EMLab

Energy Modelling Laboratory

Overview

EMLab is an agent-based model (ABM) developed with the purpose of investigating the long-term effects of climate and energy policies. In contrast to optimization models, ABMs are programmed according to decision rules given a certain context. In this ABM, the agents are power companies with limited information about the future system that make imperfect investment decisions. The investment decisions are based on the expected profitability of possible power plants in the future. Hence, it requires clearing the market multiple times in every simulation year. EMLab can simulate a CO_2 market and capacity mechanisms (CM) such as strategic reserve and capacity market.

As flexible resources will characterize the future power system, this research consortium's goal is to consider the elastic demand, storage options, and sector coupling along with some market designs. For this purpose, it is indispensable to simulate an hourly unit commitment. The original EMLab uses a segmented load duration curve and therefore doesn't enable the analysis of added flexibility, so it will be soft-linked with models that have a more detailed short-term market.

The original EMLab was developed in Java as a standalone model. The modules are controlled with a scheduler, and it is not possible to interrupt the calculation to extract values. For this reason, the algorithms are being rewritten into separate Python modules, and these modules will be referred to as EMLab-py.

Workflow

EMLab-py – AMIRIS soft linking

To analyze the role of flexibility, EMLab-py will be soft-linked with AMIRIS. This is an ABM focused on the simulation of short-term markets. In AMIRIS, the market-clearing and the renewable energies support calculations will be executed. Subsequently, the CO2 market and the capacity mechanism will be triggered in EMLab-py. Besides the capacity market, a strategic reserve and capacity subscriptions will be considered for the capacity mechanisms.
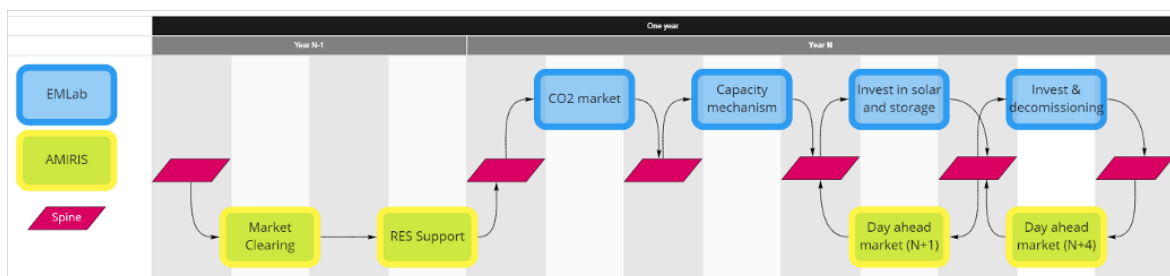

Figure 1 EMLab-py AMIRIS soft coupling workflow

Finally, the short-term investment algorithm of EMLab-py will trigger multiple iterations of AMIRIS market-clearing one year ahead of the simulation year (N+1). This short-term investment will represent the decision of installing technologies that have shorter building times and that can be profitable if these are quickly commissioned. Similarly, a long-term investment will trigger market-clearing iterations four years ahead (N+4). The optimal results will be added in the power mix considering the building time per technology.

EMLab-py – COMPETES soft coupling

See the Competes – EMLab section.

Inputs

This data is limited to the data that will be transferred between both models.

Amiris

- Hourly demand (MWh)

- Fuel Prices (Eur/MWh)

- Fixed O&M (Eur/MW)

- Demand (MWh)

- Yield profiles

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- Yearly revenues per power plant (Eur) from spot market and from RES support, one and five years ahead

- Banked allowances (ton CO2)

- Yearly unit emissions per power plant (ton CO2)

- CAPEX (Eur/MW)

- Fuel Prices (Eur/MWh)

- Fixed O&M (Eur/MW)

Outputs

Amiris

- Yearly revenues per power plant (Eur)

- Hourly production per power plant (MW)

- Renewable support per power plant (Eur)

- Hourly nodal price (Eur/MW)

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- CO2 prices (Eur/ton CO2)

- Capacity Market Clearing price (Eur/MWh)

- New power plants

- Capacity Mechanisms revenues per power plant (Eur)

How to run it

EMLab-py – AMIRIS

Currently, the EMLab-py – AMIRIS soft-linking is under development and the instructions to run this soft coupling will be reported in the final version of this Deliverable. The latest code can be found in this repository https://github.com/TradeRES/toolbox-amiris-emlab.

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 code: https://github.com/ejlchappin/emlab-generation2

EMLab-py – 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
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