Strategic Reserve in a ~ 100% renewable power system

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

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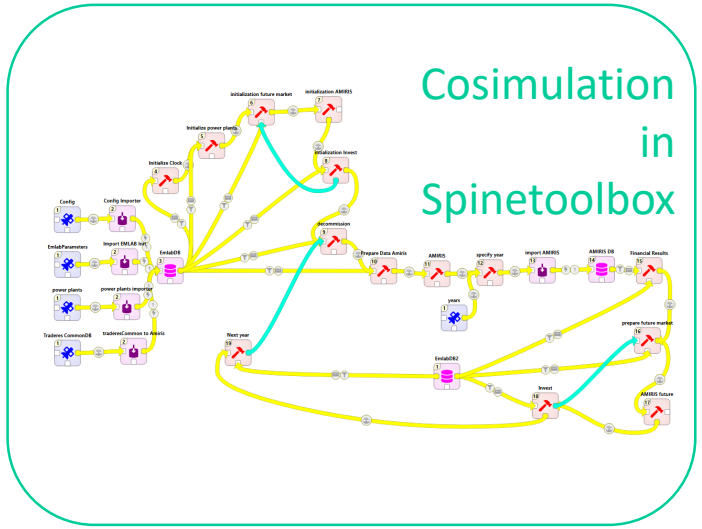
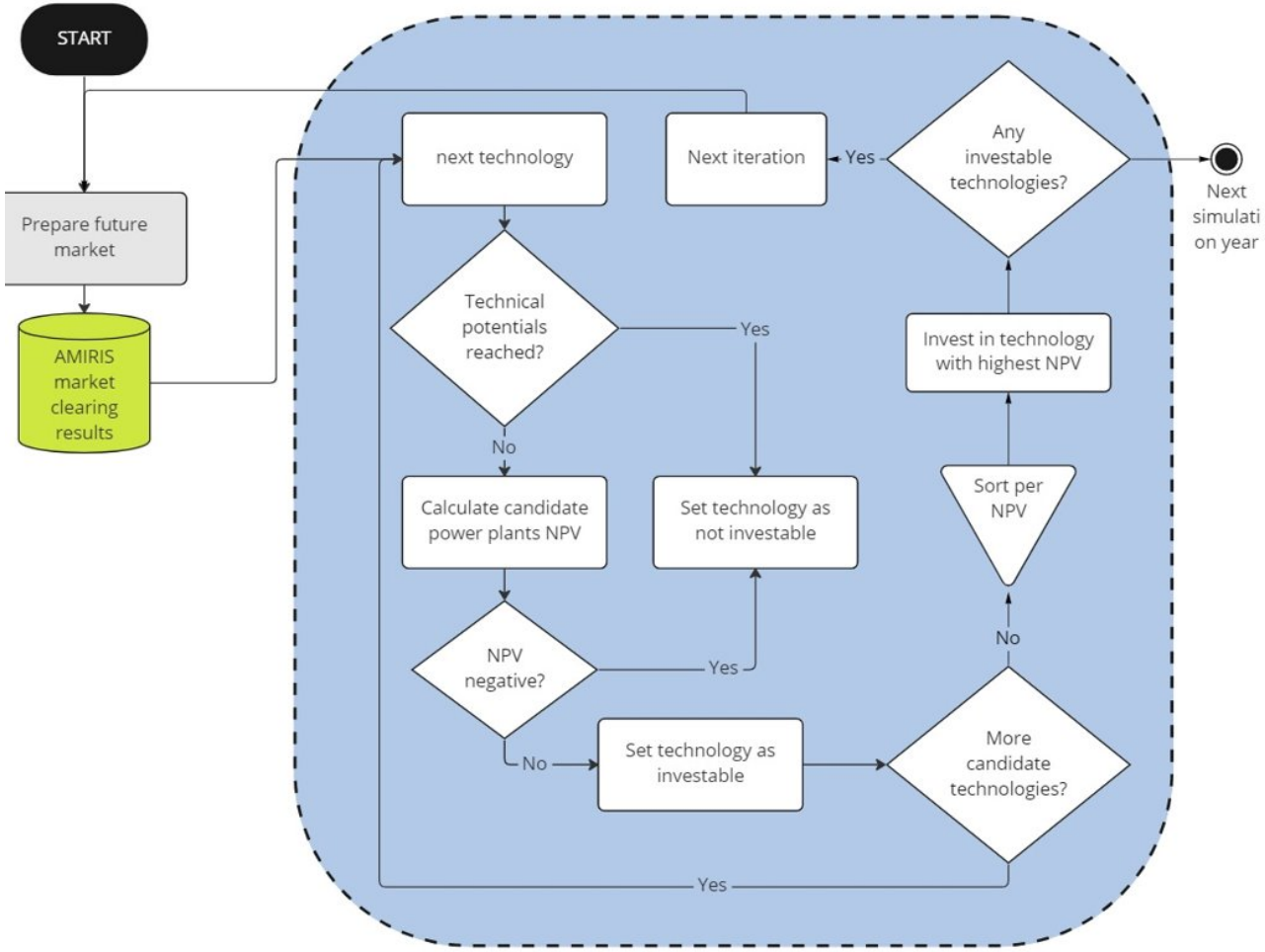
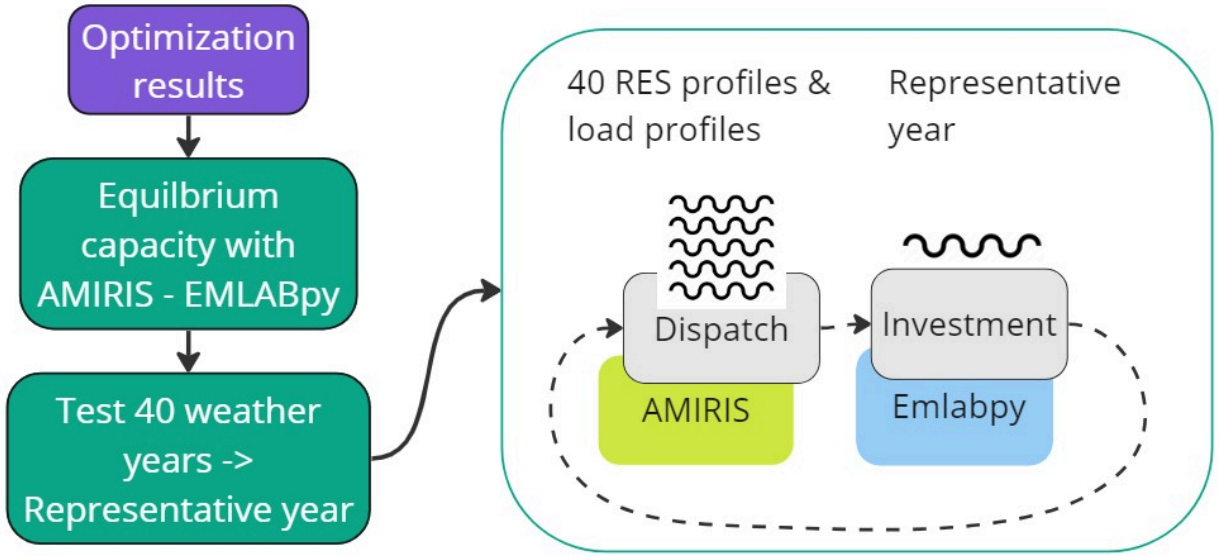
Cosimulation of investment and dispatch ABM



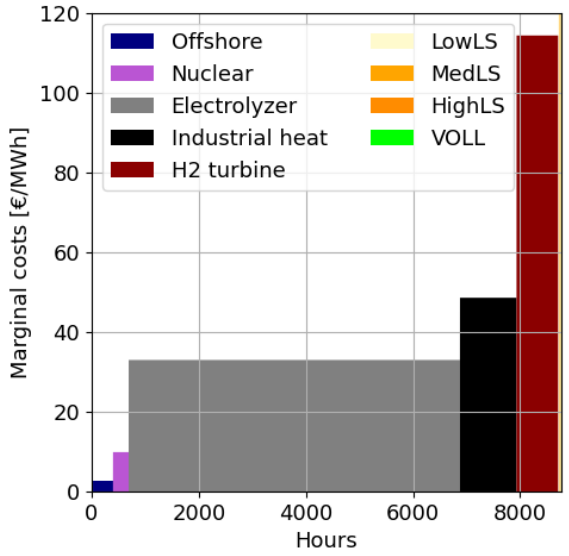


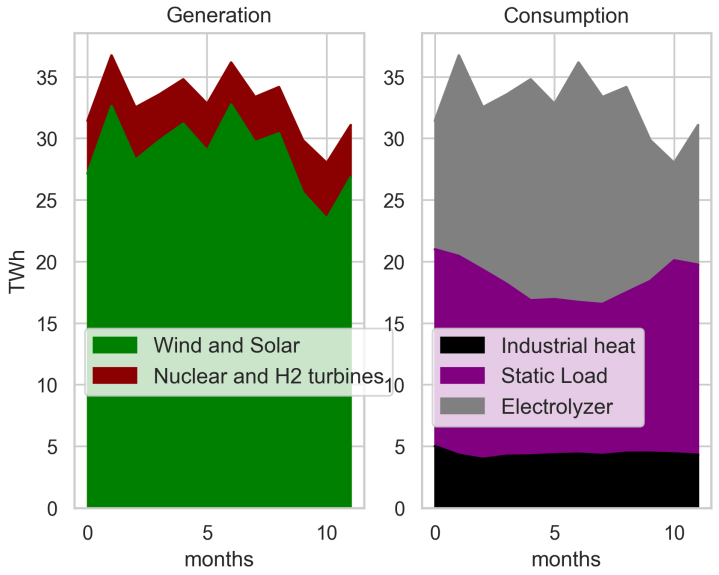
Can an EOM enable resource adequacy in a ~ 100% RES system ?

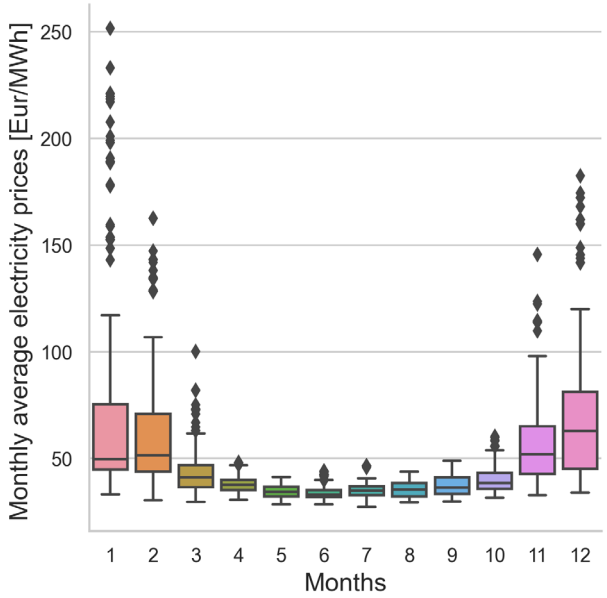


Load		Type
Flexible consumers	Percentage of load (20%)	Load shedding
Hydrogen	Constant demand corresponds to electrolyzer capacity	Load shedding
Industrial heat load	Load-shifting unit with an opportunity cost price cap	Load shifting
Heat pump load	Yearly demand as a function of temperature and hour of the day	Static
EV load	According to projected EV shares	Static

Future flexible energy only market

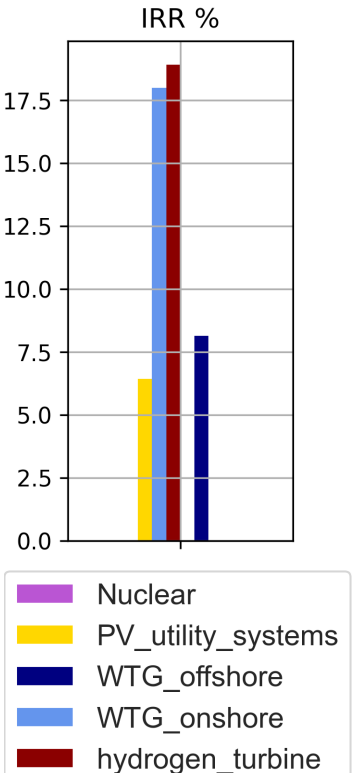


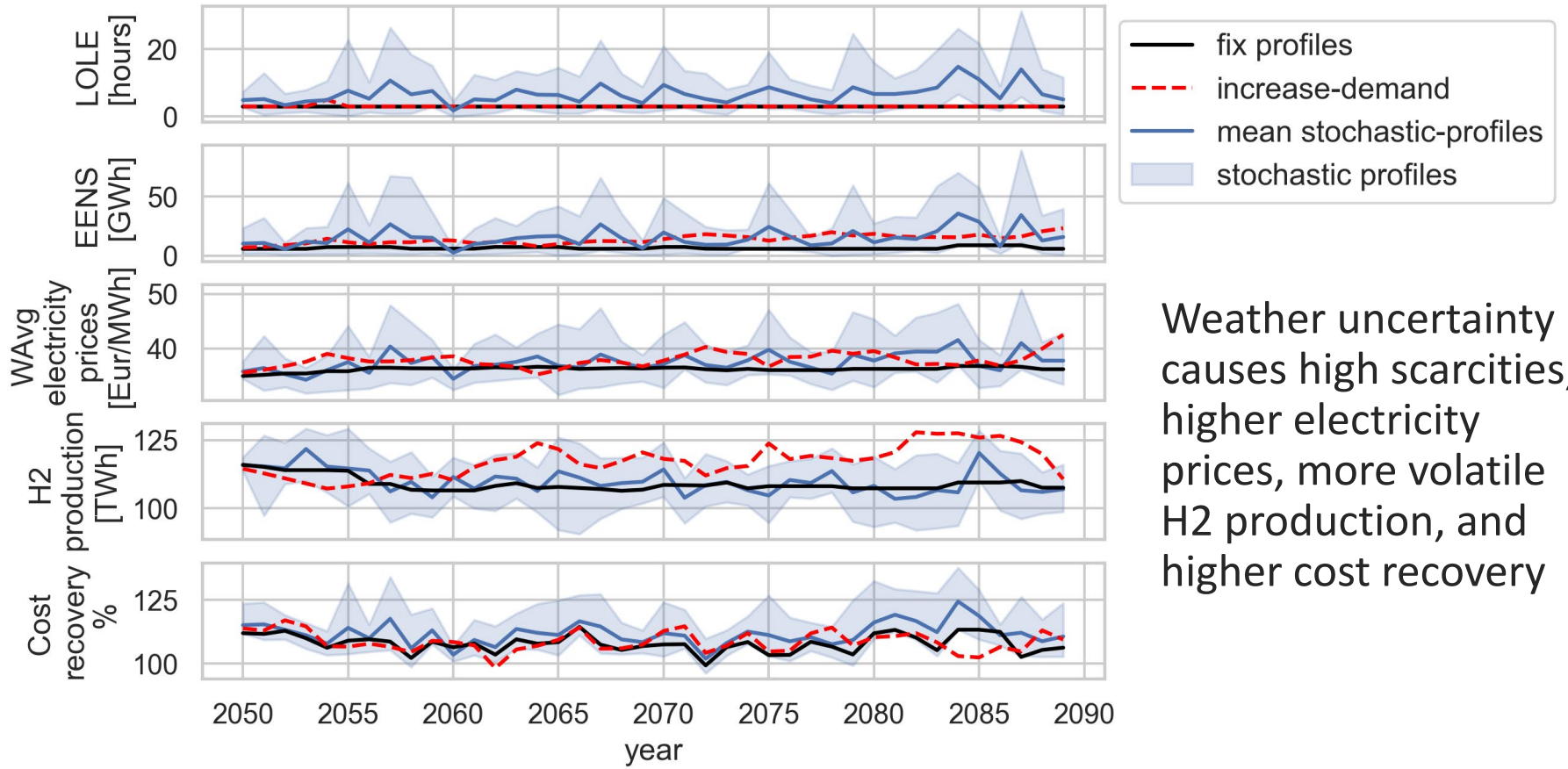




- Most energy was renewable, but the **price was mostly set by the flexible demand** (electrolyzer and the industrial heat)
- In winter demand was high and RES production was low.
- Electrolyzer consumption decreased, but still electricity prices and scarcities were highest in those months.

Weather uncertainty in an energy only market

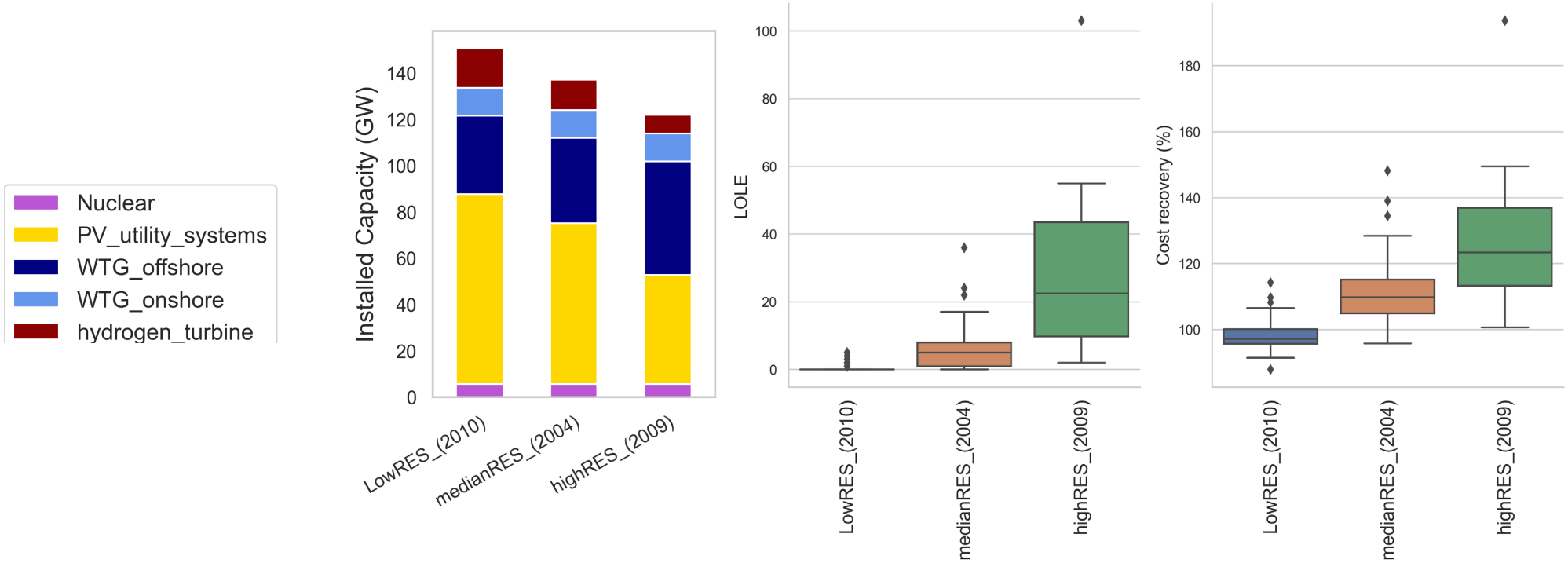




Weather uncertainty causes high scarcities, higher electricity prices, more volatile H2 production, and higher cost recovery

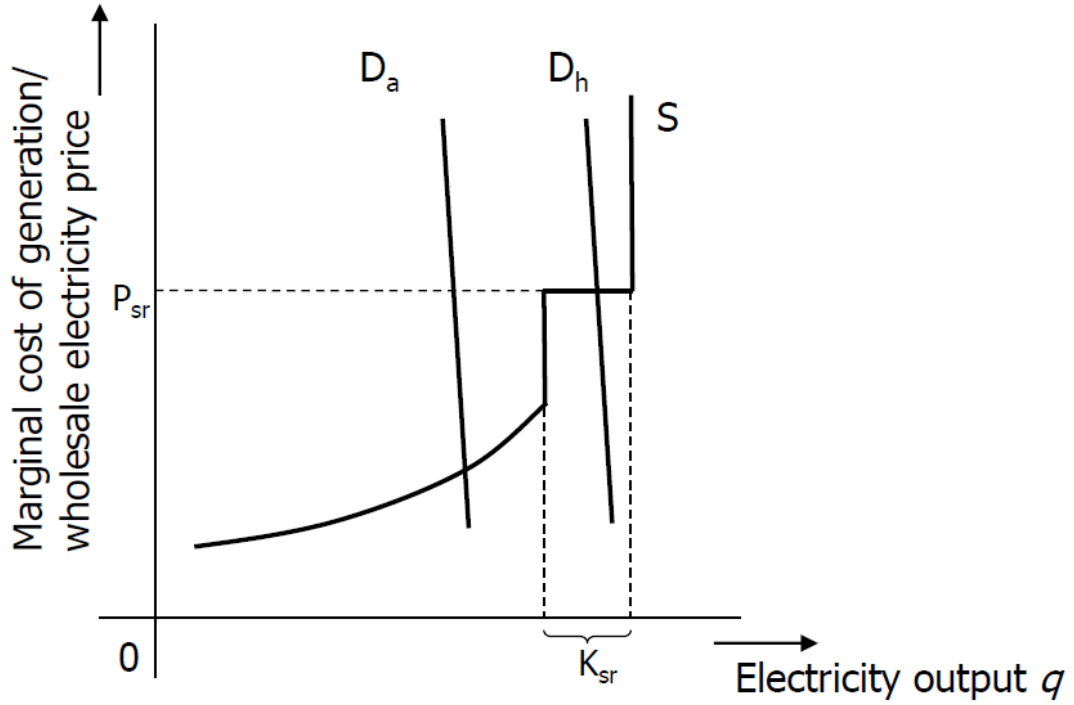
Would companies overinvest to ensure reliability?

- Investment decisions based on RES estimation: low (2004), median (2004) and high (1990)
- Realized dispatch based on historical sequence

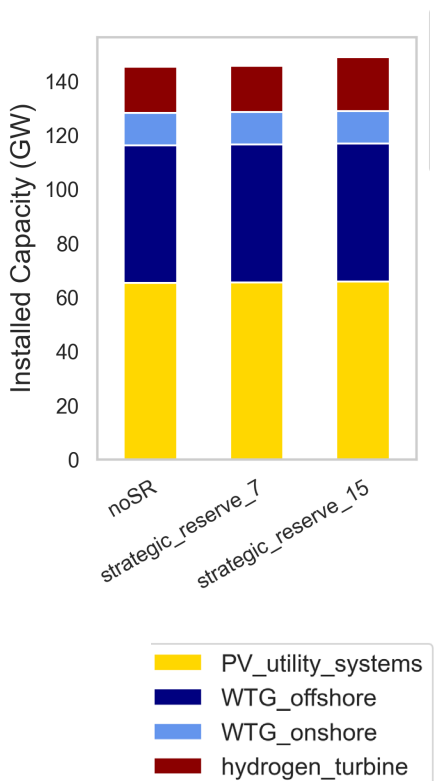


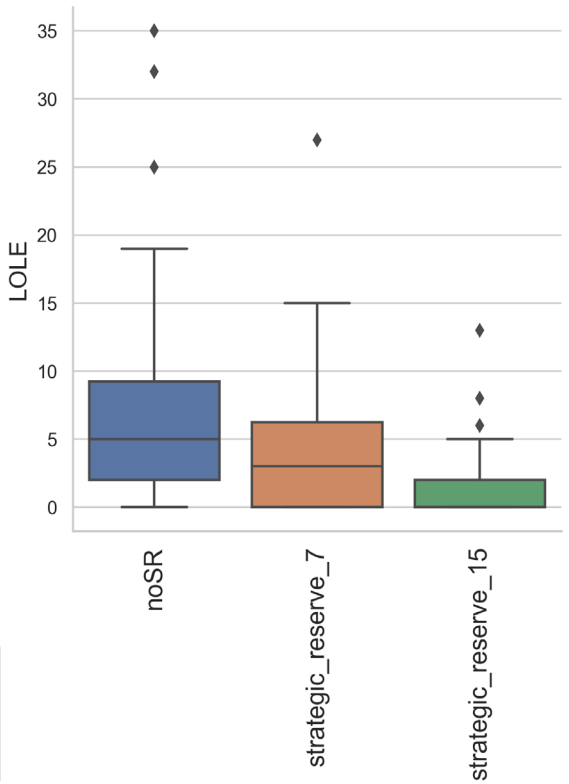
Preliminary results: **Strategic reserve**

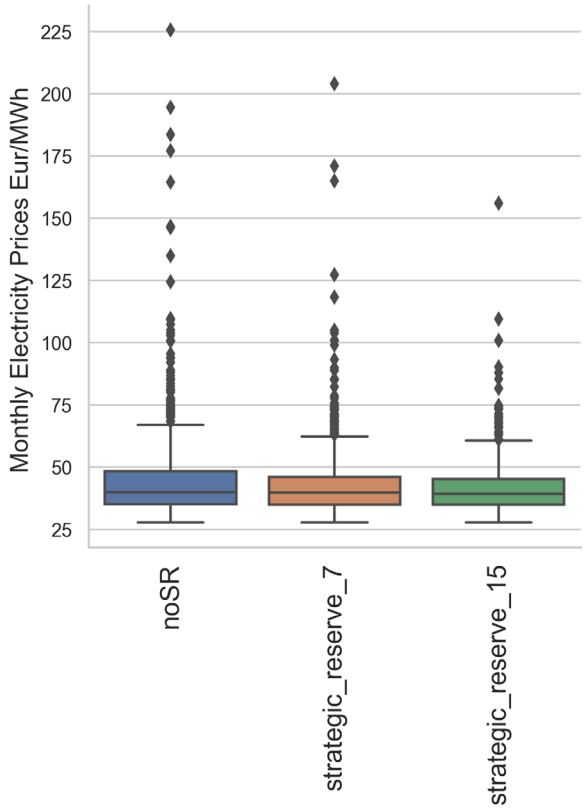
- Reserve volume contracted set to 7% and 15% of inflexible peak load (186 TWh, excl. hydrogen demand ~150 TWh)
- Reserve dispatch price: 800 Eur/MWh
- Contracted plants are paid for their fixed costs and variable costs if dispatched
- TSO keeps the difference between the wholesale market revenues and the variable cost payments.

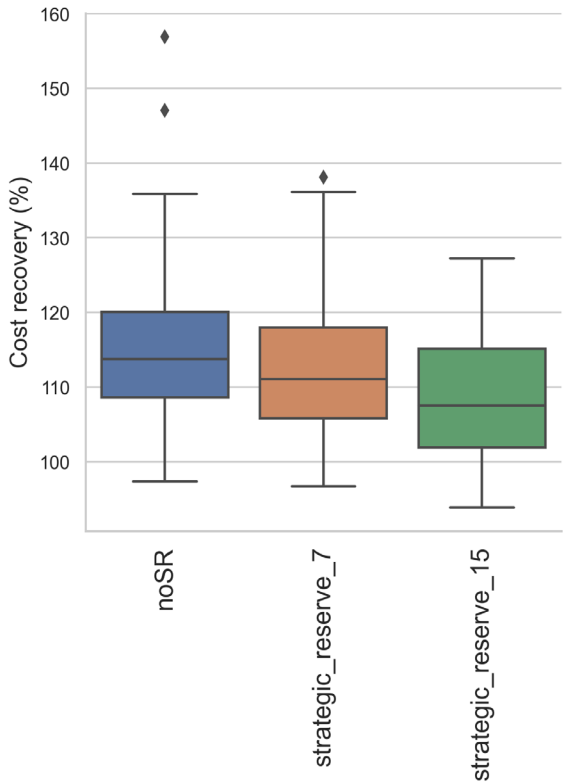


Preliminary results: **Strategic reserve**



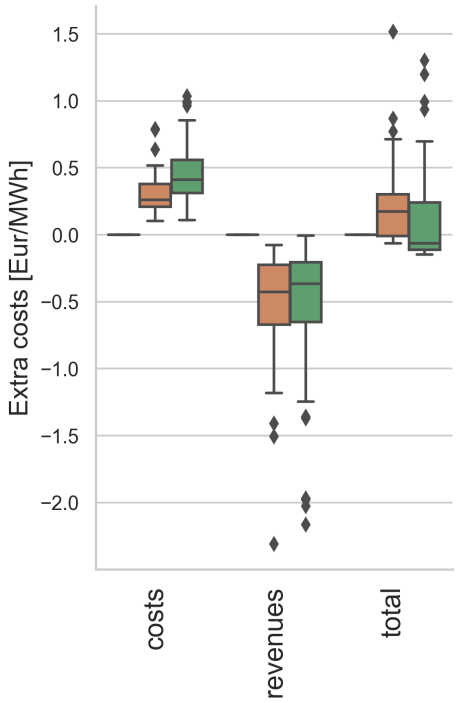


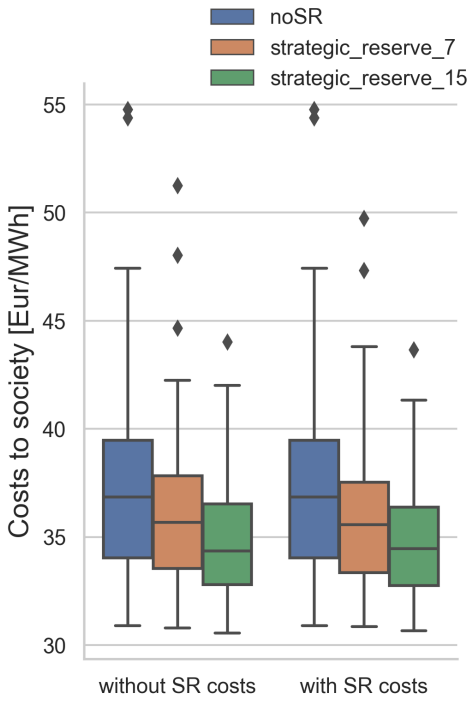




Preliminary results: **Strategic reserve**

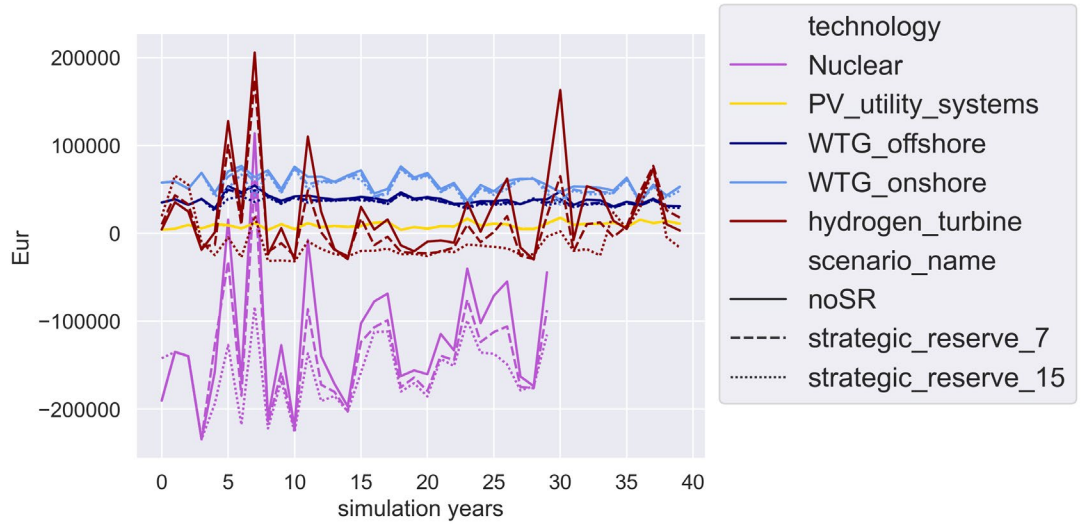
Costs to society





Results per technology

Average operational profits per MW



Dispatchable technologies have less operational profits. But they can become unprofitable

Conclusions

- In a future system, flexible consumers set the price most of the time.
- Base load technologies (nuclear) would not recover their costs.
- In an energy-only-market, investors have no incentive to ensure reliability.

- Strategic reserve produce more frequent and lower price spikes. This causes more investments, which lowers cost to society. But oversizing strategic reserve or setting reserve dispatch price too low can worsen peak-load technologies returns.

- Next steps: better parametrization of SR, transition scenarios with financial CFDs, capacity market, capacity subscription

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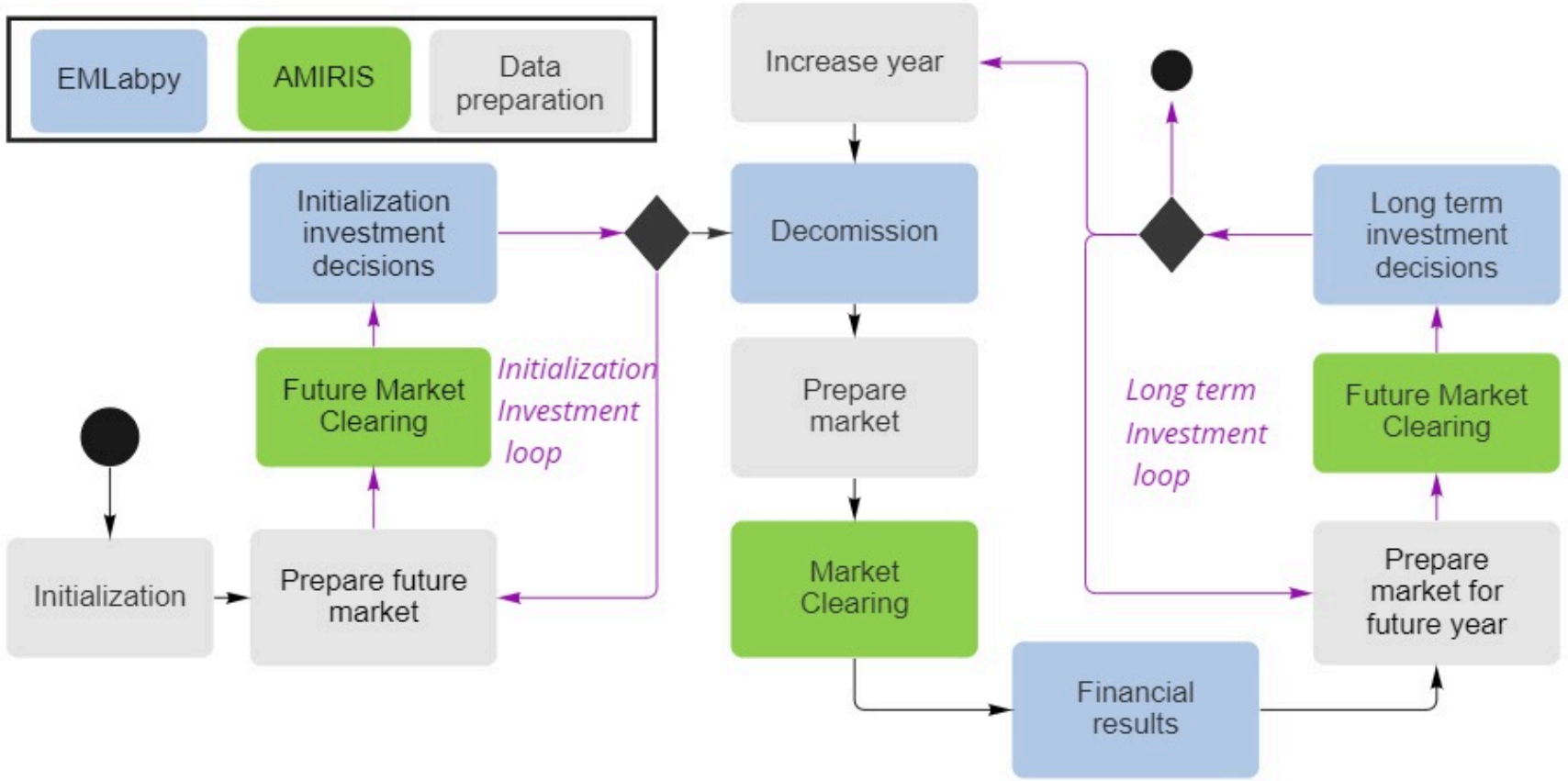
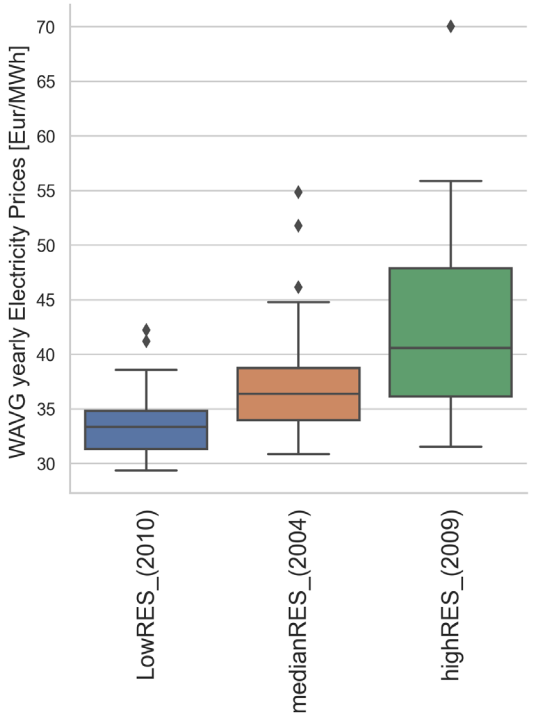
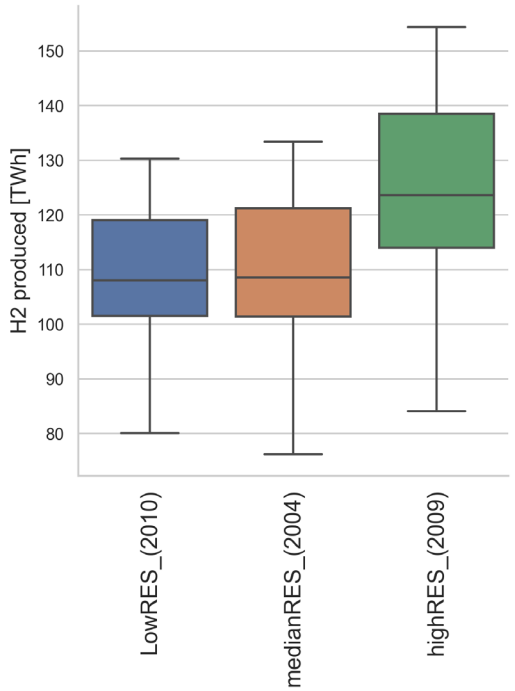
Thank you!

Workflow AMIRIS - EMLabpy



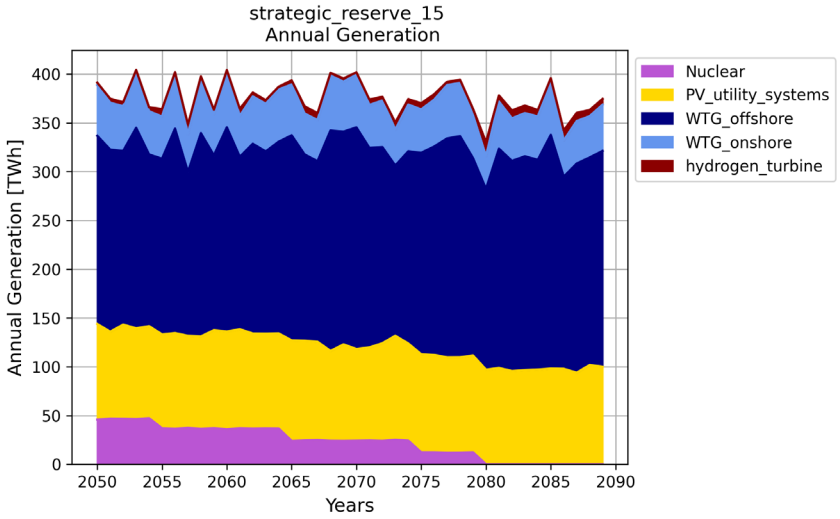
Would investors base their decisions to ensure reliability?



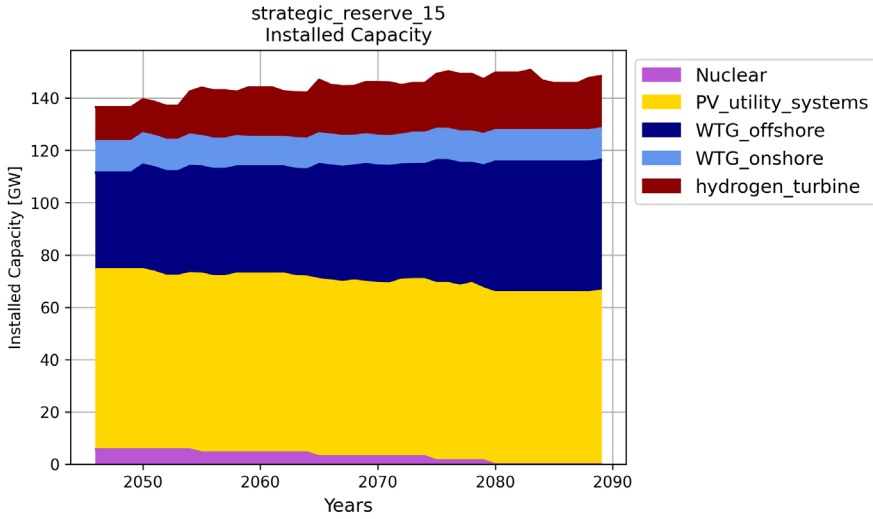


Results SR 15%

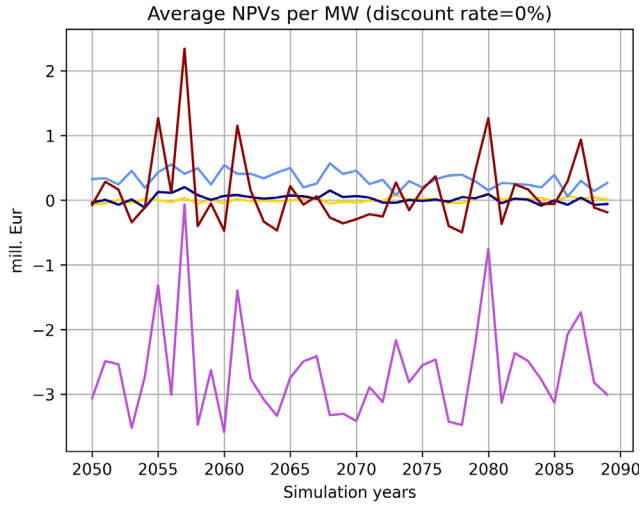
Annual generation



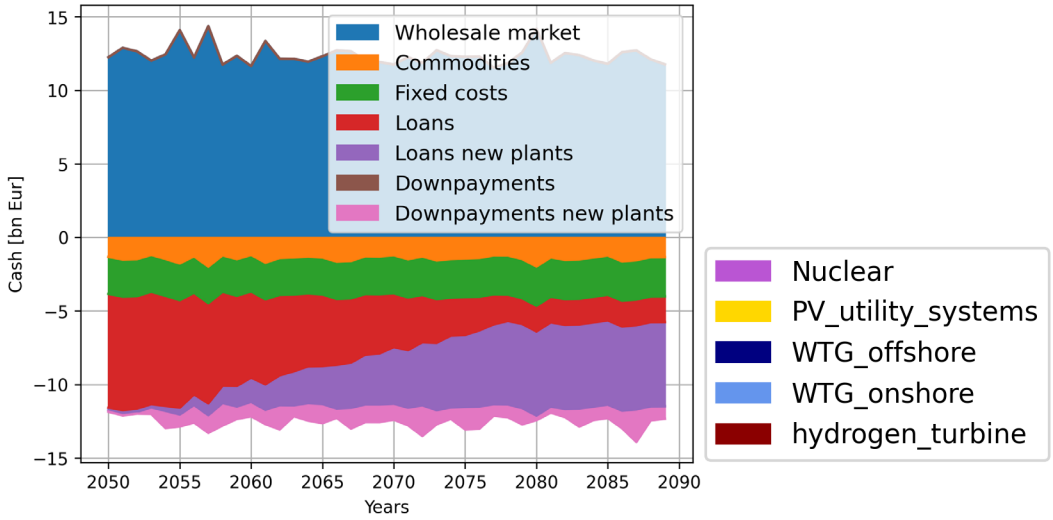
Installed capacity

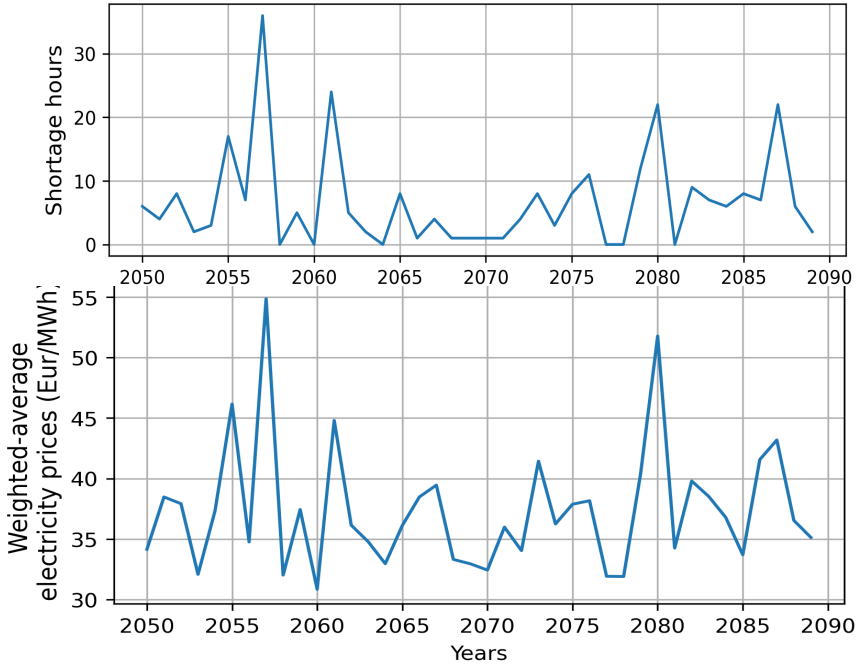


Investments based on representative year



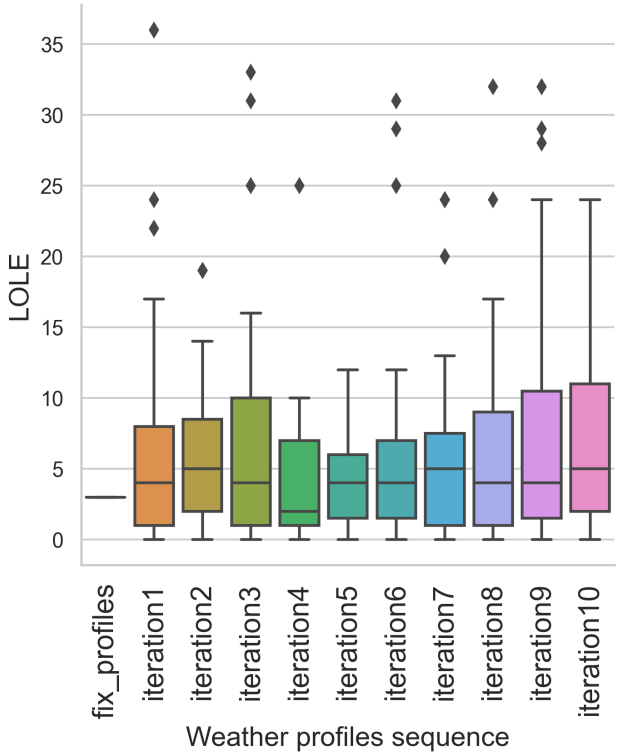
- Base-load technology (i.e. Nuclear) was unprofitable.
- Hydrogen turbine IRR were the most volatile but also the most profitable
- Years with the highest shortages caused the highest costs and highest electricity prices



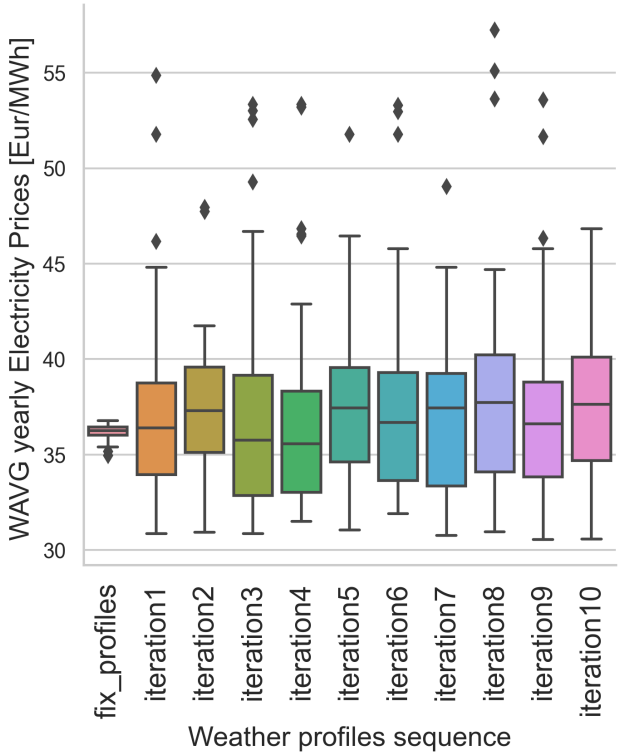


Weather impact on electricity prices

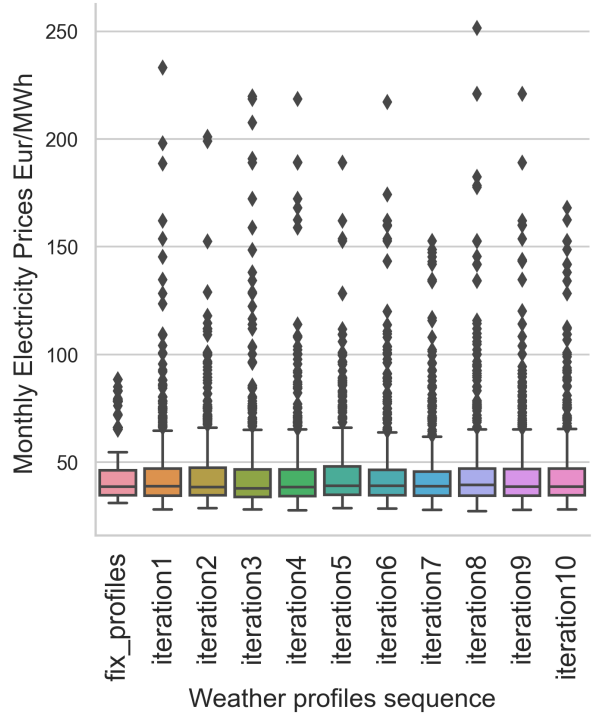
Shortage hours



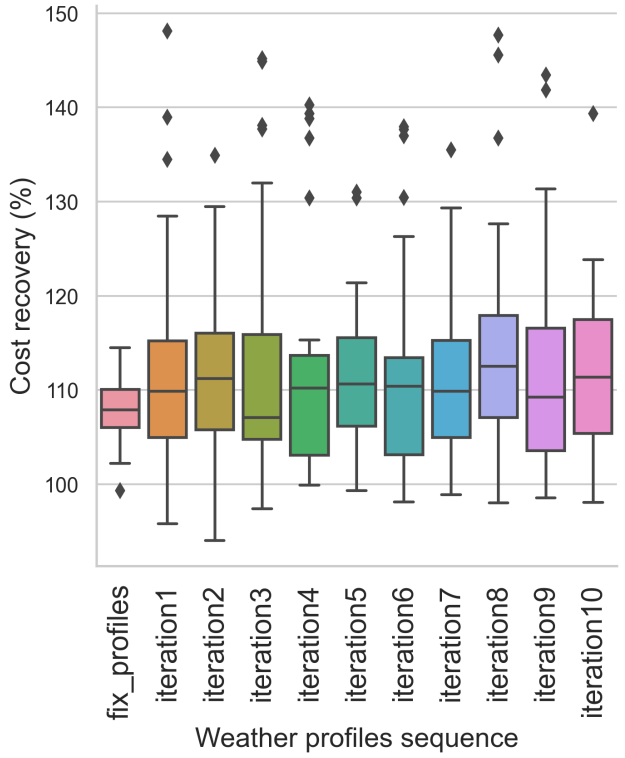
Yearly electricity prices



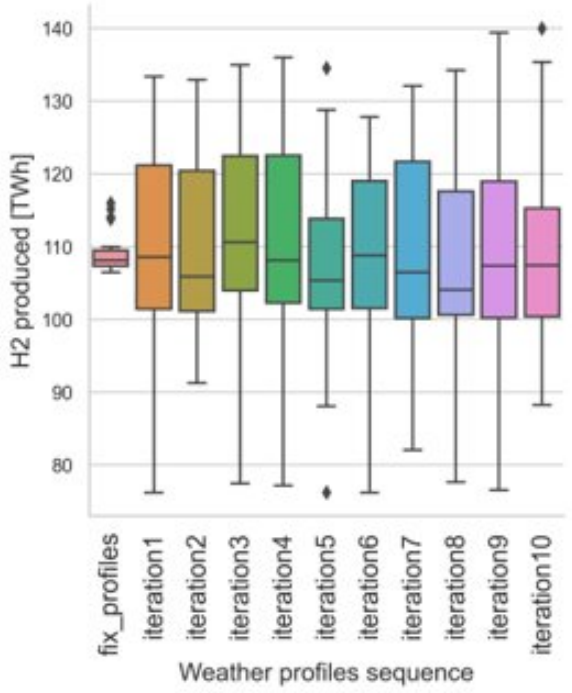
Monthly electricity prices



Cost recovery %



H2 production TWh



Historical weather years sequence (1980 to 2019)

Installed capacity