

PowerACE from a computational view

Agent-based electricity market model

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Introduction

PowerACE simulates the European day-ahead electricity market in hourly resolution for several years into the future with bidding agents for demand and supply. The model integrates an endogenous calculation of investment decisions for conventional power plants by the operating agents.

Outputs & results

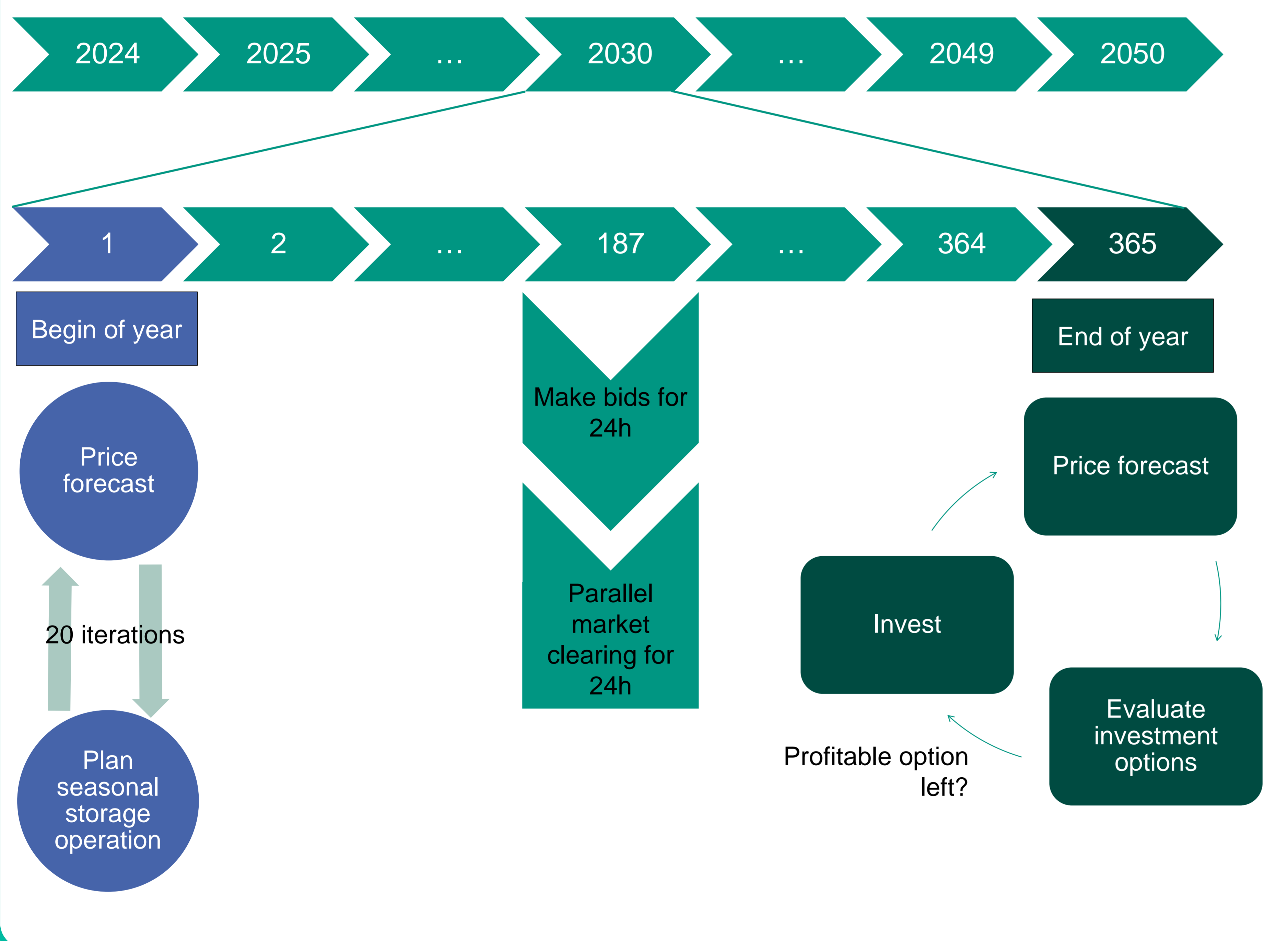
PowerACE can be used to simulate various energy policies and economic scenarios in the medium and long term. Effects and shocks on electricity prices, the expansion activity of conventional power plants by market players or national security of supply can be analyzed. In addition to the bottom-up view on several European countries, detailed results regarding effects on national electricity markets are available.

Current work & future implementations

Robustness: Due to the increasing number of fluctuating generation units such as wind and PV, it is important to better represent these uncertainties in the model. Sensitivity analyses provide a straightforward approach to achieve this. This also allows for the investigation of different climate change scenarios.

Methodology: To better represent flexibilities, such as storage systems, so-called complex bids will be integrated, which lead to larger linear problems. Simultaneously, bidding behavior will be enhanced through reinforcement learning to more accurately model indifferent agents. By implementing neural networks for price forecasting, the difference between the price forecast and the final market prices within the market simulation is reduced as well as the computation time.

Simulation process



General parameters

- JAVA Code
- Simulation run-time between 15 hours and several days (Intel® Core™ i9-10980XE CPU, 18 cores with 3,75 GHz)
- Up to ~240 GB RAM
- Several linear programs:

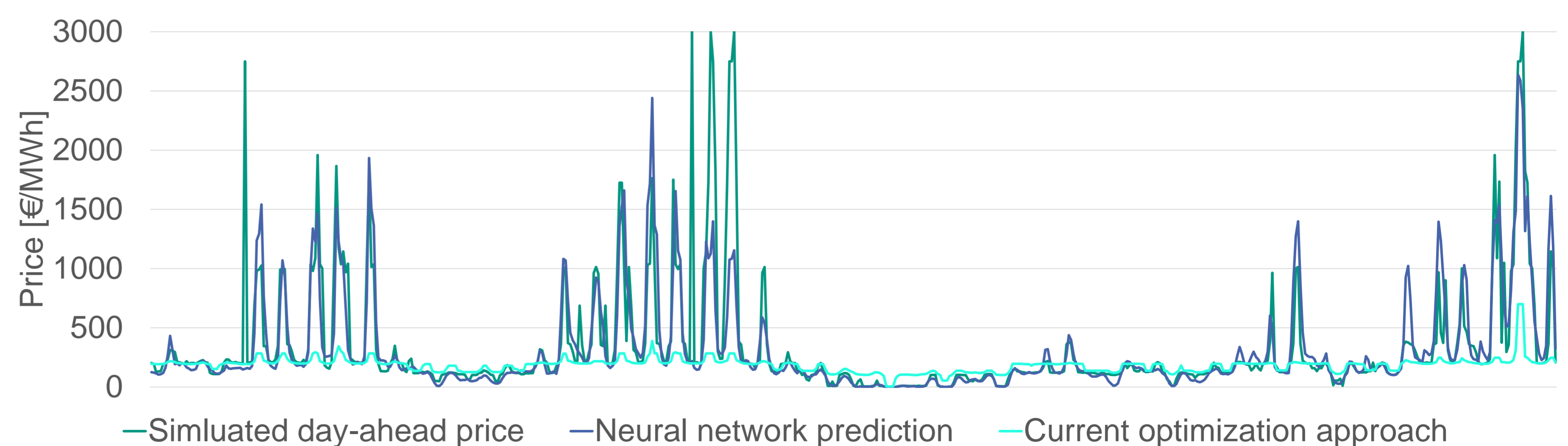
LP	Time period	Constr	Vars	NZ
Price forecast*	168 h	12.600 - 122.000	329.300 - 596.000	396.600 - 989.000
Market clearing	1 h	~45	~3.600	~3.800
Storage	24 h	30.000	30.000	74.000
Hydrogen production*	8760 h	1	8.760 - 140.160	8.760 - 140.160
Seasonal Storage production*	8760 h	8814	17576	26493
DSM	24h	650	1201	2496

*iterative processes

Improvements due to the HPC

- Up to 5 % computational time improvements due to code optimization to fit in the 72 hour time limit
- Gurobi parameter tuning to gain additional 20-30 % time saving
- Up to 10 % improvements to due better hardware itself
- Price forecast improved by ~63% in terms of RMSE and ~33% in terms of R²

Comparison between current forecast, neural network forecast and simulated results



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