

IDP

Migration of the problem-building library of the energy system modelling framework *urbs* for runtime and memory benefits

Background

Energy system models play a vital role in the scientific and political discussion about the future energy systems across the world. To facilitate informed decisions and increase transparency, open software is key. To this end, the open-source energy optimization framework *urbs*¹ was developed at the Chair of Renewable and Sustainable Energy Systems (ENS). *urbs* is a linear program written in *Python/pyomo*, which allows for sector-coupled, multi-nodal and intertemporal energy system sizing and operation optimization.

The upcoming trend towards increased complexity in energy system modelling (ESM) brings along computational challenges. These can be grouped in two: a) possibly superlinear increase in runtime, b) memory (RAM) limitations. While the currently-used *pyomo* library is known for being very intuitive as it allows for flexible definitions of variables and constraints over pre-defined set combinations as indices, its very low computational performance² when writing models to be then read by a solver is very counterproductive when dealing with large-scale models.

This issue has been addressed in the energy system modelling community in several ways. For instance *PyPSA*, another open-source framework, developed an alternative, custom handler ("*nomopyomo*"³) for the solvers, which has then been published as an open-source Python package ("*linopy*"⁴) which can in principle be used by any framework for building optimization models. The runtime and RAM benefits are found to be significant.

Goals

In this Interdisciplinary Project in an Application Subject (IDP) you will work on the following topics:

- Implementing the *linopy* logic into *urbs* for building and writing models as an alternative to *pyomo*
- Conducting test runs to evaluate the runtime and RAM benefits of the updated framework for a set of example energy system models with varying sizes

Requirements

- Good command of Python, OOP and version control

Learning outcomes

By completing this IDP, you will

- gain understanding of energy systems
- get familiar with the model framework *urbs*
- employ your programming experience to an energy-related application
- make a big contribution to tackle the issue of scalability in ESM

Contact

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¹ <https://github.com/tum-ens/urbs>

² <https://stackoverflow.com/questions/51269351/pyomo-seems-very-slow-to-write-models>

³ <https://github.com/PyPSA/nomopyomo>

⁴ <https://github.com/PyPSA/linopy>