Effects of power plants mothballing on electricity markets

Ahmed Ousman Abani[*,+], Marcelo Saguan[x], Vincent Rious[x], Nicolas Hary[*,+]

[*] Mines ParisTech/PSL Research University, France

[+] Microeconomix (Deloitte France), France

[x] Florence School of Regulation, Italy

15th IAEE European Conference, 6 Sept. 2017

Outline

- **Motivation and research question**
- Methodology
- Simulations and results
- Concluding remarks

Motivation and research question

- Until recently, mothballing decisions have been overlooked in dynamic simulation models used for generation adequacy assessment

- This paper aims at:
  - Proposing a methodology for the integration of mothballing decisions in dynamic simulation models
  - Assess the consequences of such decisions in the case of an energy-only market in terms of:
    - Investments
    - Shutdowns

Outline

- Motivation and research question
- **Methodology**
- Simulations and results
- Concluding remarks

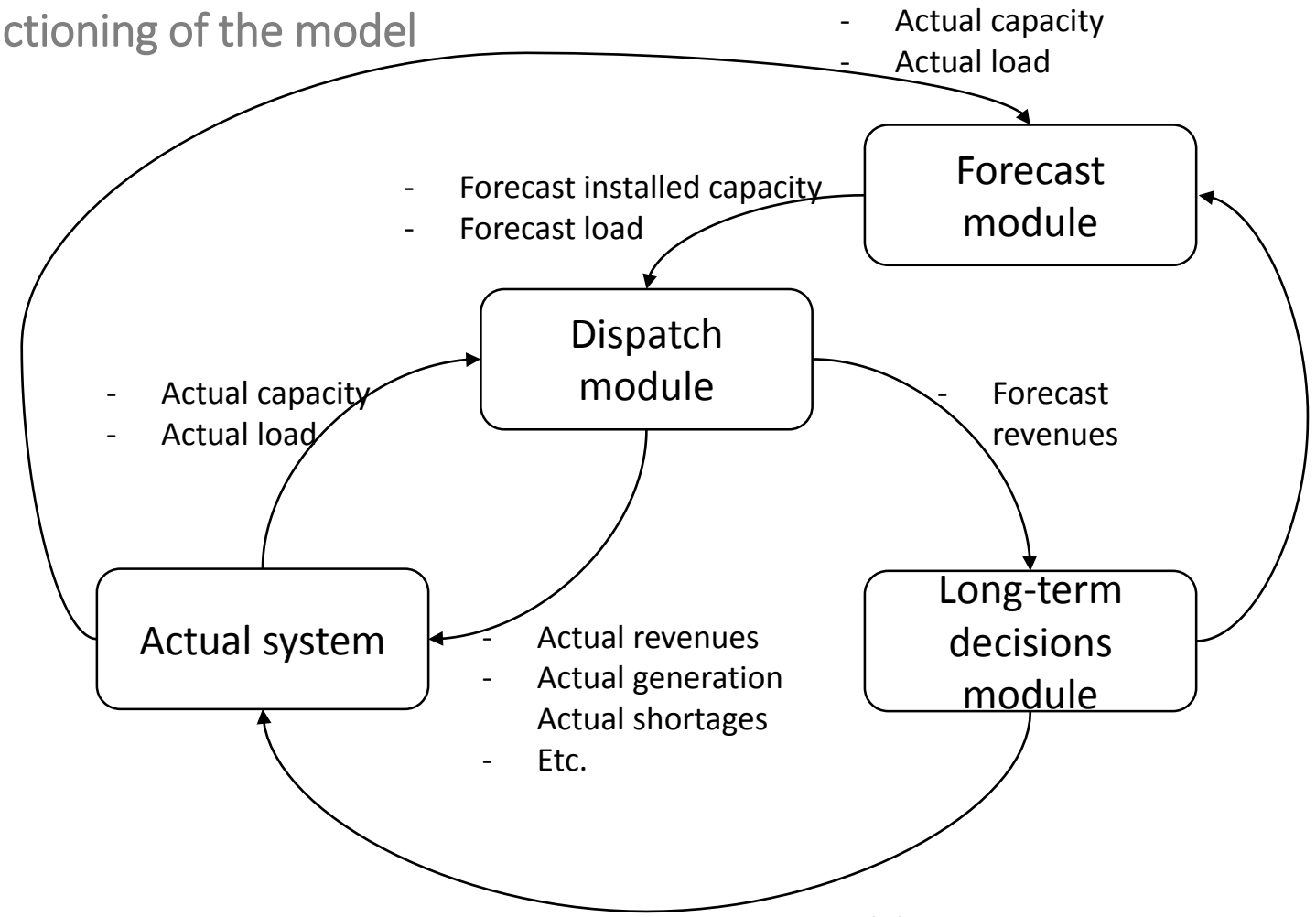
Methodology (1/7)

General functioning of the model

- Main features and assumptions of the model
  - System dynamics approach
  - Representative agent
  - Energy-only market (for now)
  - Several generation technologies (Nuclear, Coal, gas-fired CCGT, oil-fired CT)
  - Simple dispatch module (for now)
  - Uncertain electricity demand
  - Yearly time step for investments/mothballings/shutdowns

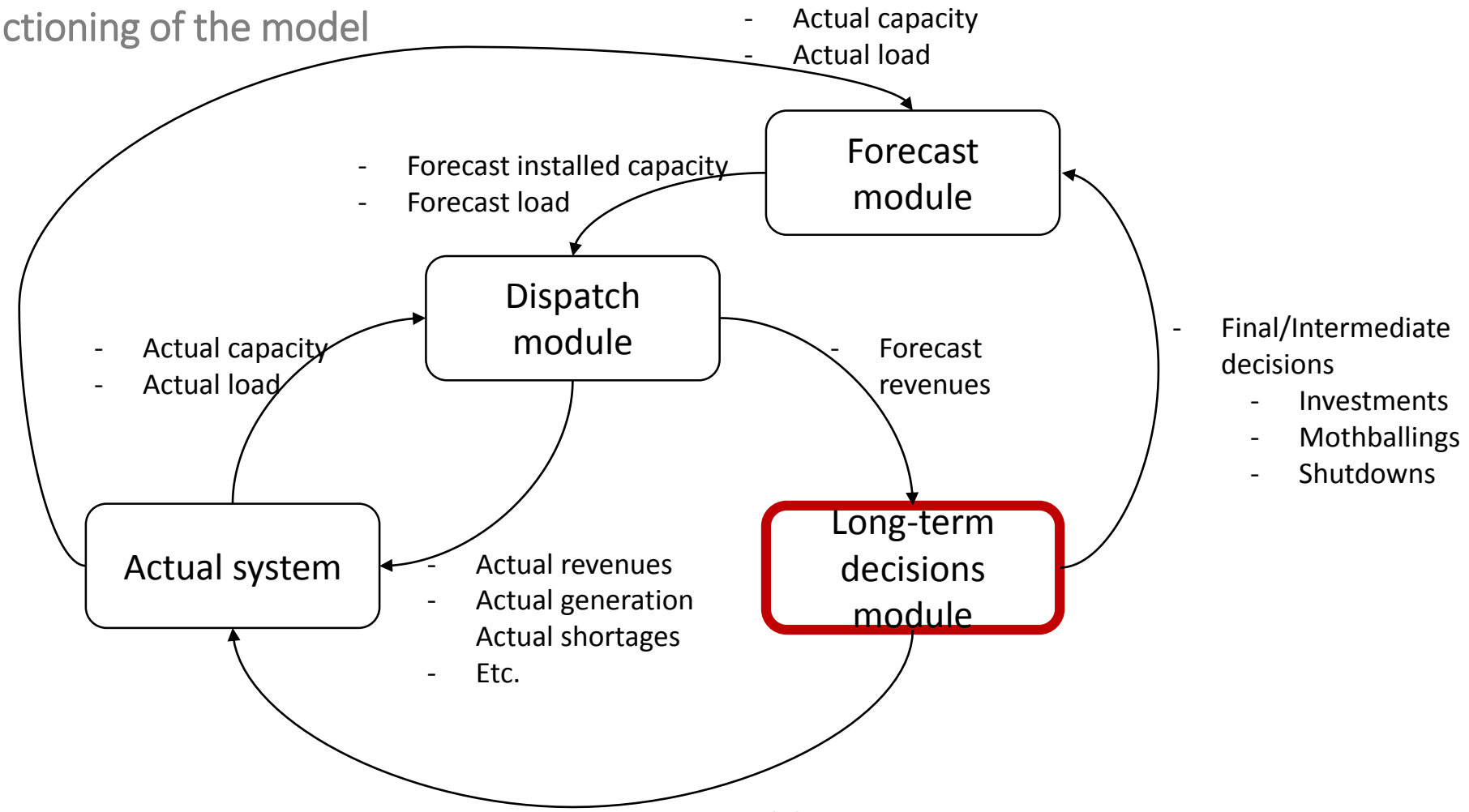
Methodology (2/7)

General functioning of the model



Methodology (3/7)

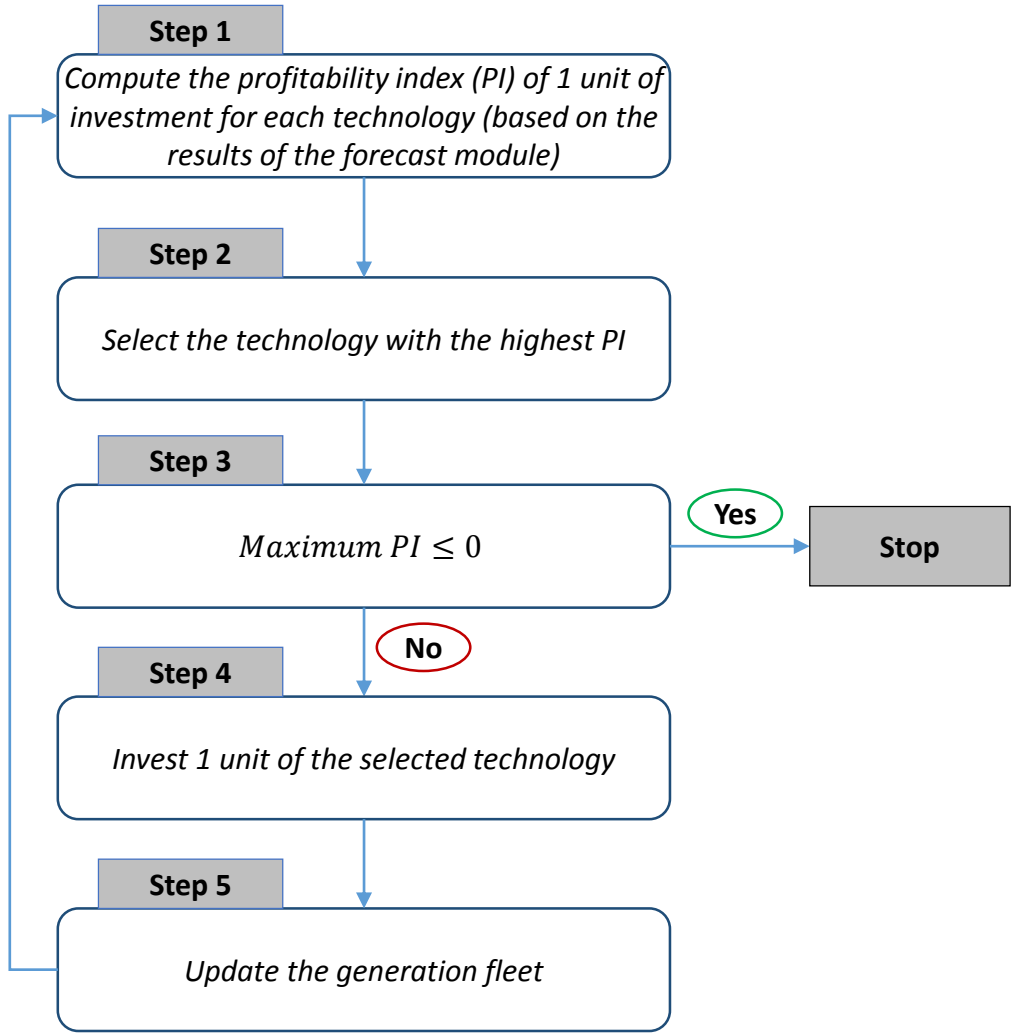
General functioning of the model



Methodology (4/7)

Investment decisions

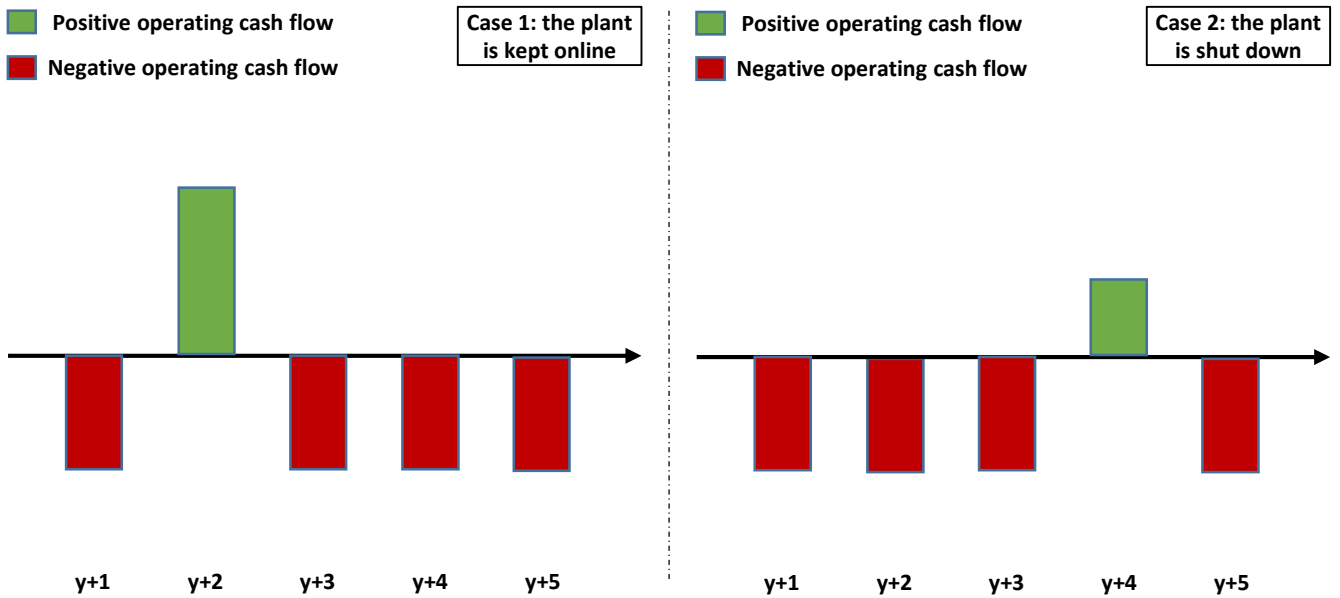
- Investment decisions are based on the results of the forecast module
- The attractiveness of an investment is assessed through the profitability index (NPV divided by investment cost)
- Agents select the one with the highest profitability index first
- They add capacity until new investments are no longer profitable



Methodology (5/7)

Simple shutdown decisions (without mothballing)

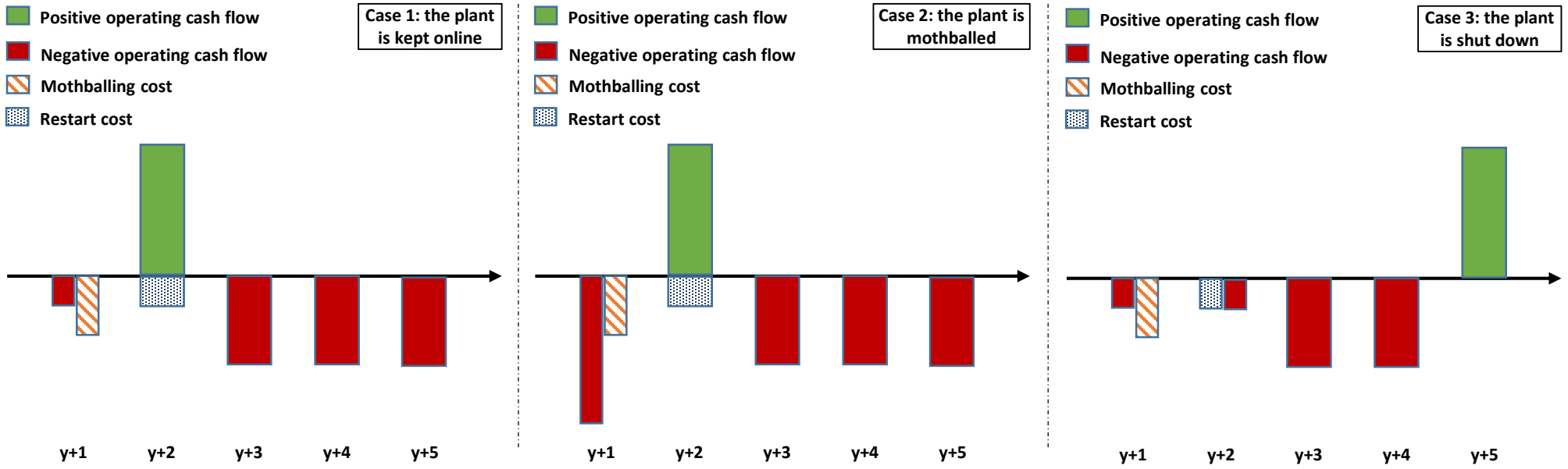
- Shutdown decisions are based on the expected profitability of operating the plant over the forecast horizon



Methodology (6/7)

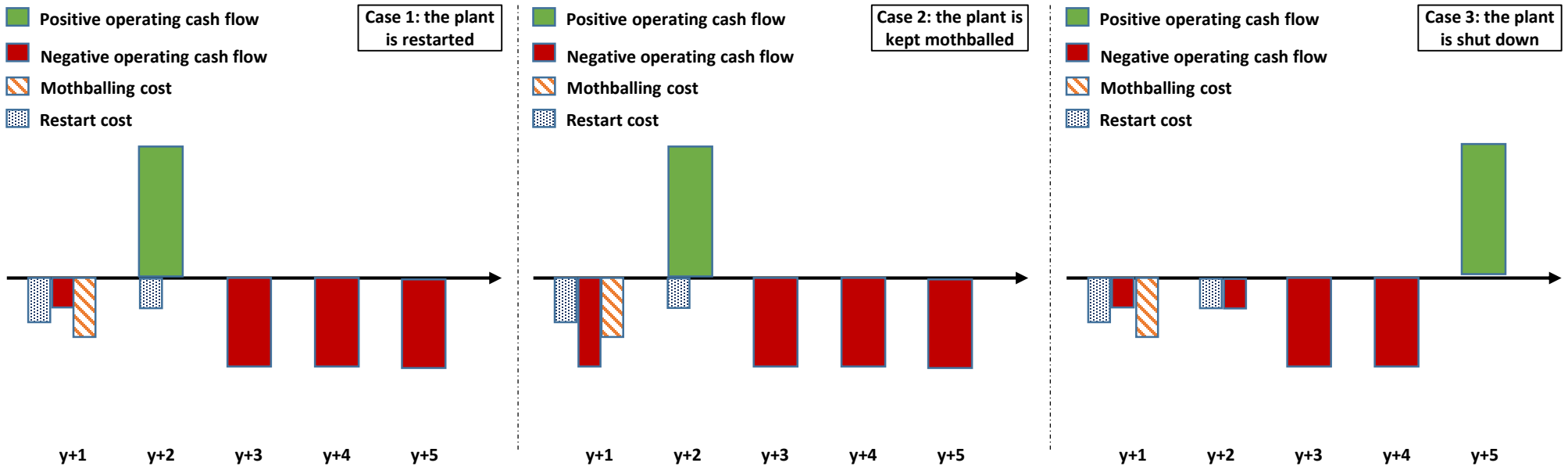
Shutdown and mothballing decisions – Example for an active plant

When mothballing is considered, the decision process is more complex but the general logic presented before remains



Methodology (7/7)

Shutdown and mothballing decisions – Example for a mothballed plant



Outline

- Motivation and research question
- Methodology
- **Simulations and results**
- Concluding remarks

Simulations and results (1/4)

Simulations setup

- Comparison between two settings using a Monte Carlo simulation (200 runs) over a 20-year horizon
  - A setting in with no possibility to mothball plants ➔ Setting 1
  - A setting in which mothballing is allowed ➔ Setting 2

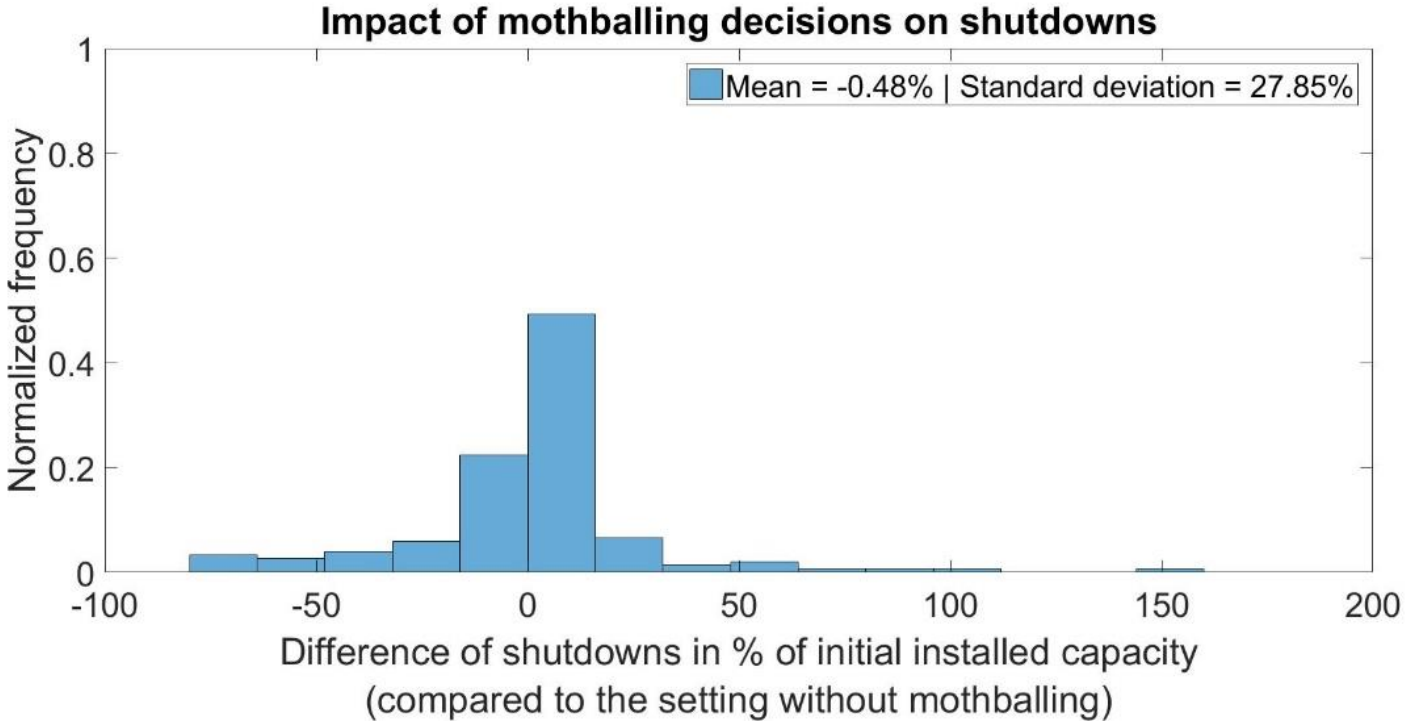
- We use data from the literature (IEA 2015, Petitet 2016) for plants parameters

- Mothballing and restart costs are modelled as a % (25%) of annual O&M costs based on Frontier Economics (2015)

- The model is initialized with an optimal generation mix (based on the French load duration curve for 2015)

Simulations and results (2/4)

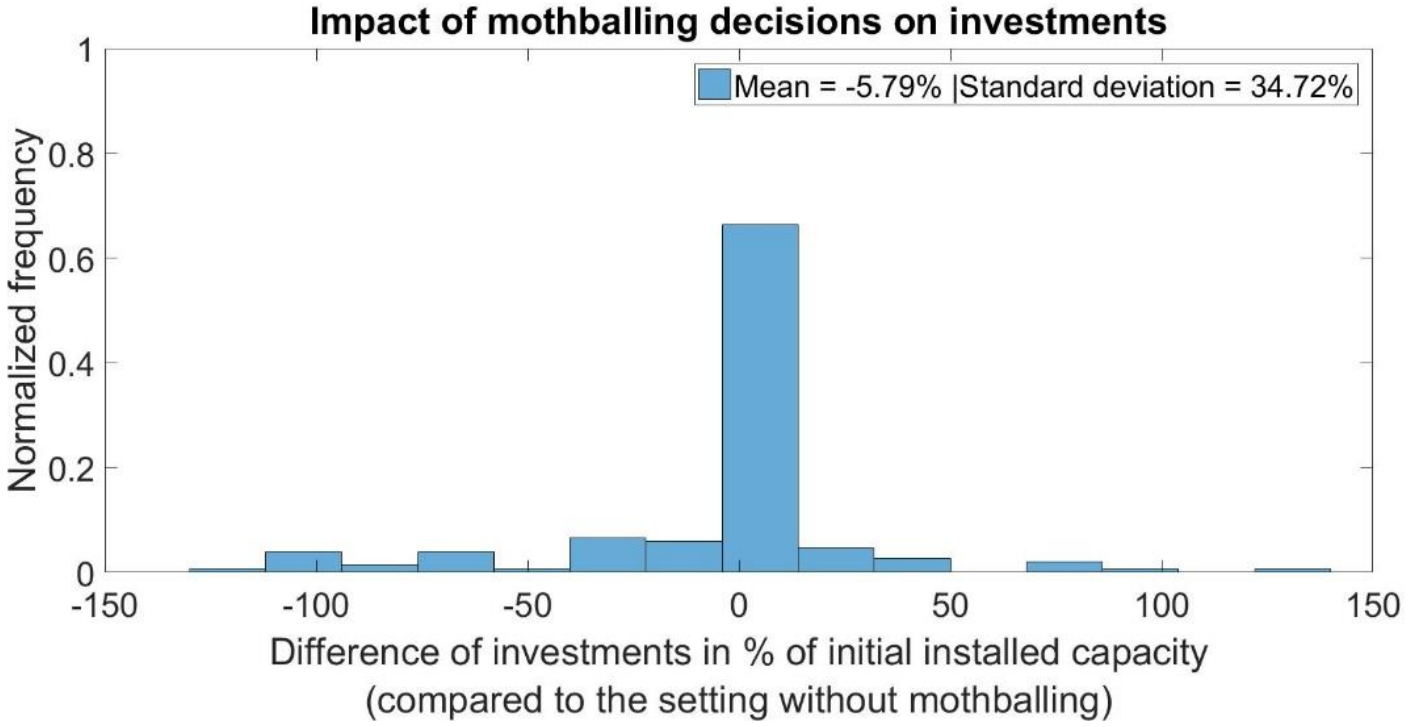
Impact of mothballing on shutdown levels (Monte Carlo)



- There seems to be no significant effect on the overall level of shutdowns on average
- However mothballing tends to delay shutdowns (not visible on this figure)

Simulations and results (3/4)

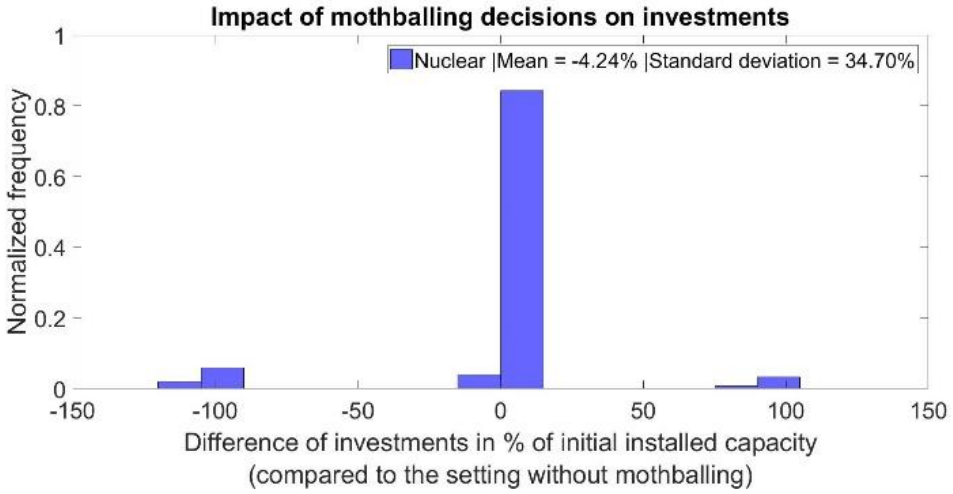
Impact of mothballing on investment levels (Monte Carlo)

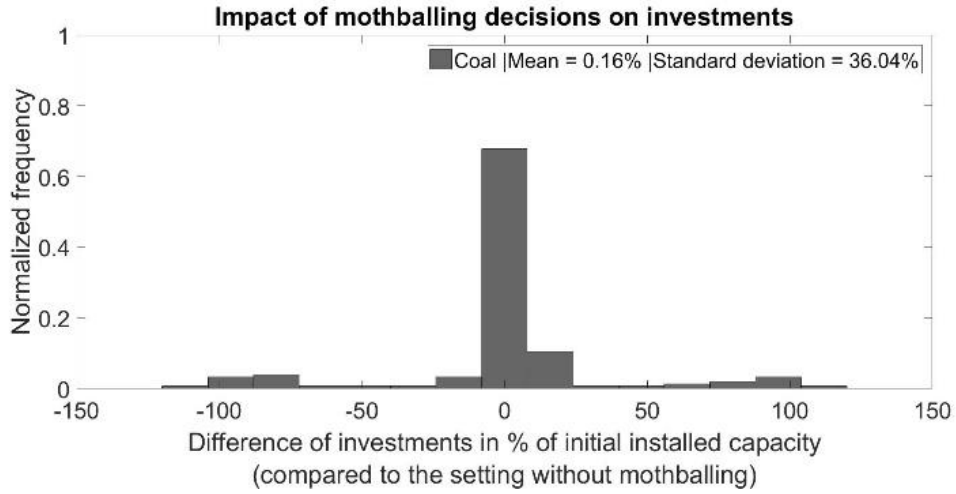


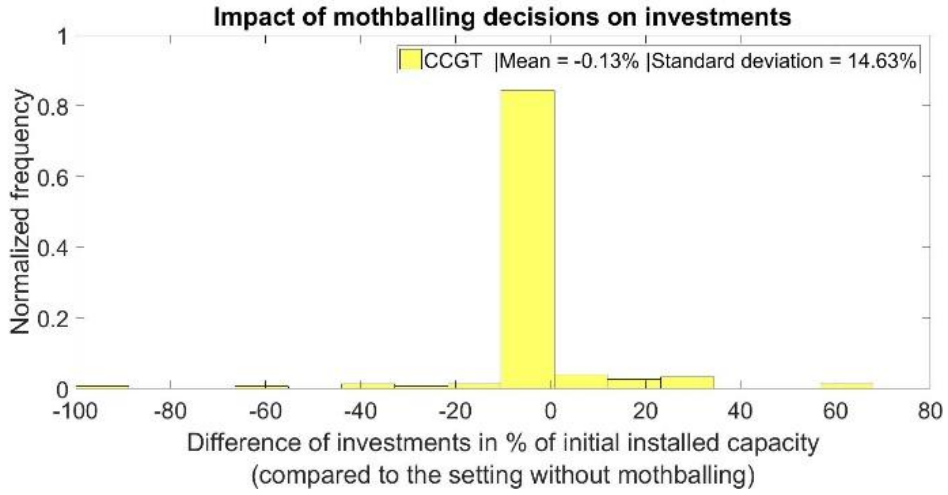
- Investment levels are reduced (on average) when mothballing is introduced
- This effect is different depending on the technologies (see next slide)

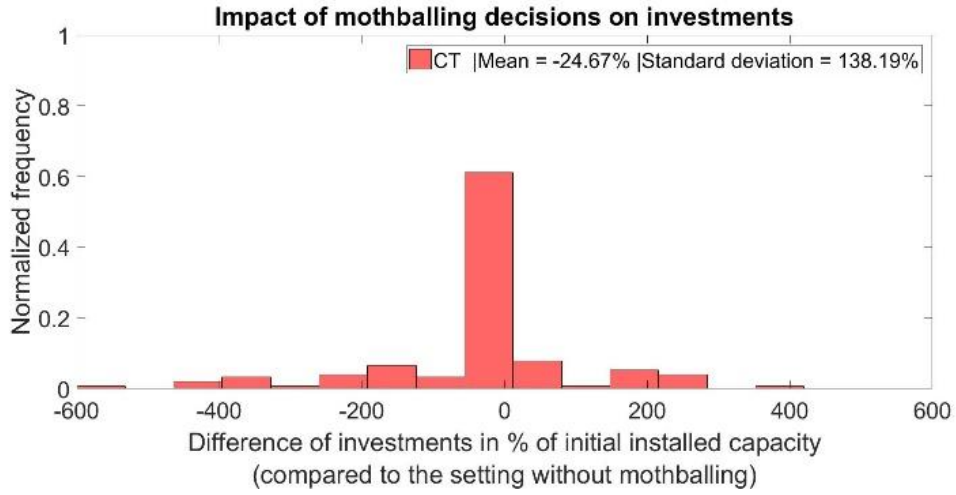
Simulations and results (4/4)

Impact of mothballing on investment levels (Monte Carlo)









Outline

- Motivation and research question
- Methodology
- Simulations and results
- **Concluding remarks**

Concluding remarks

- Our method primarily choses the least cost strategy between mothballing and staying online (or restarting and staying mothballed)
  - It also ensures that the selected strategy is profitable ultimately (given agents' expectations)
  - Shutdown is only considered in last resort
- In an energy-only market, our simulations suggest that recurrent mothballings lead to lower levels of investments (particularly in CT)
- Shutdowns are delayed due to mothballings but there seems to be no significant effect on their level in the long run
- Further work include
  - Adding some technical constraints in the dispatch module to represent flexibility (min load, ramp-up/down, etc.)
  - Modelling other types market designs (e.g., capacity mechanisms)
  - Finding more information on mothballing/restart costs

Thank you !

Feel free to send me your comments at:

ahmed.ousmanabani@mines-paristech.fr
aousmanabani@deloitte.fr