EMLabpy-AMIRIS
Energy Modelling Laboratory & Agent-based Market model for the Investigation of Renewable and Integrated energy Systems

Overview - EMLabpy

EMLabpy is an agent-based model (ABM) developed with the purpose of investigating the long-term effects of energy policies. In EMLabpy, the agents are power companies with limited information about the future power system. The investment decisions are based on the expected profitability of candidate technologies. The expected profitability is simulated by another short-term ABM, AMIRIS. This ABM can represent flexible resources, which is essential to integrate a high share of variable renewable energy sources (vRES). Furthermore, it allows to investigate the impact of renewable energy subsidies. The Spine Toolbox is utilized to execute this co-simulation, during which models exchange data and results are saved to structured query language (SQL) databases.

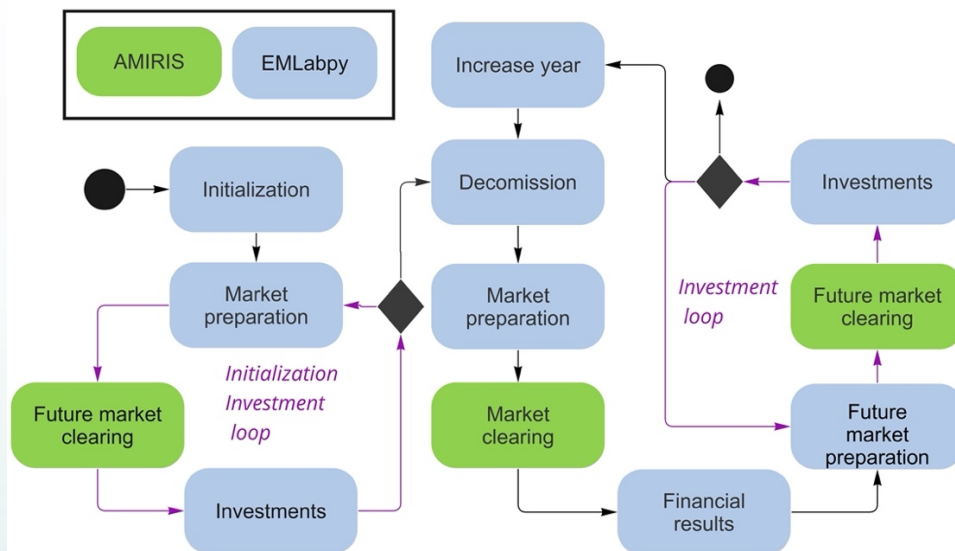EMLabpy is based on the model EMLab: http://emlab.tudelft.nl/.

Workflow

Figure C - 1. Conceptual workflow of EMLabpy-AMIRIS co-simulation.

Figure C - 1 presents a conceptual workflow of the co-simulation where the blocks in blue are executed by EMLabpy and the blocks in green are executed by AMIRIS.

Previous to the yearly loop, an initialization investment loop accounts for the power plants invested previous to the simulation start. Each simulation year (N) the age of the power plants is increased by one year, and their status is updated. Then old and unprofitable plants are decommissioned. In the market preparation step, the operational power plants are filtered and passed into AMIRIS. AMIRIS then clears the market and

the results are saved in the Spine database. Along the simulation, the cash flow of the power plants is registered. In the investment loop, a future market is simulated by selecting the power plants that should be operational in a future year and evaluating potential technologies. The EMLabpy long-term investment module selects the technology with the highest Net Present Value (NPV). This investment loop is repeated until the financial and physical constraints limit any additional investment.

Inputs

The data needed to run AMIRIS is prepared by the EMLabpy modules.

The configuration data can be specified in Coupling config.xlsx. The rest of the data is found in EMLABparameters.xlsx, Power_plants.xlsx, and an Excel with the vRES profiles which can be specified in the configuration Excel (available at https://github.com/TradeRES/toolbox-amiris-emlab/tree/dev/data). Finally, in the exported_Traderes.xlsx, the technology data (investment costs, fixed and variable costs, efficiency) can be updated.

AMIRIS

- Hourly demand (MWh)
- Fuel prices (EUR/MWh)
- Variable costs (EUR/MWh)
- Power plants capacity (MW)
- Power plants efficiency (%)
- Demand (MWh)
- Renewable profiles

EMLabpy

- Yearly revenues per power plant (EUR) from AMIRIS
- CAPEX per technology per year (EUR/MW)
- Fuel prices (EUR/MWh)
- Fixed O&M (EUR/MW)
- CO_2 prices (EUR/ton CO_2)
- Renewable potentials per country
- Emission intensity per technology (tCO_2/MWh)
- Installed power plants
- Capacity mechanisms parameters
- Flexible demand share and willingness to be curtailed (EUR/MWh)

Outputs

AMIRIS

- Yearly revenues per power plant (EUR)
- Hourly production per power plant (MW)
- Hourly zonal price (EUR/MW)

EMLabpy

- New power plants per year (MW)
- Capacity Market Clearing price (EUR/MWh)
- Capacity Mechanisms revenues per power plant (EUR)

How to run it

The Spine Toolbox can be installed following the instructions available at https://github.com/spine-tools/Spine-Toolbox.

The latest code of EMLabpy-AMIRIS can be found in this repository: https://github.com/TradeRES/toolbox-amiris-emlab. Two virtual environments should be created. One to run AMIRIS and the other one to run EMLabpy. Follow the instructions in the readme.md to install all required packages and add the required files and executables as indicated. Verify and adjust the data as needed. Once all the software and data are installed and initialized, the workflow can easily be triggered clicking the play button marked in red (see Figure C - 2).

Figure C - 2. EMLabpy-AMIRIS co-simulation in the Spine Toolbox.

TradeRES
New Markets Design & Models for
100% Renewable Power Systems

Find out more

Chappin, E. J. L. et al. (2017) 'Simulating climate and energy policy with agent based modelling: The Energy Modelling Laboratory (EMLab)', Environmental Modelling and Software. Elsevier Ltd, 96, pp. 421–431. doi: 10.1016/j.envsoft.2017.07.009.

EMLab general purpose description: http://emlab.tudelft.nl/.

Latest EMLab source code: https://github.com/ejlchappin/emlab-generation2.
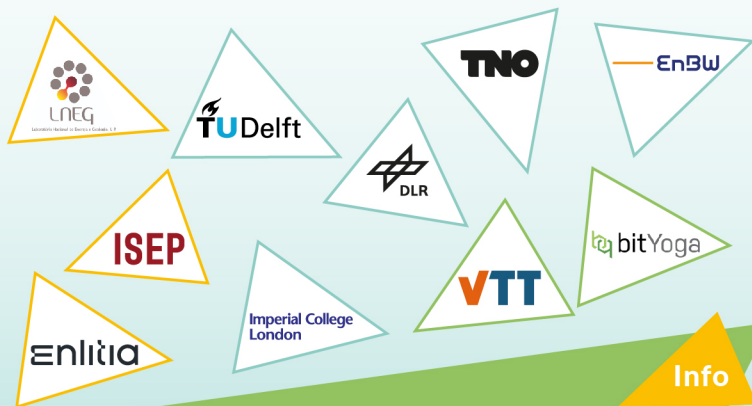
EMLabpy–AMIRIS implementation: https://github.com/TradeRES/toolbox-amiris-emlab.

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Info

The TradeRES project will develop and test innovative electricity market designs that can meet society's needs of a (near) 100% renewable power system. The market design will be tested in a sophisticated simulation environment in which real-world characteristics such as actors' limited foresight into the future and risk aversion are included.

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1 February 2020

End date
30 November 2024

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