Can an Energy Only Market (EOM) enable Resource Adequacy in a nearly 100% Renewable Power System?

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Motivation and research question

An energy transition implies an evolving capacity mix that creates a long-term economic disequilibrium. Modelling investment decisions with an agent-based model (ABM) allows the evaluation of the capacity expansion if energy producers would invest based on estimated profits with limited knowledge about the future [1]. With the recent RepowerEU plans, the phase out of fossil fuels is accelerating towards a nearly 100% renewable energy system. Departing from an optimal, nearly 100% renewable capacity mix in the Netherlands, we explore whether an EOM provides enough incentives for investing further in renewable capacity and for covering the costs of the power plants.

Method

To answer this question, we apply soft-coupling of two ABMs with the Spinetoolbox [2], an application that enables the execution of complex simulations tasks in sequence and parallel. This way, the investments can be modelled with EMLab-py and use the dispatch results from another ABM, AMIRIS. EMLab-py is a new python model inspired by EMLab [3], an ABM that investigates the influence of various policies on generation investments. AMIRIS [4] is a model that allows the effect evaluation of policies in the electricity market. Figure 1 shows an overview of the conceptual workflow in Spinetoolbox, which is executed in a yearly loop.

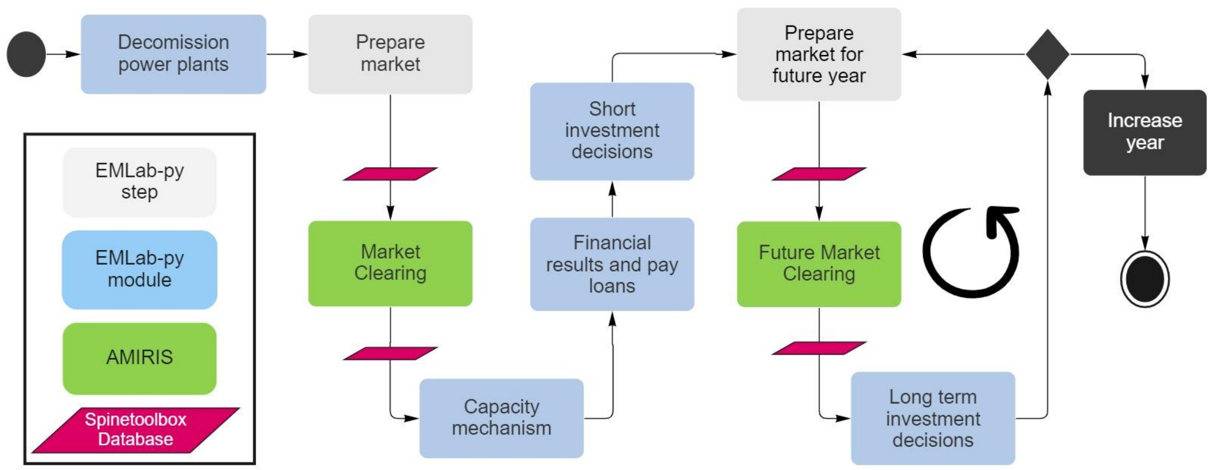

Figure 1 Conceptual soft-coupling EMLabpy-AMIRIS

For the first simulations, the inputs for the initial year 2050 are taken from the resulting capacity mix of COMPETES [5]. This is a power system optimization and dispatch model that covers all European Union (EU) Member states and some non-EU countries. Under these conditions, we calculate the supply ratio, the expected energy not supplied (EENS), the loss of load expectation (LOLE), and the market-based cost recovery.

Results and Conclusions

Here, preliminary results of the validating simulations are presented. Investments in wind offshore and solar energy were not profitable and therefore not installed at the scale that these

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are planned, according to the Dutch national plans (Fig. 2a). The share of RES on the energy demand was maximum 62% (Fig. 2b). The market-based cost recovery (Fig. 2c) suggests that in a future market with an increasing demand, energy producers could recover their costs only after 2045. The LOLE (Fig. 2d) indicates that the standard reliability of 3 – 8 hours/year would not be fulfilled for all years. So far, a single simulation was executed with fixed costs and the country was modelled as an island.

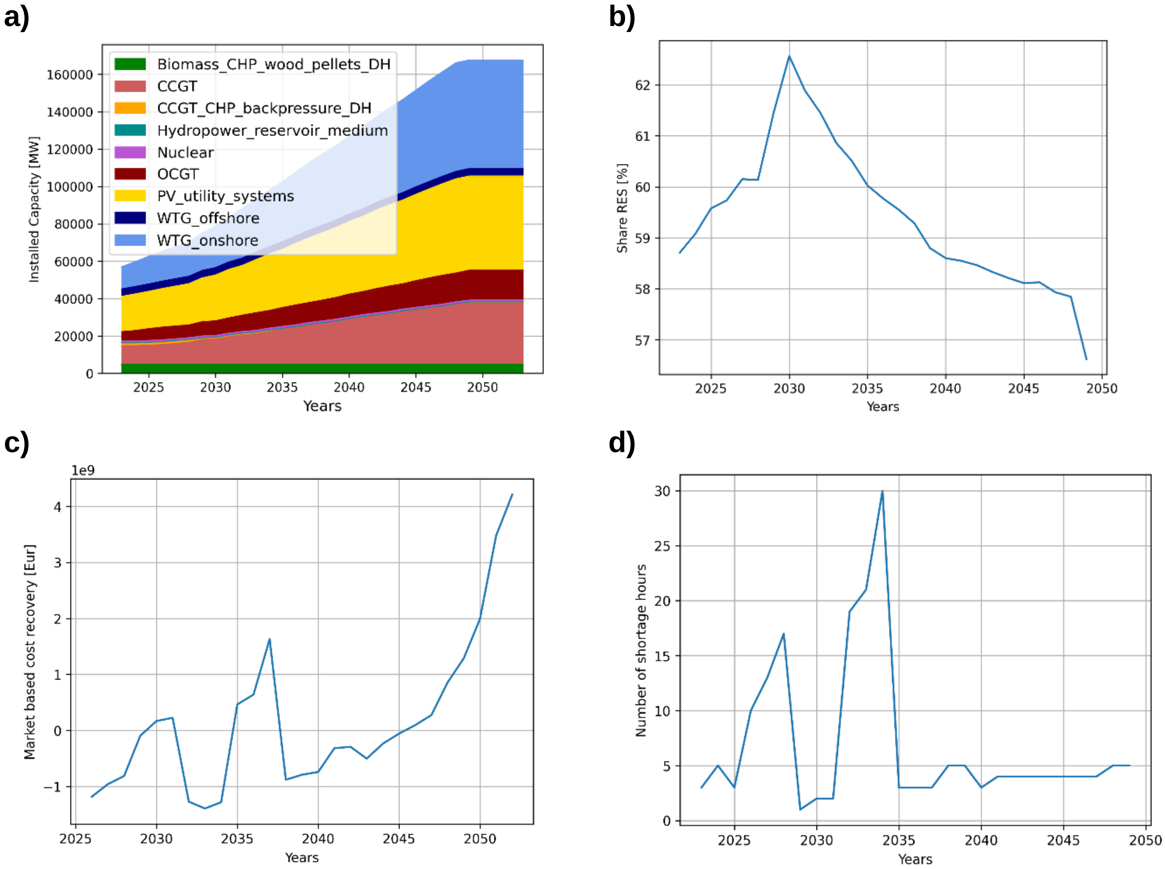

Figure 2 Results of the EMLapy-AMIRIS soft-linking a) Installed capacity b) Share of RES c) Market-based cost recovery d) Loss of Load Expectation

Further work will consider physical limitations of the technologies, decreasing technology costs, and increasing CO_2 and fuel costs. The initial simulations will run from a nearly 100% power system. Next, the transition towards 100% RES will be analysed with a stochastic growth rate of the demand.

Literature

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