



This brief is the outcome of the “Open Energy System Modelling in Africa: State of the Art and Future Opportunities” webinar, which took place on the 29/04/2021 and can be found under the same name on [YouTube](#).

Open Energy System Modelling in Africa

Headlines

- State of the Art
- Future Opportunities
- PyPSA meets Africa
- Call to Action

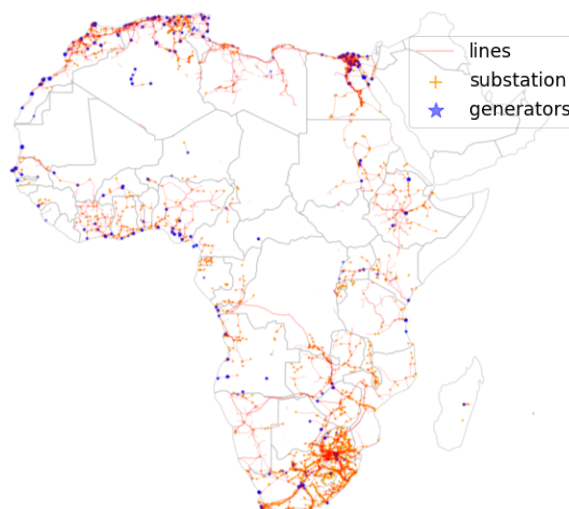
Introduction to Open Modelling

Energy system modelling applications are vast, including for long-term energy system planning, short-term optimisation, supporting least-cost electrification planning and rollout, and in modelling for pathways as part of low-carbon energy transitions. The outcomes from these decision tools can be used to inform policy, strategy and implementation roadmaps that will impact your electricity bill as a household and a business.

Thereby, energy system modelling refers to the computational representation of energy system(s) based on assumptions and calculations relating to human behaviour (e.g., demand needs and consumption), markets (e.g., costs of technologies and infrastructure), energy technologies (e.g., output, suitability) and socio-environmental dimensions landscapes (including topography) [1]. These sets of assumptions and calculations underpin and define outputs of all energy system models.

Open energy system modelling (OESM) refers to source code and datasets which are openly available for use and distribution. Openness refers to openly and freely available code, resulting outputs and interpretations.

Closed or black-box energy system modelling, refers to source code and data that is not published by researchers and institutions. An analyst would provide information into the black-box and get information out, without the power to ever understand the machinery driving outcomes. Black-Boxes are the commercial standard in an energy planning software market valued between \$0.64–1.29B. No equally useful open source alternative is currently available but significant efforts have been underway for some time.



Source: Own data extraction from public data showing high voltage assets. Code is made public by us, [here](#).

[1] Pfenninger et al., Opening the black box of energy modelling: Strategies and lessons learned. Energy Strategy Reviews, 2018.

State of the Art

The power of open models.

- **Increased social welfare.** OESM can lead to increased transparency and improved governance in energy planning and operational decisions. This is especially valid if studies are shared in an open and reproducible manner, potentially billions in infrastructure cost could be saved or be invested elsewhere (opportunity cost).
- **Higher model quality.** By being open and continuously used by industry and researchers, the code can be rigorously reviewed and improved multiple times. Untracked code or data bugs have a hard time surviving which can make open models more robust and reliable.
- **Independent development and speed.** Black-box models depend on a small team of developers with their own vested interest agenda (public and enterprise). It is not common practice to allocate new developers on demand for solving problems or creating new features. In contrast open source models have 'one earth' of software developers that can help build tailored features independently and much faster.
- **Saving license fees and competition.** The user of OESM don't have to pay any license fee. Some enterprises might offer services around the OESM to make commercial processes more efficient or to build capacity and capabilities, however, the open market tends to be more competitive which drives down costs due to competitive forces.
- **Open sea of talents.** Black-box models have a hard time finding new talents for the well hidden complex code and data structures.

Letting people work early in education and research with such open source tools nurtures more talent ready to contribute straight away.

The power of commercial black-box models.

While open models are trending in research because of the previously mentioned reasons, they have not been commercially established. What do they do better? Below we give some thoughts:

- **Reliable business model.** The classical business model of licensing software and offering services around that works. It keeps the company alive, employees employed and usually leads to continuous improvements.
- **Rich in user-centric features.** Closed models are designed to offer solutions for its customers to increase sales. As a result, the range of features that are provided by closed-models are extensive and user-centric.
- **User friendly and support on-demand.** Users of energy models are often not data scientists. Providing clear graphical user interfaces (GUIs) and support on-demand makes commercial closed tools reliable and efficient for its typical users.
- **Trusted legacies.** Widespread adoption of closed tools lead to tremendous amounts of trust and inertia. Users trust in their data, code and produced outputs. It appears that with established trust, users need less evidence - Because all other trusted and established companies are using the same tools and data.

- **Transparency confusion.** Some models are transparent by revealing mathematical equations of the implementation and advertise that by being transparent to jump on the trend of transparency and openness. Although, according to the strict definition, since the source code is not open, these opaque models can be even worse – robbing valuable time of users without contributing much to better understanding model formulations.
- **Education and research.** The relevance of open source increases with the strength and knowledge within the community. Education and research can play a crucial role in the wide spread superior adoption of OESMs by building up an international community of talented developers and users across research and industry.

Introducing “PyPSA meets Africa”

The PyPSA meets Africa initiative is currently developing a high-resolution open energy system model for the African continent based on Python for Power System Analysis (PyPSA). A first prototype will be available at the end of 2021. Our main goals are:

Future Opportunities

The future opportunities in open energy system models (OESMs) are in making the tools more useful and supported for both research and industry. A condensed list of opportunities is given below:

- **Create sustainable open source businesses.** Build an economy where business models with GUIs, support on demand can be offered around the open source model. These can act to be more user centric whilst also improving the open source landscape by keeping the community active, attracting more users and funding.
- **Create industry relevant features.** Open energy models must get applied beyond research to leverage all benefits. Building the same or even more features compared to black-box models is possible but will take time. Estimates are in the range between 1-3 years
- **Build trust.** OESMs could build trust by being able to perform studies where results are benchmarked and provide similar results relative to trusted closed models. Once that is achieved there are not many more reasons “not” to adopt OESMs.
- Introducing a powerful and easy to use open energy system modelling platform for Africa
- Enabling high geospatial and temporal resolution power-flow modelling using beyond state-of-the-art data sources
- Creating a modular and reproducible methodology that can be improved and extended to other parts of the world (scalable)
- Promoting transparent energy policy, research and industry development with strong socio-economic potential in Africa
- Open-source development built on already trusted PyPSA framework

Our current work packages

- WP1 demand modelling
- WP2 existing generator modelling
- WP3 renewable energy modelling
- WP4 land coverage constr. modelling
- WP5 network modelling
- WP6 data creation and validation.

CALL TO ACTION

Institutions

Invest in open source

- **Create** developers and users in your country
- **Support** developers and open source initiatives
- **Adopt** open source tools

This can happen for instance by demanding openness for public funded projects, creating own open source projects that build up on the shoulders of previous work or by using it in education.

Individuals

Join actively an open source initiative:

- Be a developer hero.
- Be an outreach hero.
- Be a finance hero.
- Be a HR hero.

Interested in our PyPSA meets Africa initiative? We would love to hear from you.

Discover more on: <https://pypsa-meets-africa.github.io/>

The “OpenMod initiative” provides also a great forum for like-minded people [here](#).

