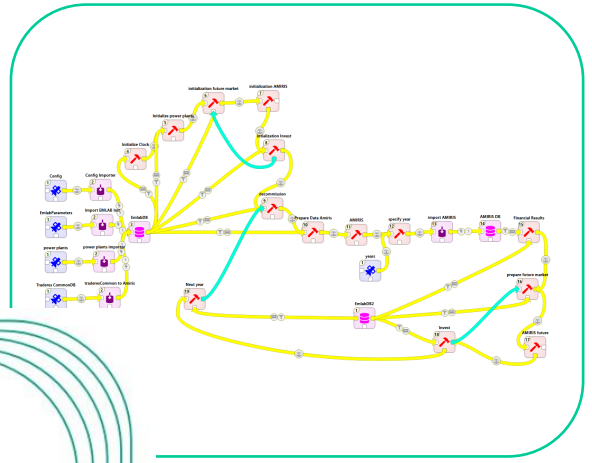
Can an Energy Only Market (EOM) enable Resource Adequacy in a nearly 100% Renewable Power System?

Ingrid Sanchez Jimenez, David Ribo Perez, Laurens de Vries (TU Delft)

Christoph Schimeczek, Johannes Kochems (DLR)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864276

Cosimulations with an investment and operational ABMs



2050 optimization

Nuclear and electrolyzers capacity,
Industrial heat demand

DSR (Load shedder groups)
Electrolyzer (load shedder),
Industrial heat (load shifter),

Equilbrium mix with ABMs

Test 40 weather years to find representative

40 weather profiles & 40 loads profiles

Representative year based on year 2004

Dispatch

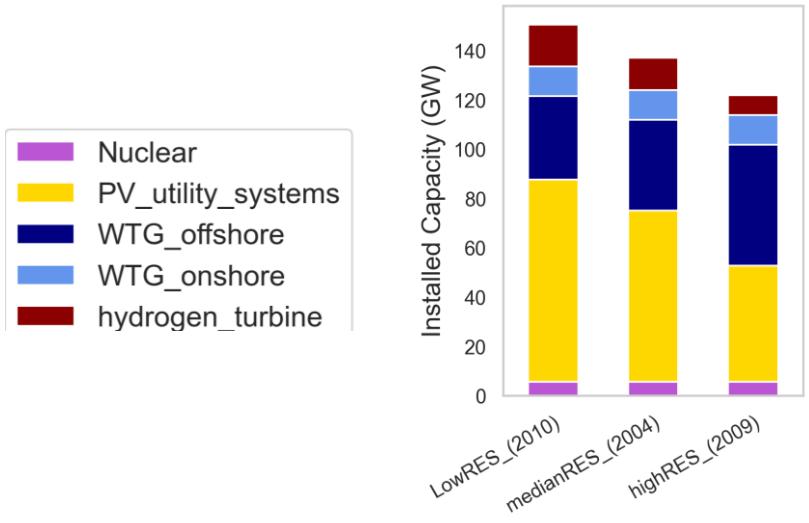
Investment

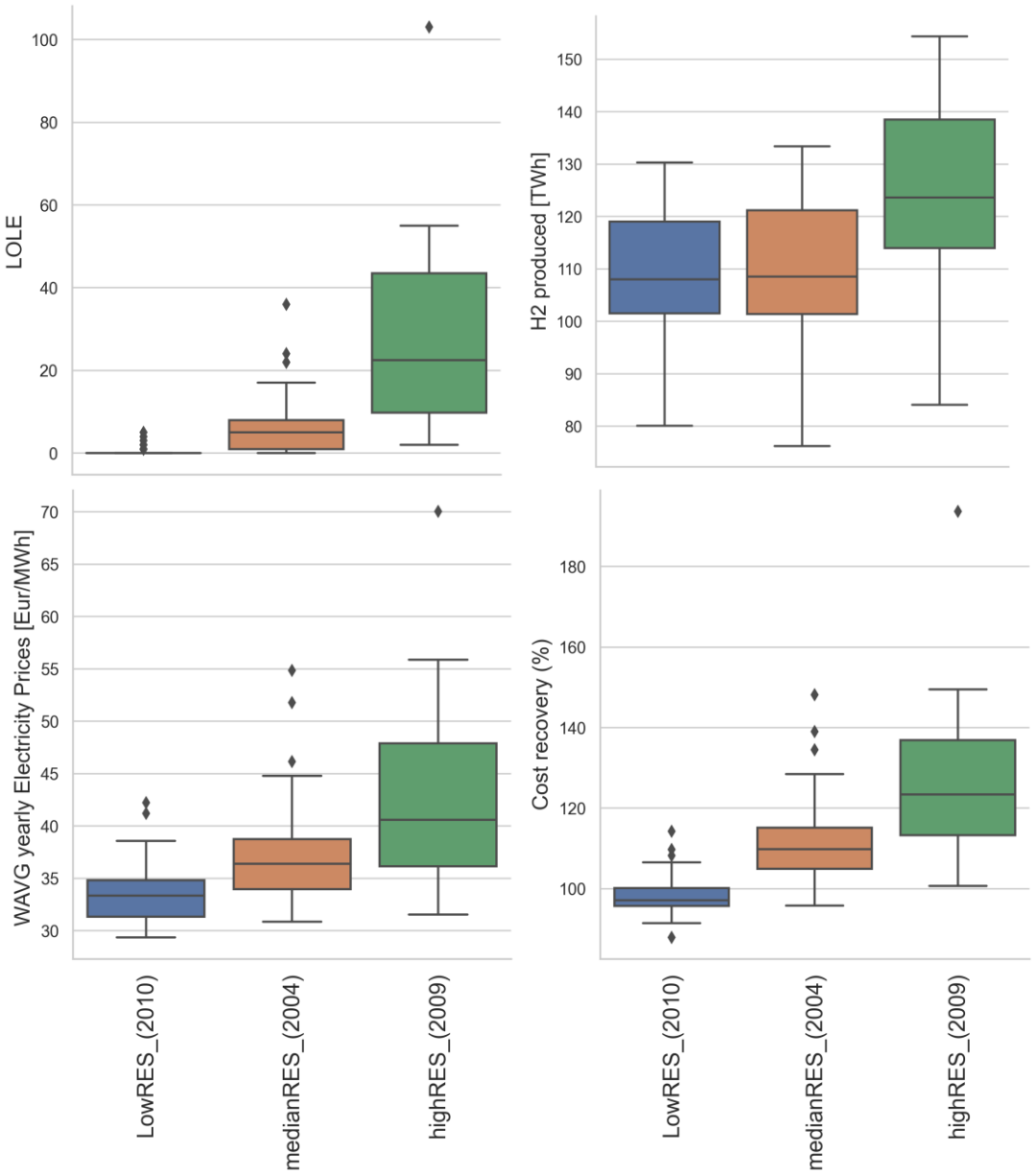
AMIRIS

Emlabpy

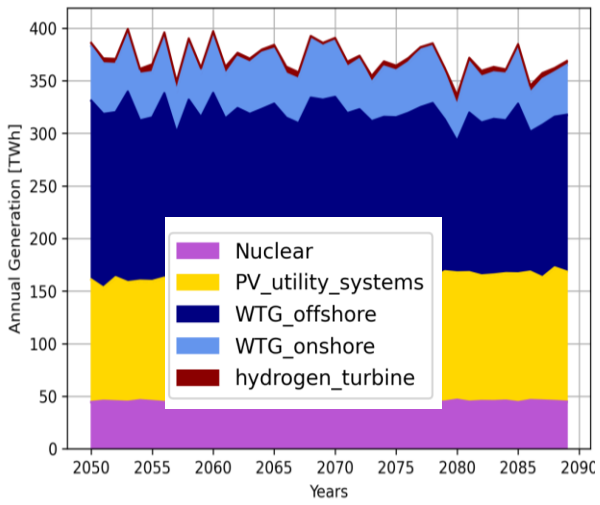
Would investors base their decisions to ensure reliability?

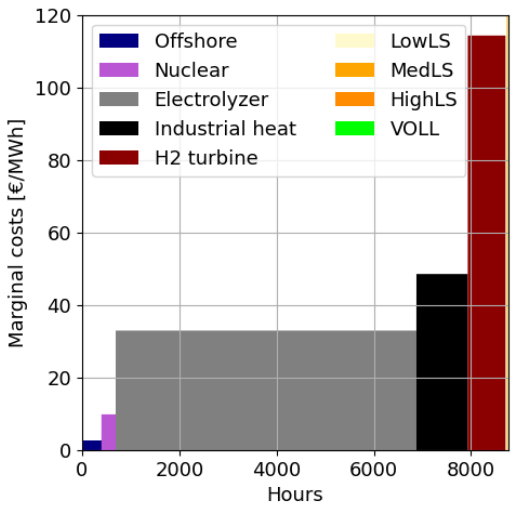
- Investment decisions based on RES estimation: low (2004), median (2004) and high (2009)
- Realized dispatch based on historical sequence (40 years)

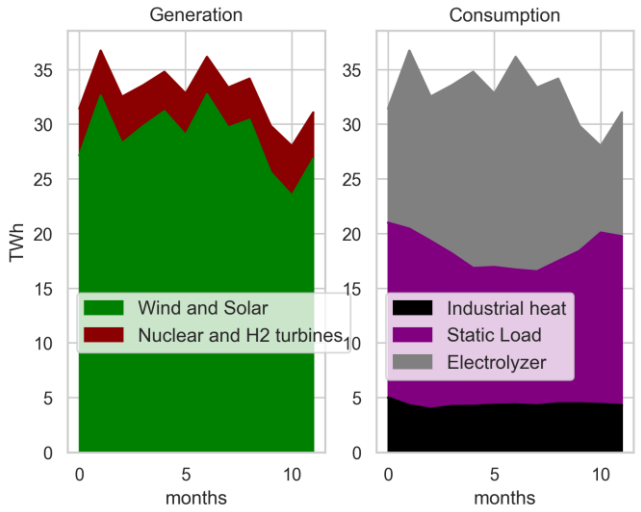


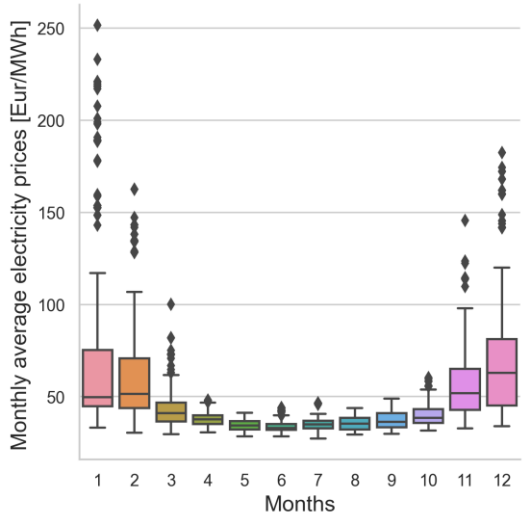


Investments based on median year
Realized dispatch based on historical sequence





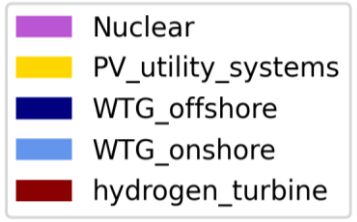


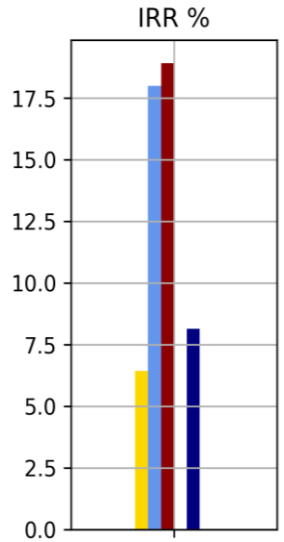


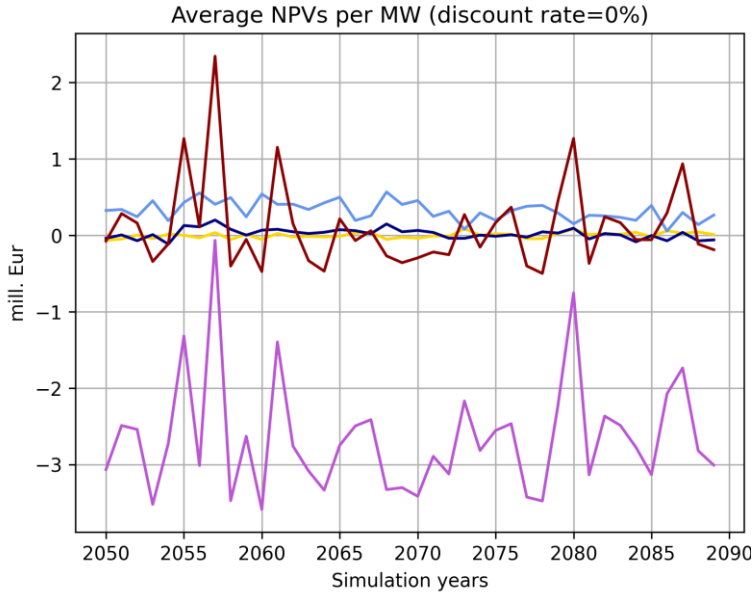
- Most energy was renewable, but the **price was mostly set by the flexible demand** (electrolyzer and the industrial heat)
- In winter demand was high and RES production was low. Electrolyzer consumption decreased, but still electricity prices and scarcities were highest in those months.

Investments based on median year
Realized dispatch based on historical sequence

- Base-load technology (i.e. Nuclear) was unprofitable.
- Hydrogen turbine IRR were the most volatile, but also the most profitable. It is active at scarcity times.

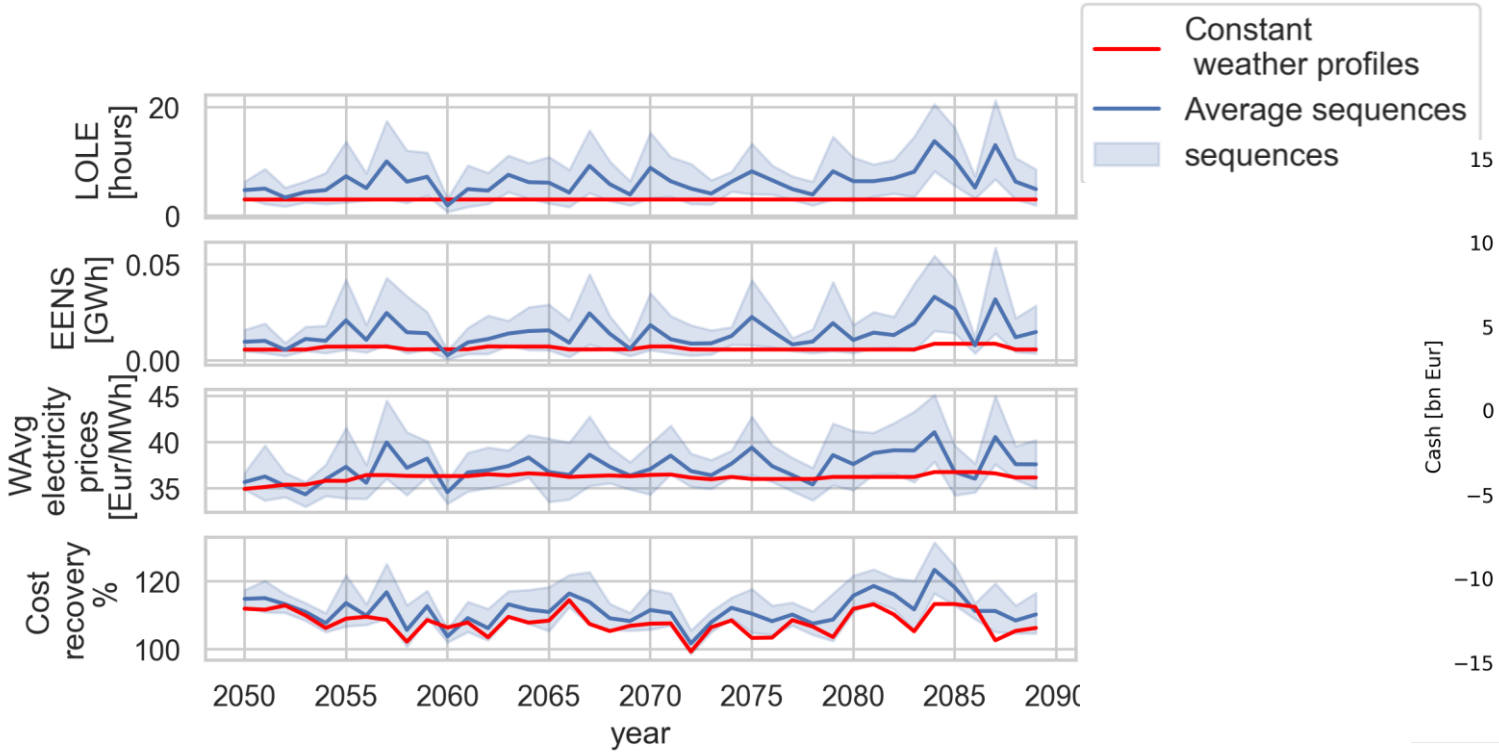


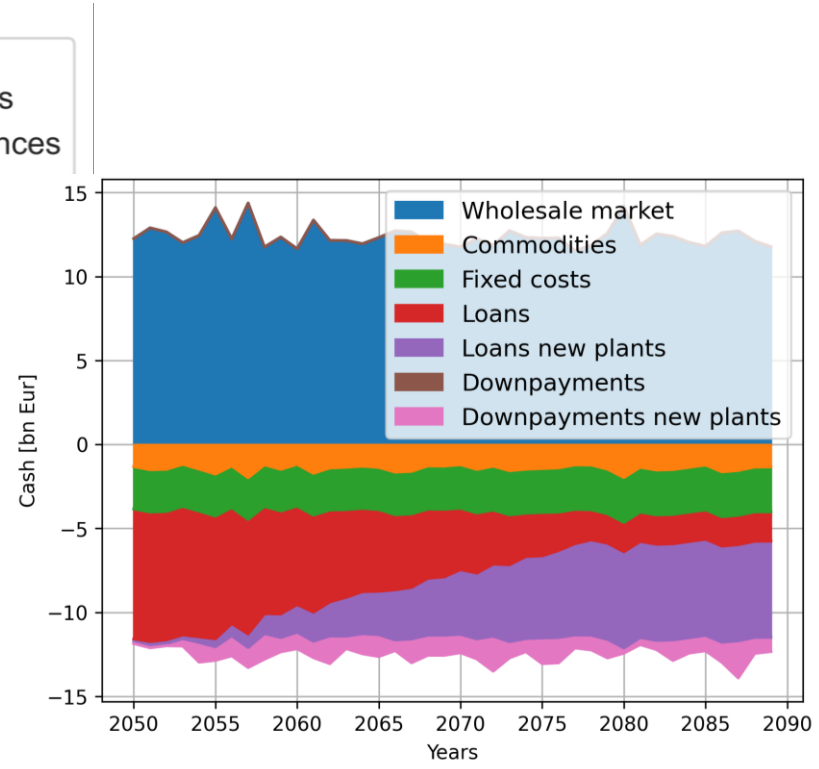




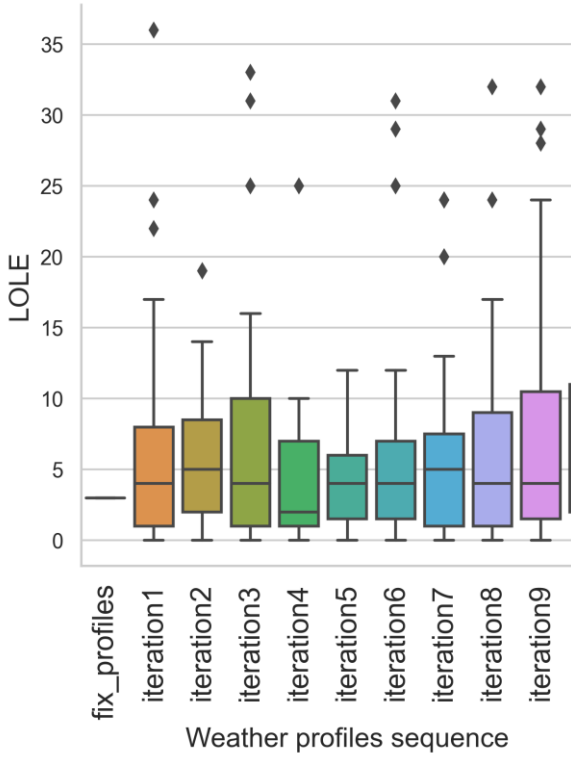
Investments based on median year 10 sequence of dispatch

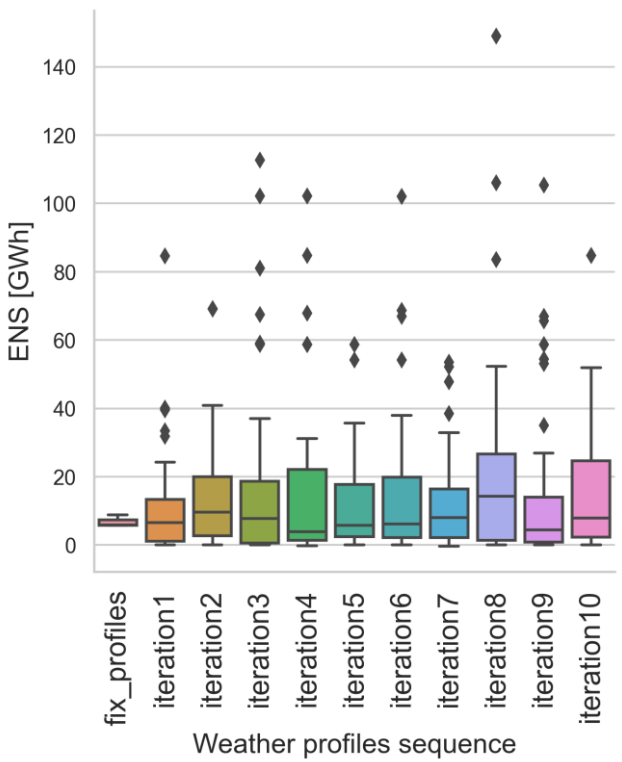
Years with the highest shortages caused the highest electricity prices and highest cost recovery

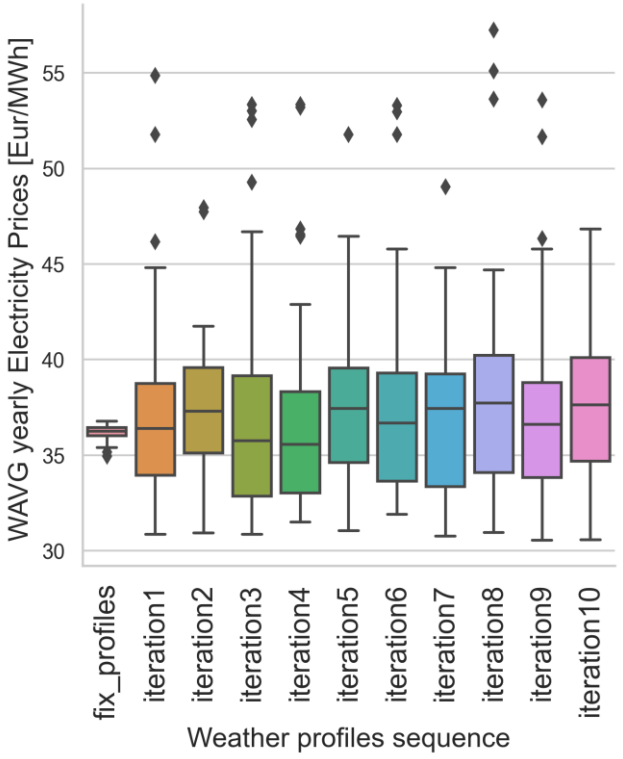


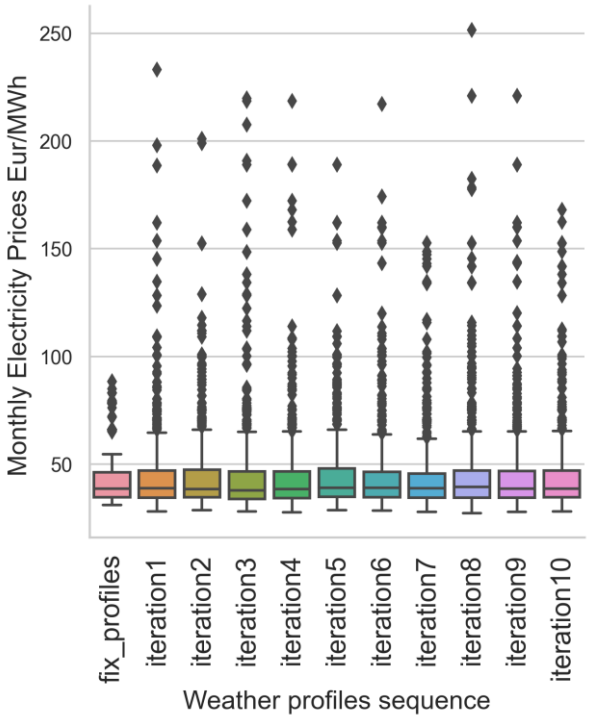


Weather impact on electricity prices

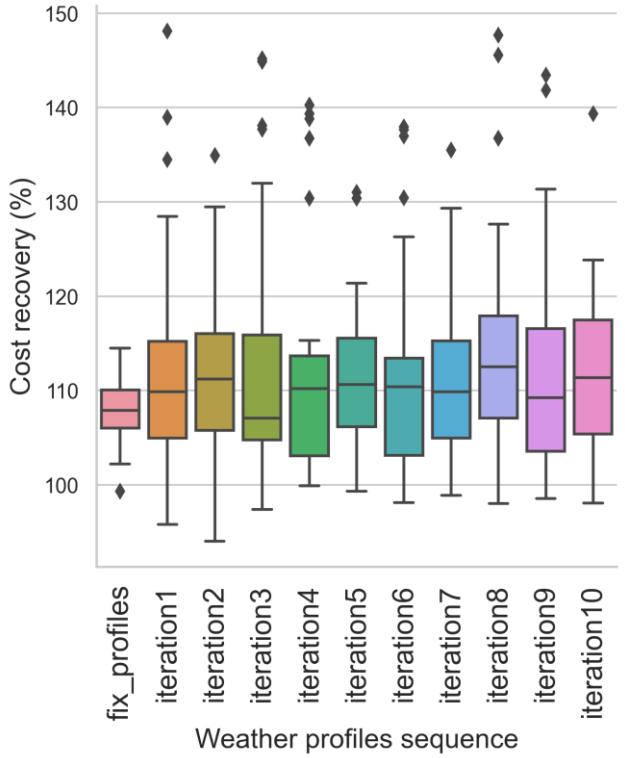




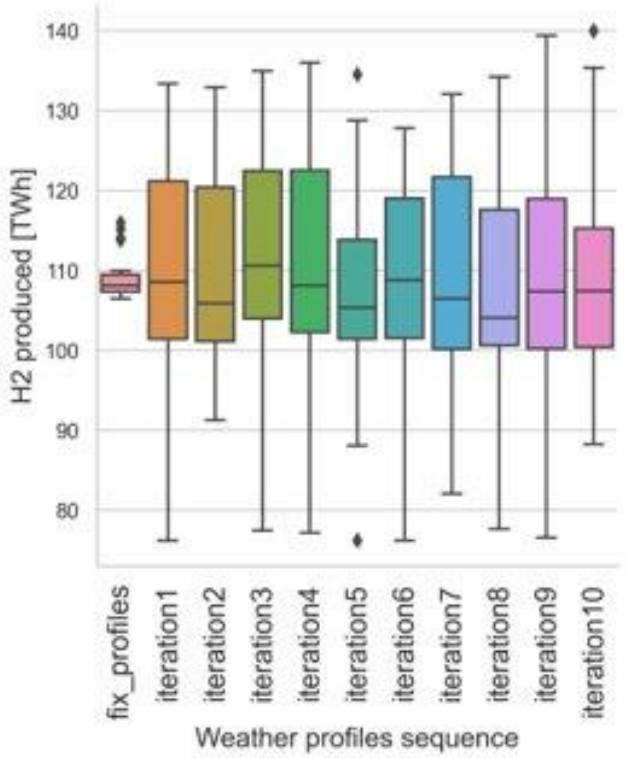




Cost recovery %



H2 production TWh



Conclusions

- Electricity prices are mostly set by flexible demand
- If investors would base their decisions on a median weather year:
  - Generation costs were recovered (except base technology)
  - Reliability standards were compromised
  - Monthly electricity prices and hydrogen production would be very volatile.
- Next steps: transition scenario and capacity mechanisms (Capacity subscription)

TradeRES

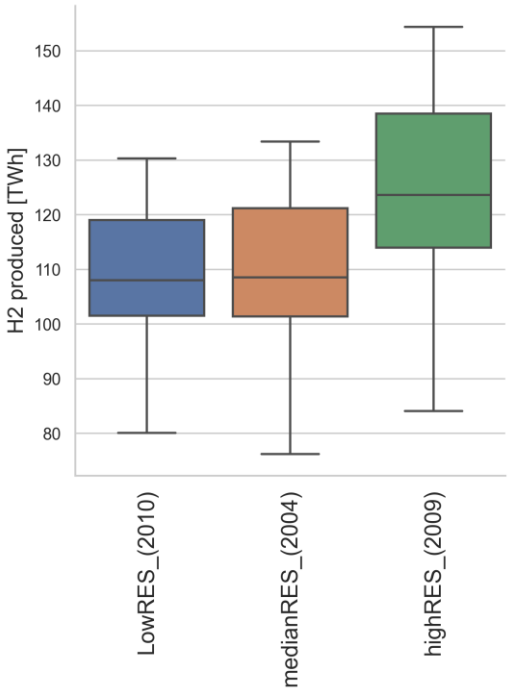
New Markets Design & Models for
100% Renewable Power Systems

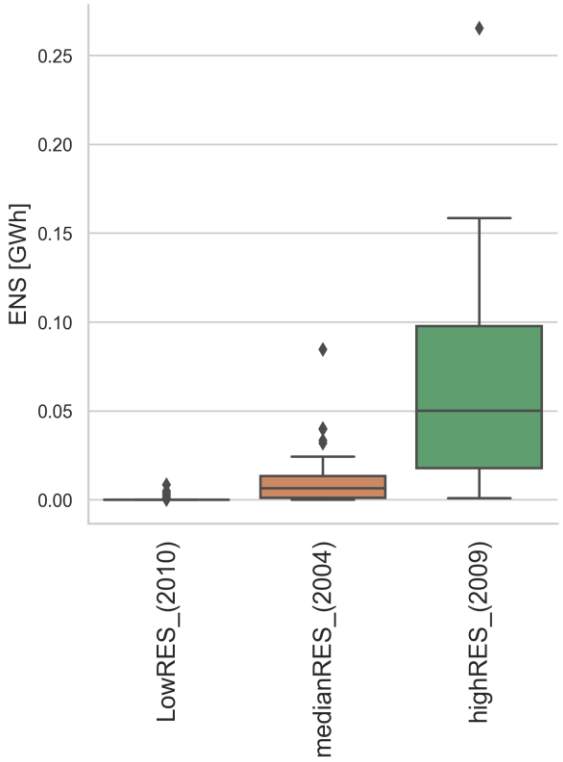
Backup

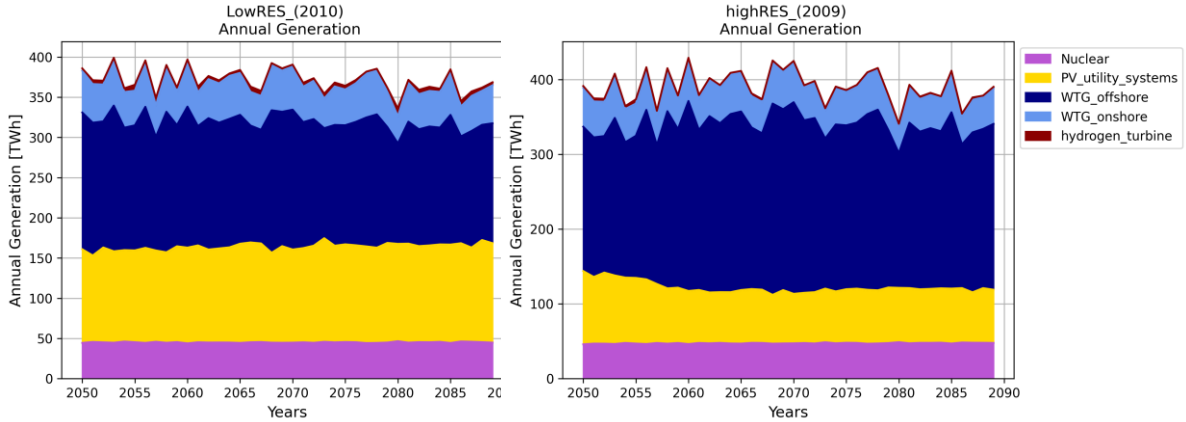
Investment decisions based on RES estimation: low (2004), median (2004) and high (2009)

- Low

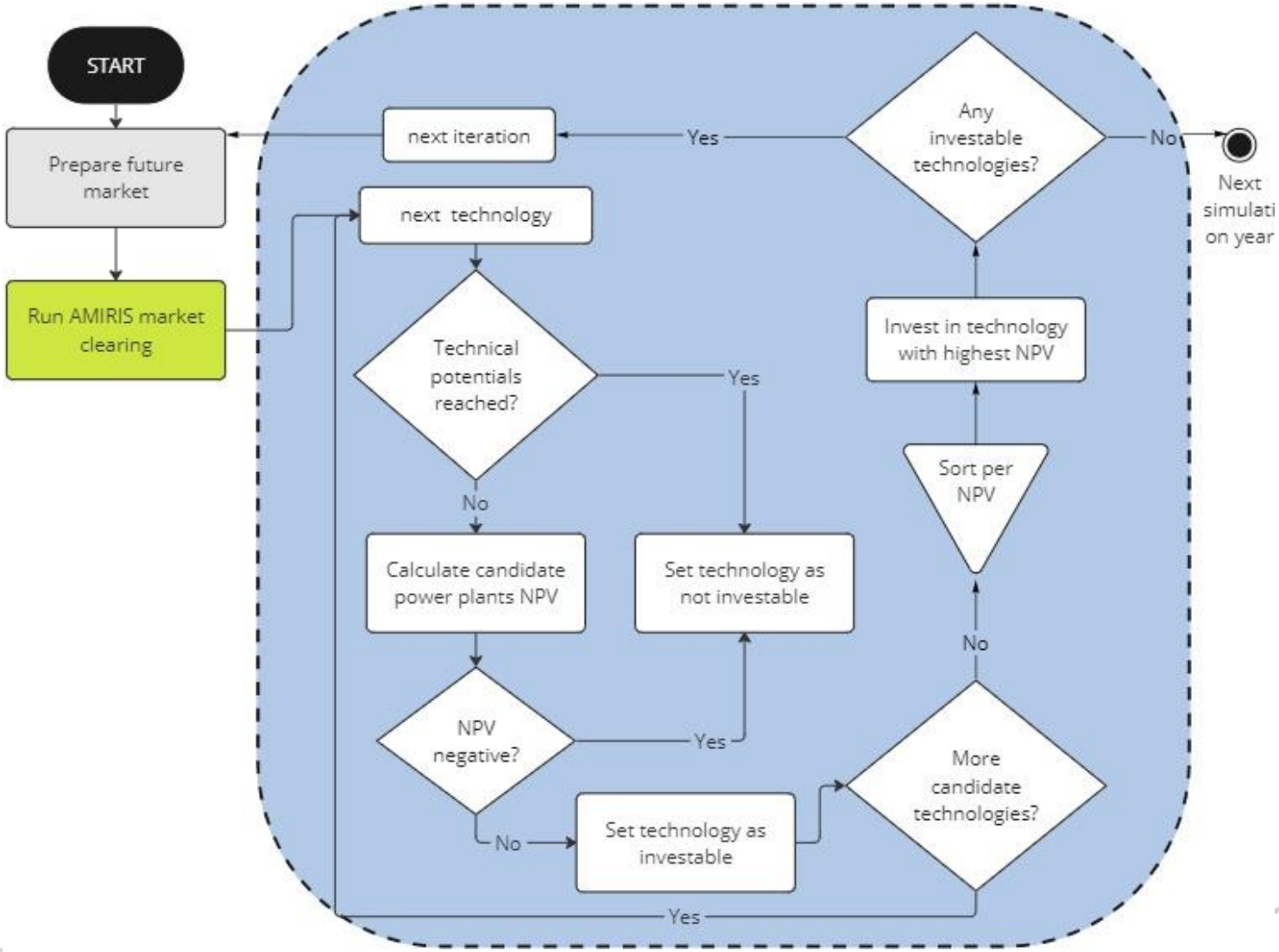
High



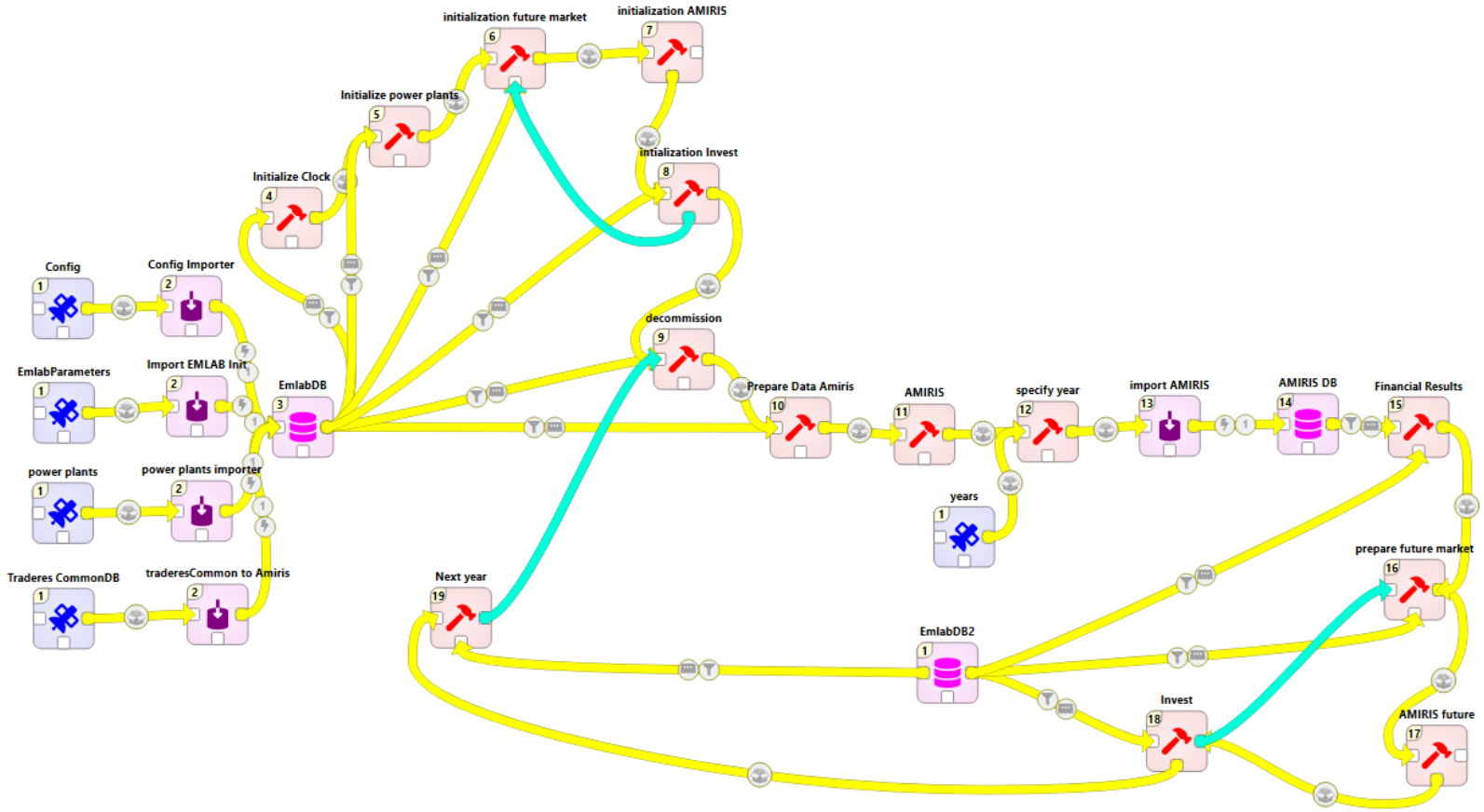




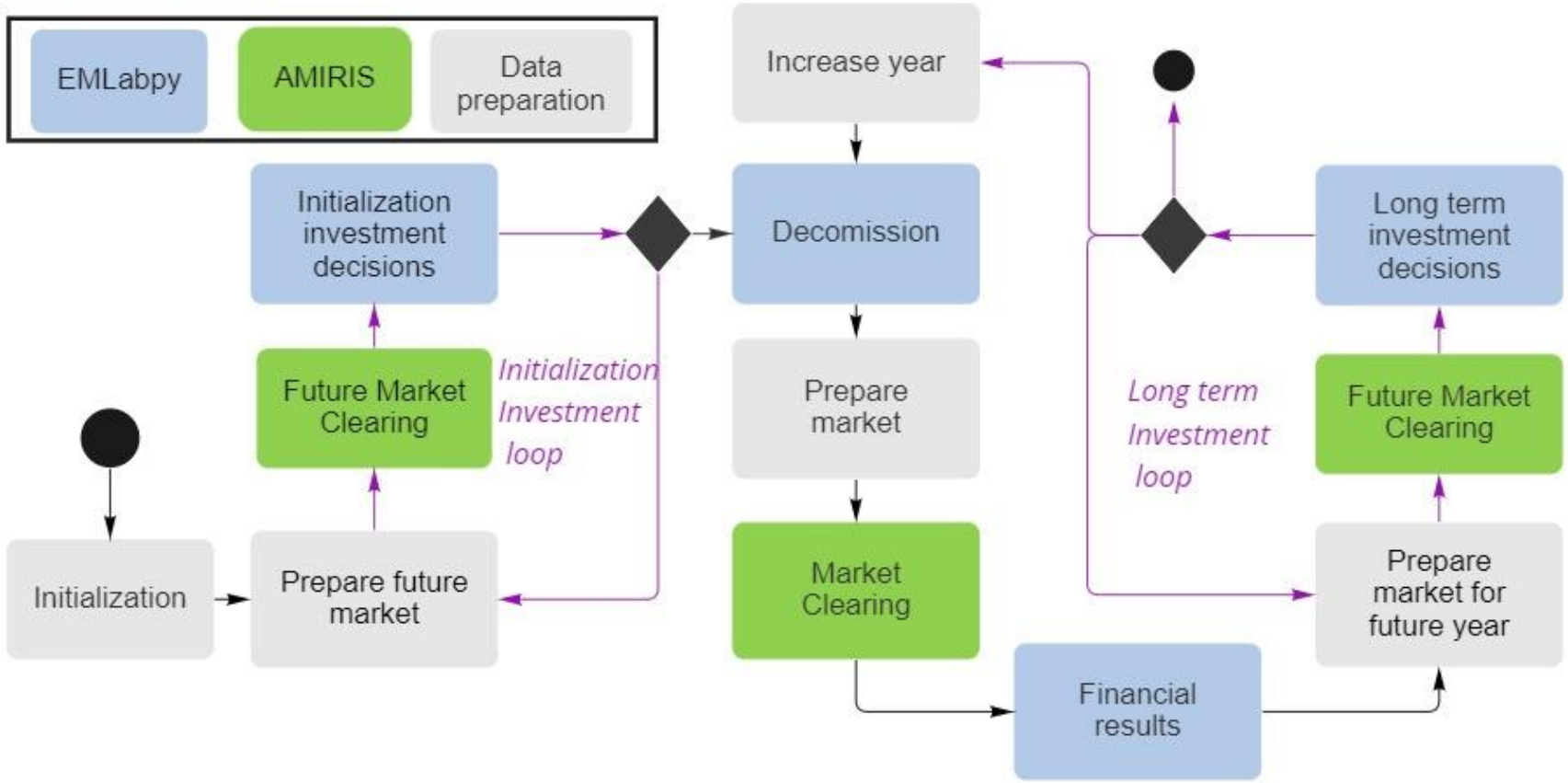
EMLabpy Investment



Coupling AMIRIS – EMLabpy in Spinetoolbox



Workflow AMIRIS - EMLabpy

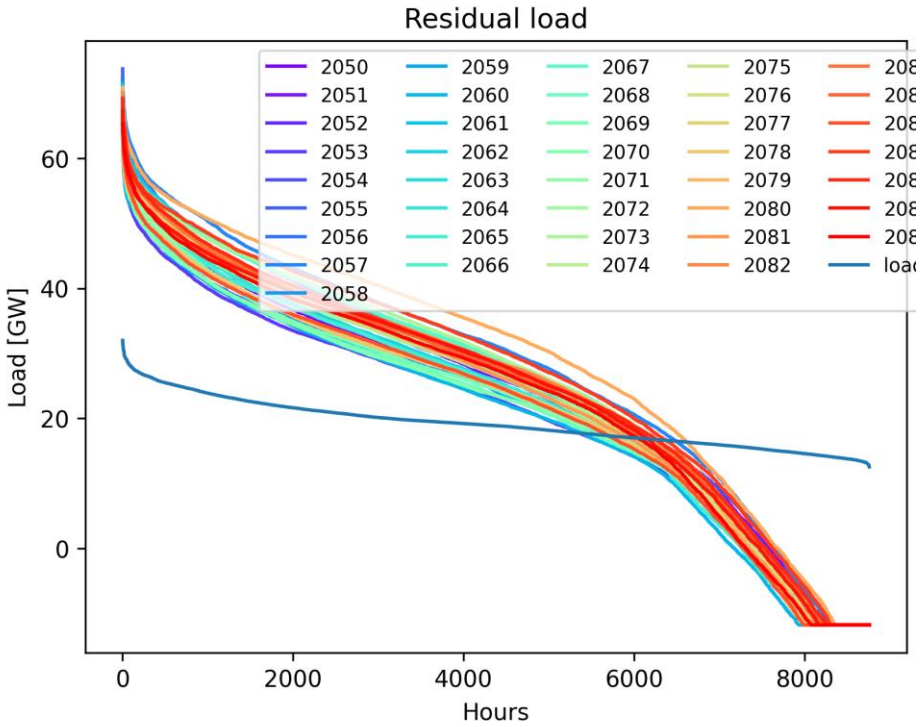


Modelling flexibilities in AMIRIS

Load	Load shifter	Type
Flexible consumers	Percentage of load	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 hourly temperature and hour of the day	Static
EV load	According to projected EV shares	Static

High res (less capacity, more offshore, more hydrogen)

Low res



Lower residual load at more hours