

EMLab-Generation Factsheet

Purpose

The **main purpose** is to explore the long-term effects of interacting energy and climate policies by means of a simulation model of power companies investing in generation capacity. With this model, we study the influence of policy on investment in the electricity market in order to explicate possible effects of current and alternative/additional policies on the various sector goals, i.e. renewables targets, CO₂ emission targets, security of supply and affordability. The methodology, agent-based modelling, allows for a different set of assumptions different as to the mainstream models for such questions: this model can explore heterogeneity of actors, consequences of imperfect expectations and investment behaviour outside of ideal conditions.

Model overview

EMLab-Generation is an agent-based model of **two interconnected electricity markets**. These may be two countries, such as the Netherlands and Germany, or two groups of countries, for instance the UK and Continental Europe. The two markets are linked by an interconnector.

Various **power companies** are modelled as the main agents. They bid into a power and they invest based on the NPV of prospective power plant investments. Power companies invest in various technologies, using scenarios from the IEA World Energy Outlook 2011.

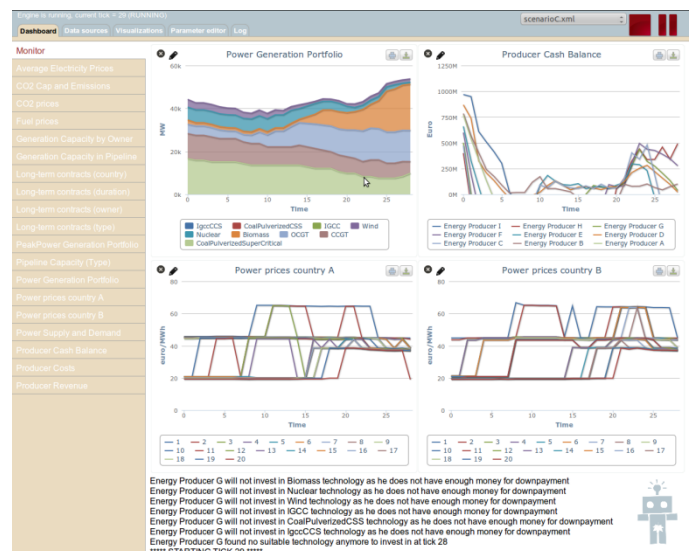
Load is represented as a load-duration curve divided into 20 segments, thus reducing the simulation time and enabling us to do Monte-Carlo simulations of the entire model.

Various **energy and climate policies** are implemented. The EU ETS is modelled according to the EU 2050 roadmap. An optional price floor is modelled as a complementary tax (as implemented in the UK) in either one or both countries. A gradually increasing, optional CO₂ tax is implemented and exogenous subsidized renewable investors that invest according to renewables targets, which are a linear extrapolation of the national renewable energy action plans.

A **scenario** is implemented that contains demand and fuel prices modelled as stochastic trends based on Matthes (2010).

Methodology

In an **agent-based model**, actors are modelled as individual agents who make autonomous decisions. In that sense, energy producers are modelled as separate agents and each of those decides on their own investments.



Agents **interact** through markets and therefore, their decisions influence each other over time. For example, an investment decision is based on expected power prices, which are, in turn, affected by past investments. All decisions together determine the **system-wide developments** and performance. For example, electricity prices are influenced by the bids of individual players in the market, which are based on their generation portfolio.

An agent-based model is conceptualized as a **script** of behavioural modules of agents; a basic set of power generation modules are implemented to make such scripts. The model simulates future decades of the power sector under customizable **scenarios** containing sets of agents, data sources, and behavioural modules. The model uses an open source Agent-Based Modelling platform AgentSpring, which enables a **web-based** user interface, runs on Linux, Mac and Windows, and headless mode for large-scale simulations. This enables to look at and discuss individual runs (see figure above), but also to look at multiple runs. These Monte-Carlo simulations are a step towards capturing a larger degree of uncertainty (e.g. fuel price developments) in the model that is a key characteristic of the development of a power system.

Conclusion & further reading

EMLab-Generation offers an entirely **new way** of modelling policy effects in electricity markets. It may provide insight in actor and system behaviour over time, i.e. investment cycles, abatement cycles, delayed responses, effects of uncertainty and risk upon investment decisions. It is possible to simulate cross-border effects of national policies, interactions between policies and capacity mechanisms. Developing agent-based models is time-consuming and therefore costly. However, we see the need for agent-based modelling in addition to existing approaches in order to explore the various types of insights that can be gained with each of these paradigms, and to confront each model with other assumptions.

The model is **open source** and can be accessed online. Please see <http://emlab.tudelft.nl/generation> and <https://github.com/emlab/emlab-generation>.

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