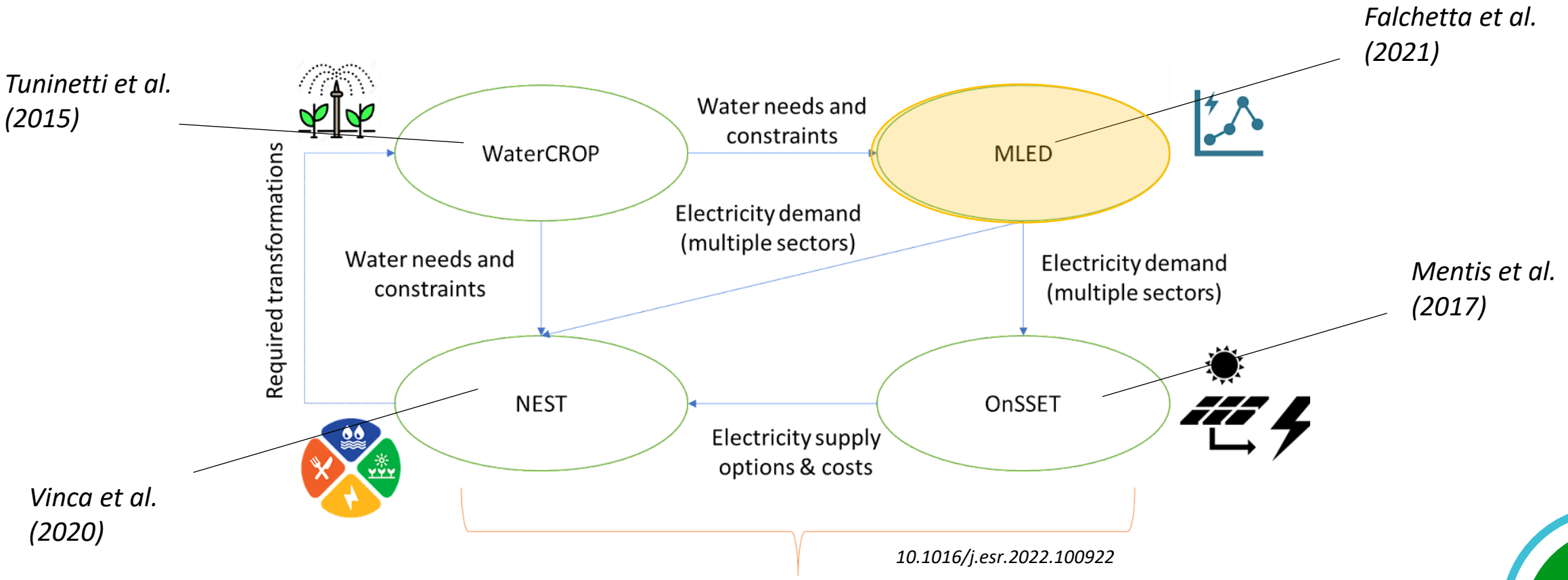
- Different **sectors** (residential, industrial, agriculture, social/public services)
- Different **drivers** (population, economic development and growth, infrastructure availability)
- **Space** -> geography, land, urban/rural, climate...
- **Time** -> seasonality

Tighly connected with:

- Population and socio-economic dynamics (GDP, income…)
- Land-use decisions (agriculture, urbanisation, etc.)
- Water (pumping and supply)
- Climate change (adaptation needs)
- Industrial and development policy (policy pushes)

THE RE4AFAGRI modelling platform

The RE4AFAGRI platform is a multi-model 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.



Infrastructure and investment requirements estimated and impact analysis

M-LED in the RE4AFAGRI modelling platform

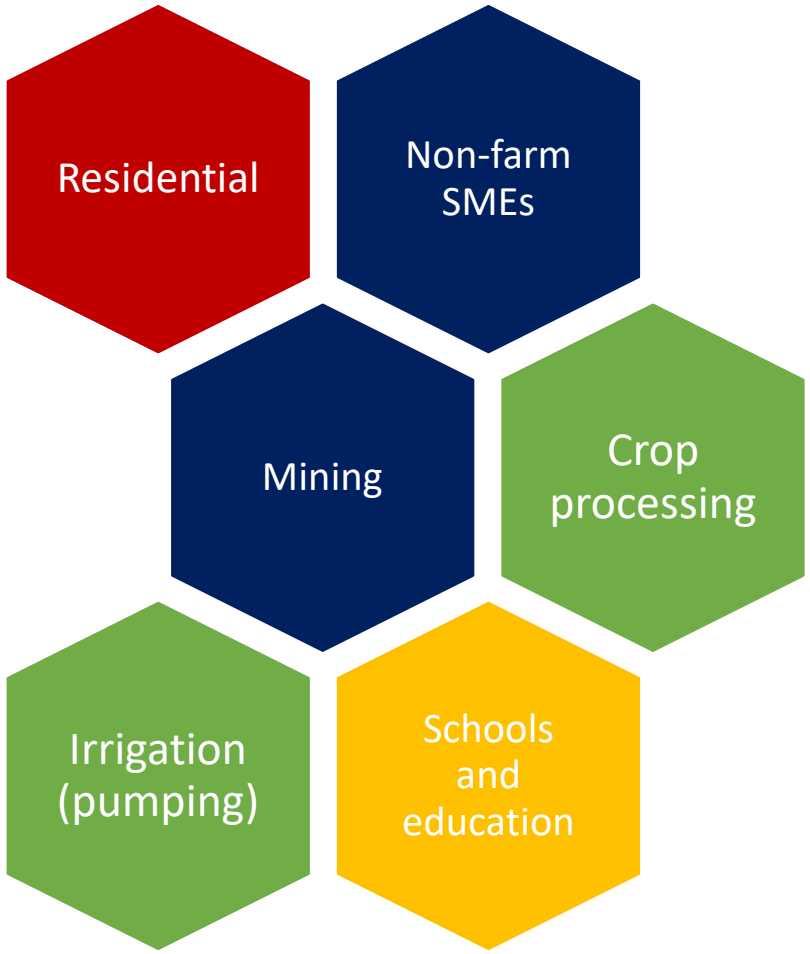
- M-LED is an **electricity demand assessment platform** covering all main demand sectors relevant to electricity system planning, modelling these in high spatial resolution and making **future projections** along different scenarios…

- …while also targeting **communities where currently electricity supply infrastructure and access are lacking**.

- M-LED **methods**:
  - Geospatial data processing algorithms
  - Appliance-based and needs-driven modelling
  - Stochastic variations in electricity demand
  - Scenario logic -> economic, demographic and climate pathways impact on future latent demand

- M-LED **assumptions**:
  - Discussed with a broad array of stakeholder from different countries of SSA
  - Field visits to assess current pattern of appliance ownership and use
  - Literature and needs-driven objectives

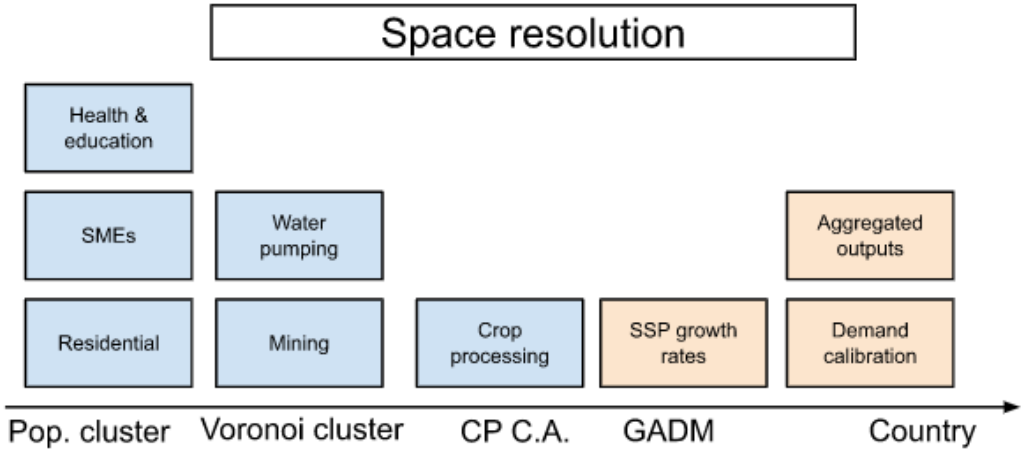
M-LED: Demand modules overview



Six sectors are represented in M-LED

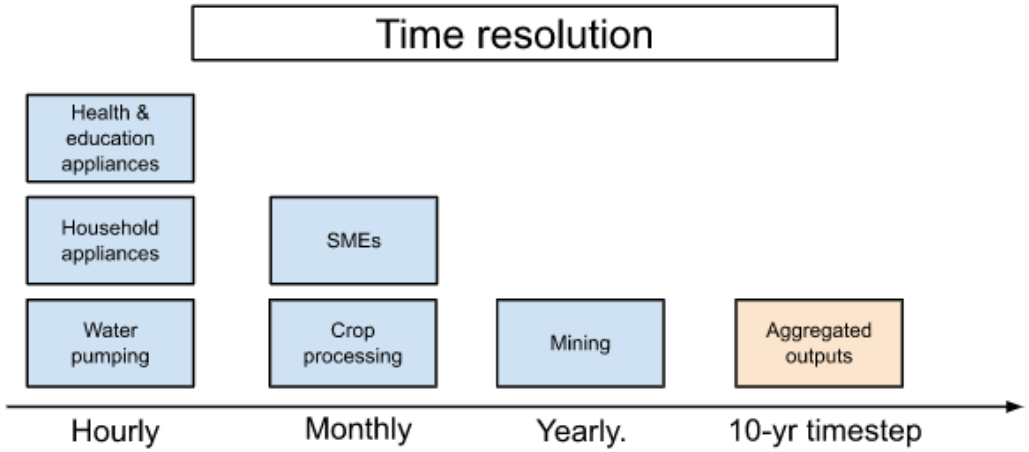
- **Residential** -> household demand of both household who already benefit from electricity access and of households gaining access to electricity in the future
- **Non-farm SMEs** -> commercial activities and small-scale handcraft
- **Mining** -> heavy industry sector
- **Crop processing** -> agricultural load, post-harvest (e.g. Milling) and cold storage of vegetables
- **Irrigation** -> ground and surface water pumping for crop watering
- **Schools and education** -> social infrastructure demand

M-LED: Spatial resolution(s)



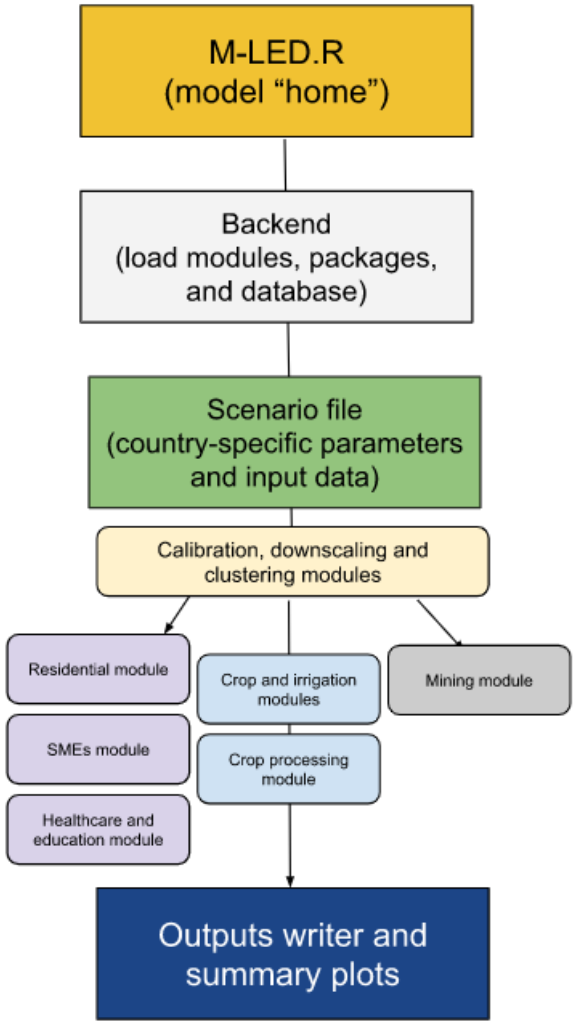
- M-LED is designed to **operate at the country-level** - calibrating current electricity consumption levels with recent national statistics and downscaling them at the local population cluster level.
- As a bottom-up assessment platform, M-LED performs calculations at **the most granular level allowed for by the input data**.
- **Cluster-based output**: clusters encapsulate population settelements and surrounding agricultural land
- **Bottom-up methodology**: output results can both be used at the native local level of analysis - i.e. communities and settlements (also called population clusters) - and be aggregated to produce sub-national or national estimates of trends in electricity demand.

M-LED: Temporal resolution(s)



- **(Hourly), monthly and yearly demand** for each sector -> load curves and seasonality of electricity demand
- Hourly load curves can be generated through the stochastic, appliance-based model **RAMP** for residential, healthcare, and educational appliances (not covered in this course, but link to documentation)
- **Monthly seasonality** is represented for all sectors and a default M-LED output
- **Yearly aggregates (by sector)** are also produced

M-LED: model structure



M-LED has a modular structure, disaggregated into four main types of modules:

1.Backend modules (libraries, working directories, and technical parameters definition)

2.Scenario module (specific to the country in question, also containing the specifics of the scenarios that the user wants to run)

3.Modelling modules (the actual code performing data and model operations to produce electricity demand estimates)

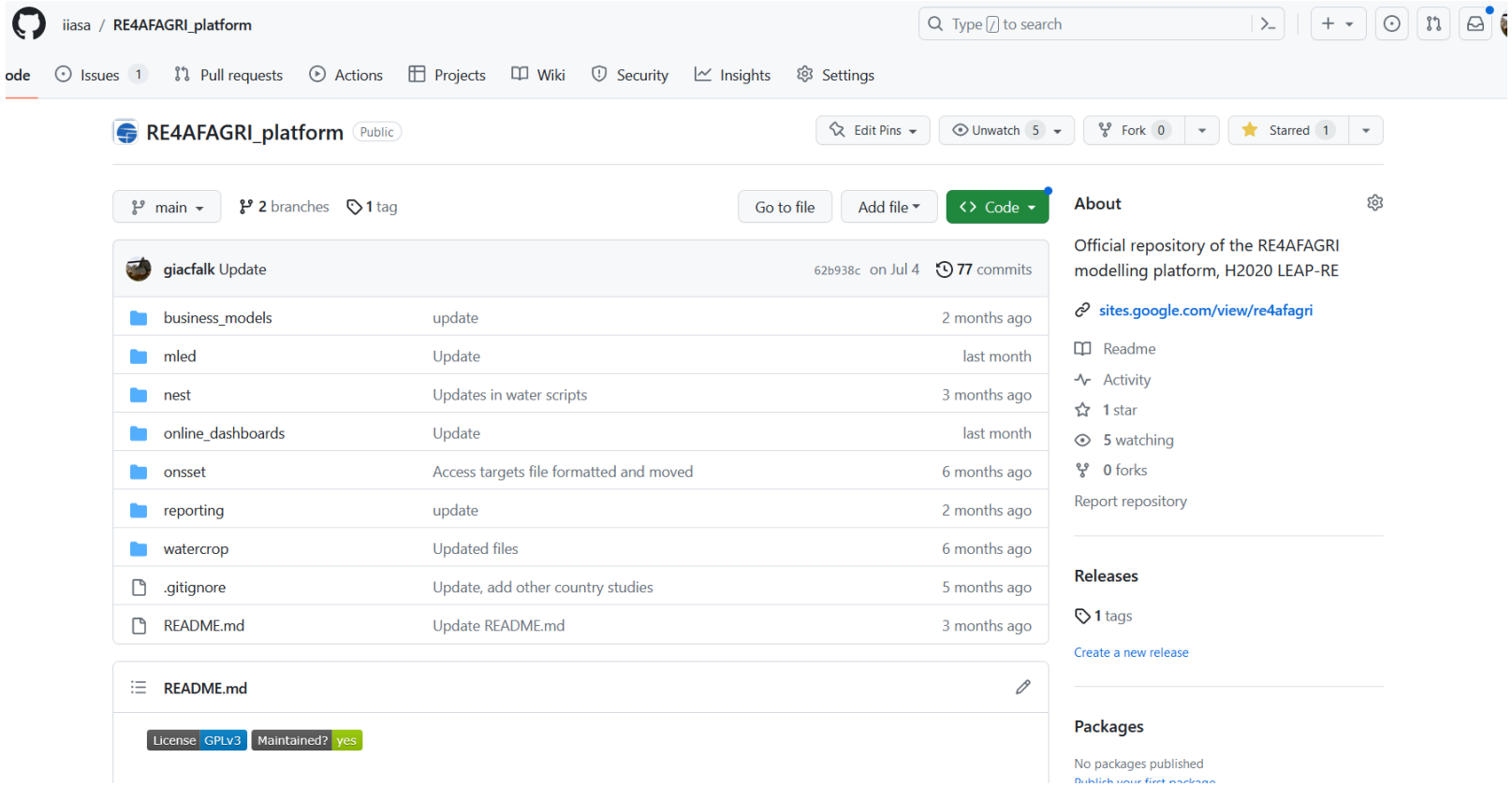
4.Output writing and reporting modules (writing output data and summary csvs and figures)

Software, hardware, and data requirements

- M-LED has been developed and tested in a Windows 11 environment (but can also be run on Linux and MacOS) connected to the Internet. It is written in the R scientific computing programming language.

- Software requirements:
  - Have R (version >=4) installed on your local computer: https://cran.r-project.org/bin/windows/base/
  - Have a recent version of RStudio installed on your local computer: https://posit.co/download/rstudio-desktop/

Accessing the M-LED model source code



The [RE4AFAGRI Github repository] hosts the source code of the [modelling platform], including the M-LED model, which, in combination with the data bundles, allows to run the analysis from scratch with customised assumptions and data, or adapt it to other geographies.

Accessing the RE4AFAGRI platform wiki

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Giacomo Falchetta edited this page on Jun 8 · 21 revisions

Introduction and contents

The RE4AFAGRI platform is a multi-model framework to analyse deficits, requirements, and optimal solutions for integrated land-water-agriculture-energy-development nexus interlinkages in developing countries.

A more comprehensive background on the design and principles behind the RE4AFAGRI platform is found in Falchetta, G., Adeleke, A., Awais, M., Byers, E., Copinschi, P., Duby, S., ... & Hafner, M. (2022). *A renewable energy-centred research agenda for planning and financing Nexus development objectives in rural sub-Saharan Africa*. Energy Strategy Reviews, 43, 100922. https://doi.org/10.1016/j.esr.2022.100922

The platform combines and soft-links four standalone peer-reviewed modelling tools:

- **WaterCROP**: WaterCROP is an evapotranspiration model to estimate the crop water demand by source (rainfall plus irrigation) as a function of the soil moisture available in the soil and the potential for irrigation expansion (by source.

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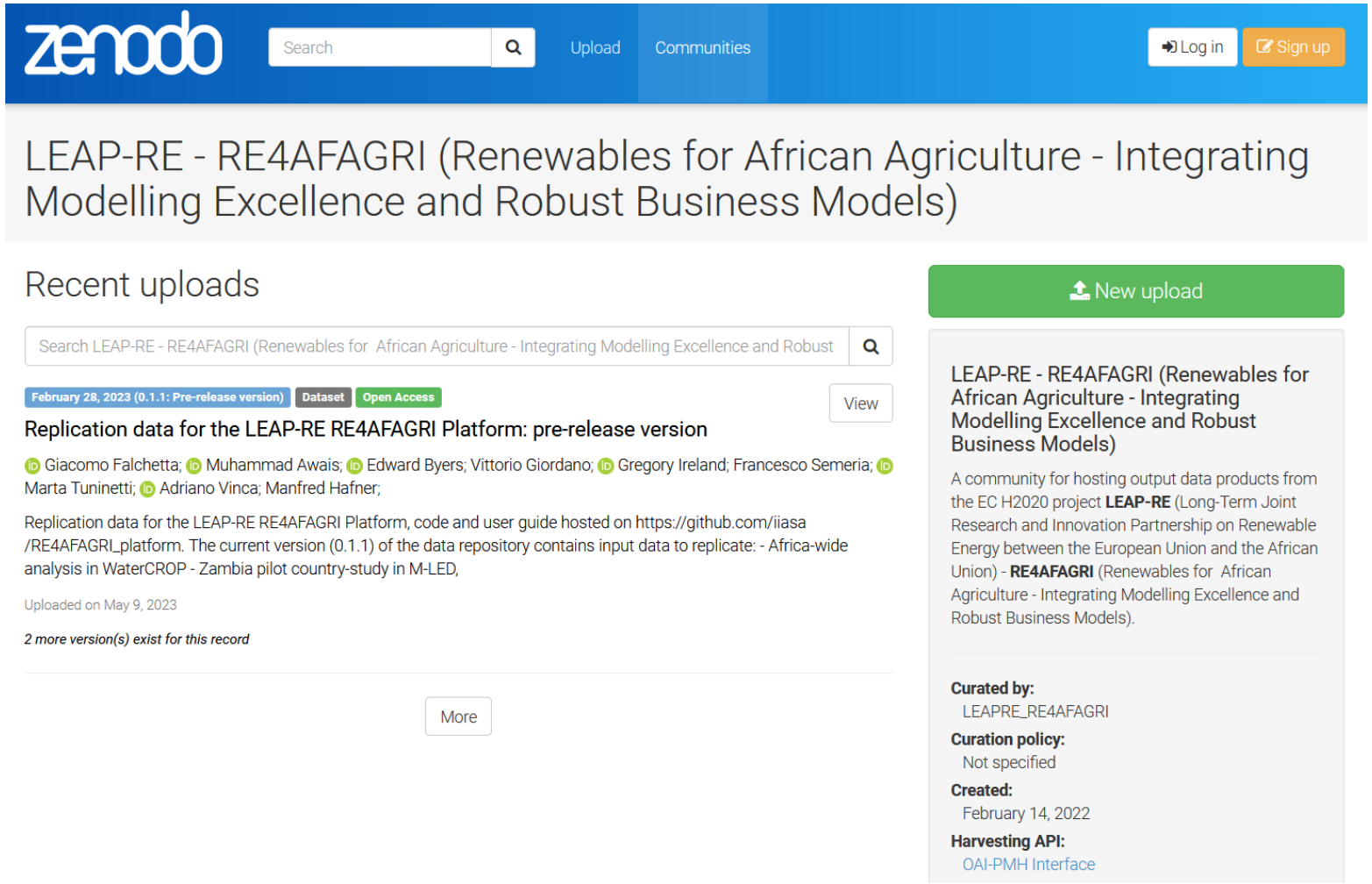
- NEST
- OnSSET

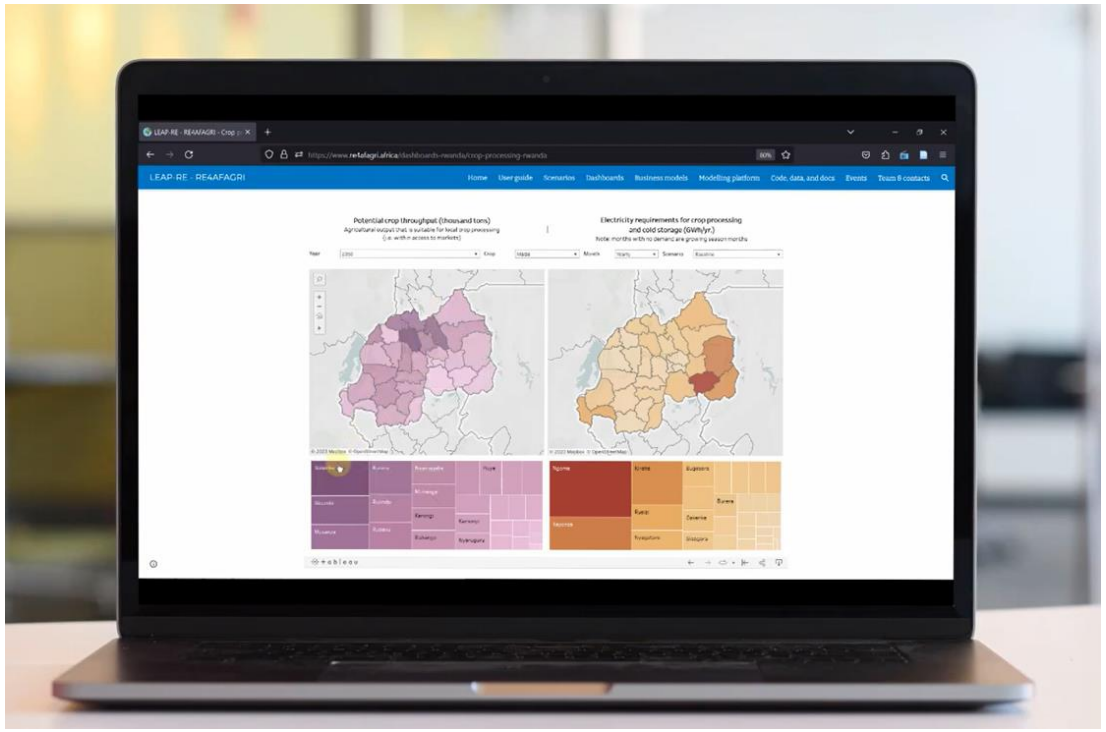
The [RE4AFAGRI Wiki] page hosts the official documentation of the modelling platform, to be used during the RE4AFAGRI capacity building activities, as well as by autonomous users willing to operate their own version of the platform.

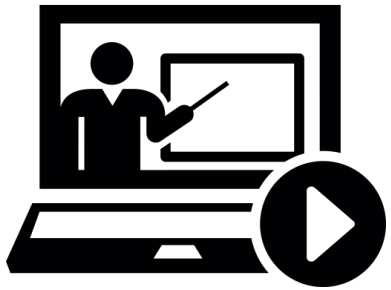
Accessing the M-LED model platform input data



The RE4AFAGRI Zenodo channel hosts both the data products generated as outputs of the modelling platform (visualised in the Dasbhoards) and the original input data to operate the modelling platform and replicate the analysis.

M-LED: extended training videos





Check out the **extended training videos**:

- M-LED Software installation procedure video
- M-LED Model introduction, running and tailoring

Thank you

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