Comparing flexibility options in Balmorel

Niels Nagel

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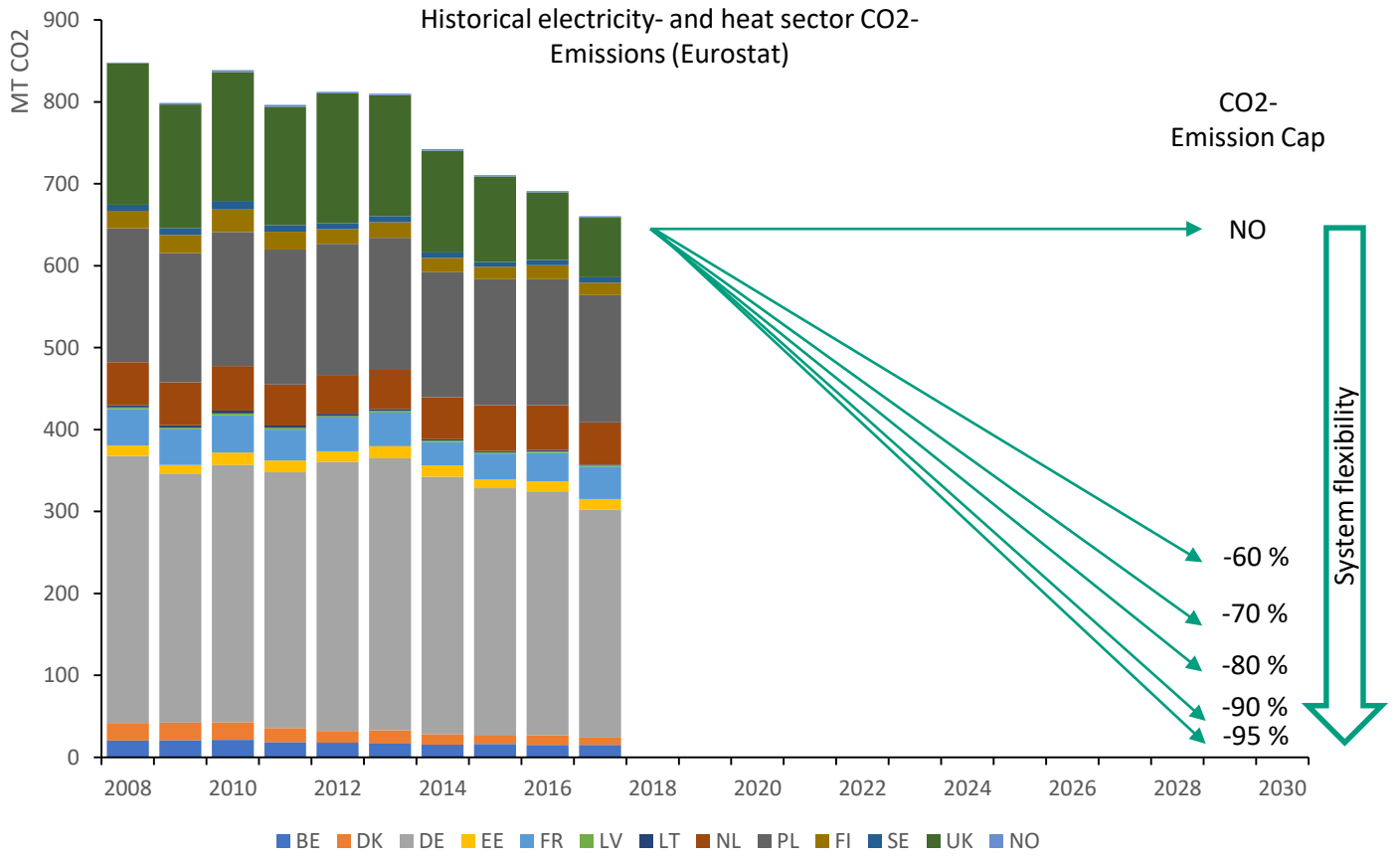
Background

- European ambition to move towards a cleaner energy system
- Increasing amounts of intermittent renewable energy entering the system
- Flexibility options needed to maintain reliability and increase efficiency of the energy system



Research objective

1. Analyze effect of flexibility options on total system costs in 2030
2. Profits for suppliers of flexibility, winners and losers of the transition towards a low emission energy system
3. Competition between flexibility options
4. Similarities and differences between the total system and the Nordics

Method and Scenarios

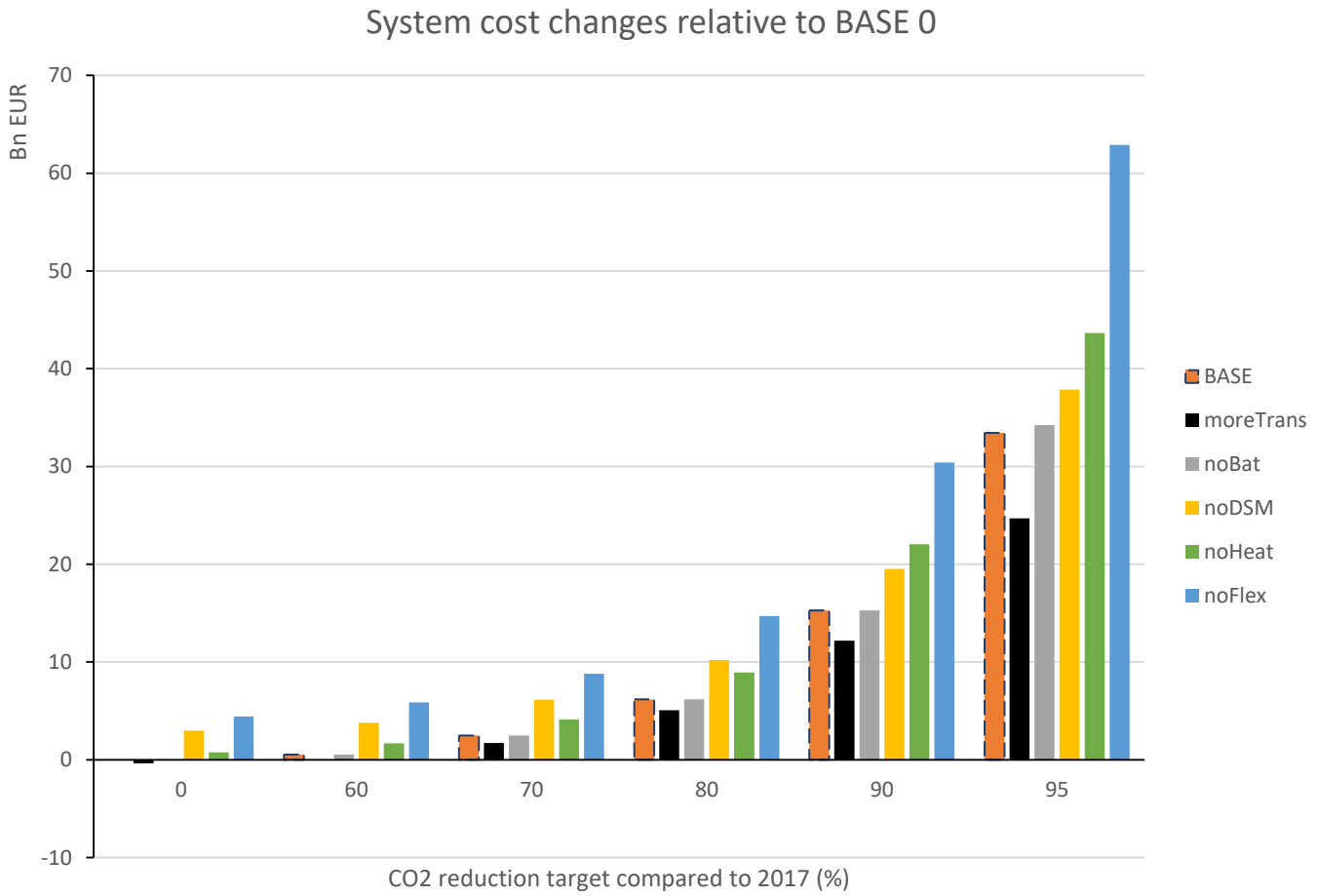
Method:

- Balmorel model
- Run scenarios which exclude one flexibility option at a time
  - Effect on system costs
  - Interaction with other flexibility options
- Run scenarios with 6 different decarbonization pathways
  - Effect of decarbonization pathway on profit for suppliers of flexibility

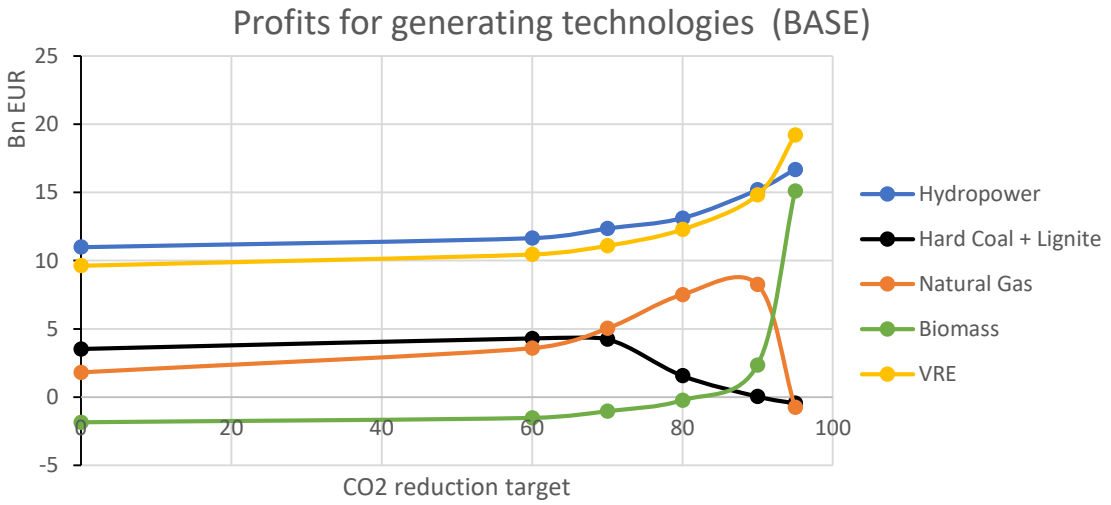
Scenario	Description
BASE	All flexibility options available and planned transmission from TYNDP 2020 until 2030
moreTrans	Endogenous transmission investment allowed
noDSM	No flexibility from EV's and demand response
noHeat	No investment in heat storage and PtH technologies
noBat	No investment in battery storage
noFlex	All above mentioned flexibility options are restricted
noPtH	No investment into PtH technologies
noHeatSto	No investment into heat storage technologies
noDR	No demand response for load shifting
noEV	No controlled charging («smart charging») available
noTrans	No transmission investment in planned projects after the year 2023

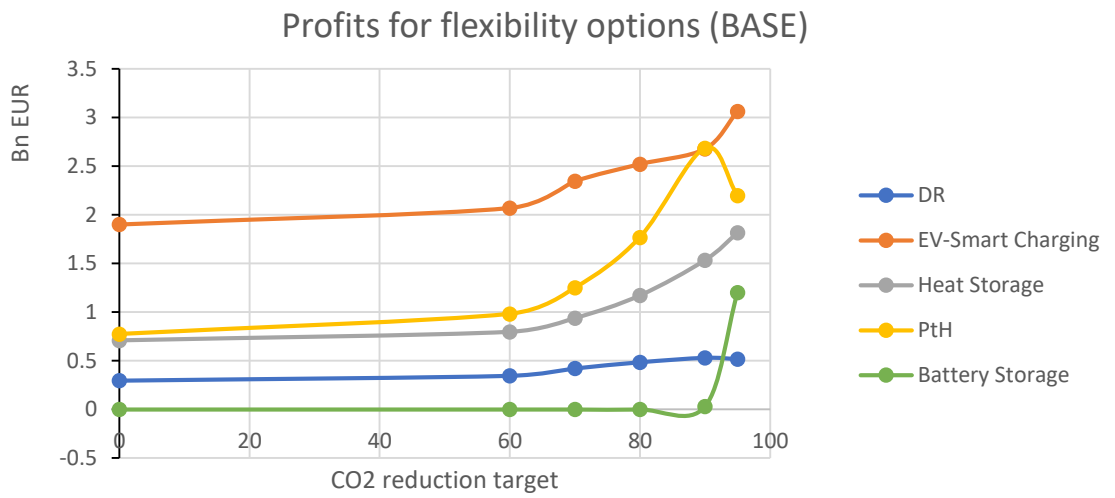
Results – System costs

- Higher emission reduction targets increase system costs
- Removing flexibility increases the costs further
- Transmission and sector coupling with the heat sector offer largest savings in deep decarbonization scenarios
- In lower emission reduction scenarios DSM offers the largest savings



Results - Profits at increasing CO2 reduction targets



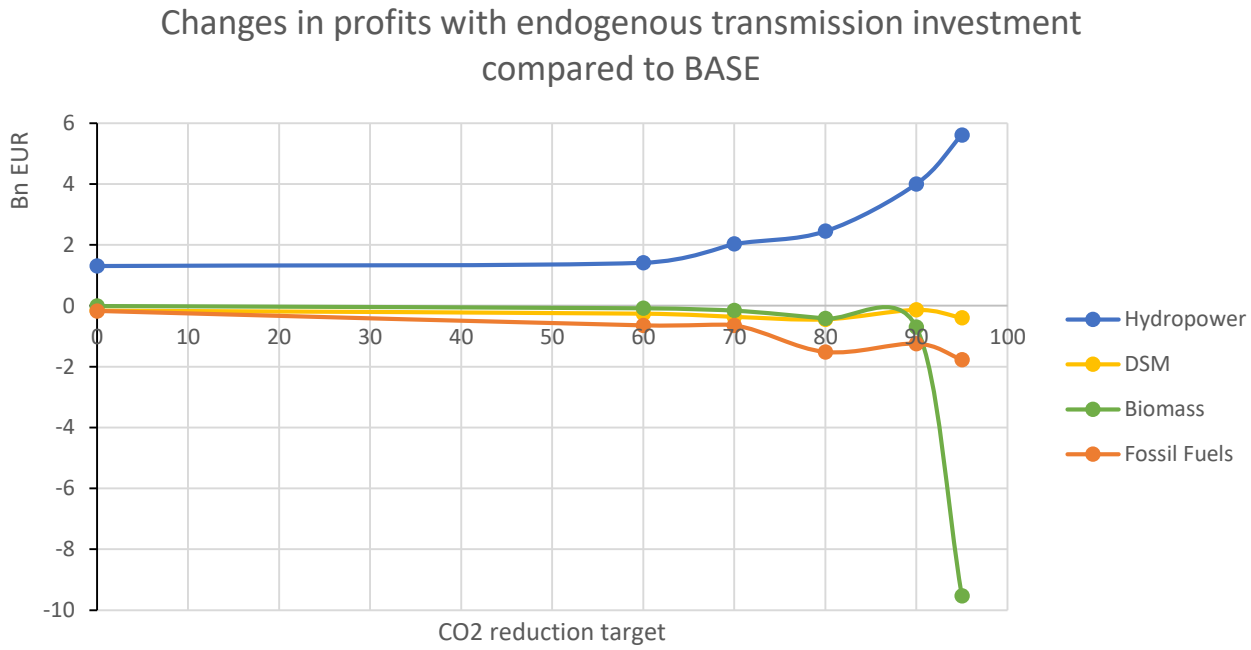


- Profits for all suppliers of flexibility except fossil fuel generation increase with increasing CO2-restrictions
- Profits per unit increase due to higher price variation in higher CO2 reduction scenarios
- Biofuels, PtH and heat storage profits rise strongly in deep decarbonization scenarios
  - Extreme price volatility in heat sector
  - Low competition with increasing phase out of fossil fuels

Results - Competition between flexibility option

Transmission investment:

- Decreases profits for Biomass, fossil fuels and DSM
  - Less price spikes in el. and heat sector
- Benefits Hydropower and coupling with heat sector
  - More price variation in the Nordics
  - More el. exports to central Europe
  - Higher utilization of PtH

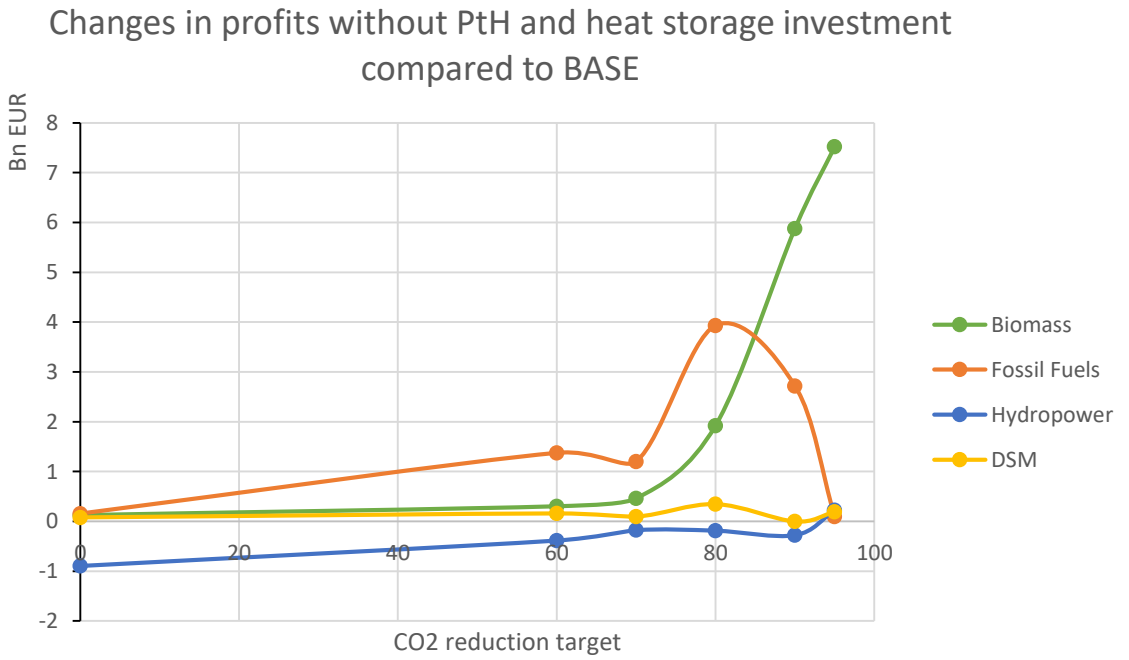


Results - Competition between flexibility option

noHeat:

- Increases profits especially from heat generation for fossil fuels and biomass
  - competition with PtH and heat storages
- Decreases profits for hydropower
  - less el. demand through PtH

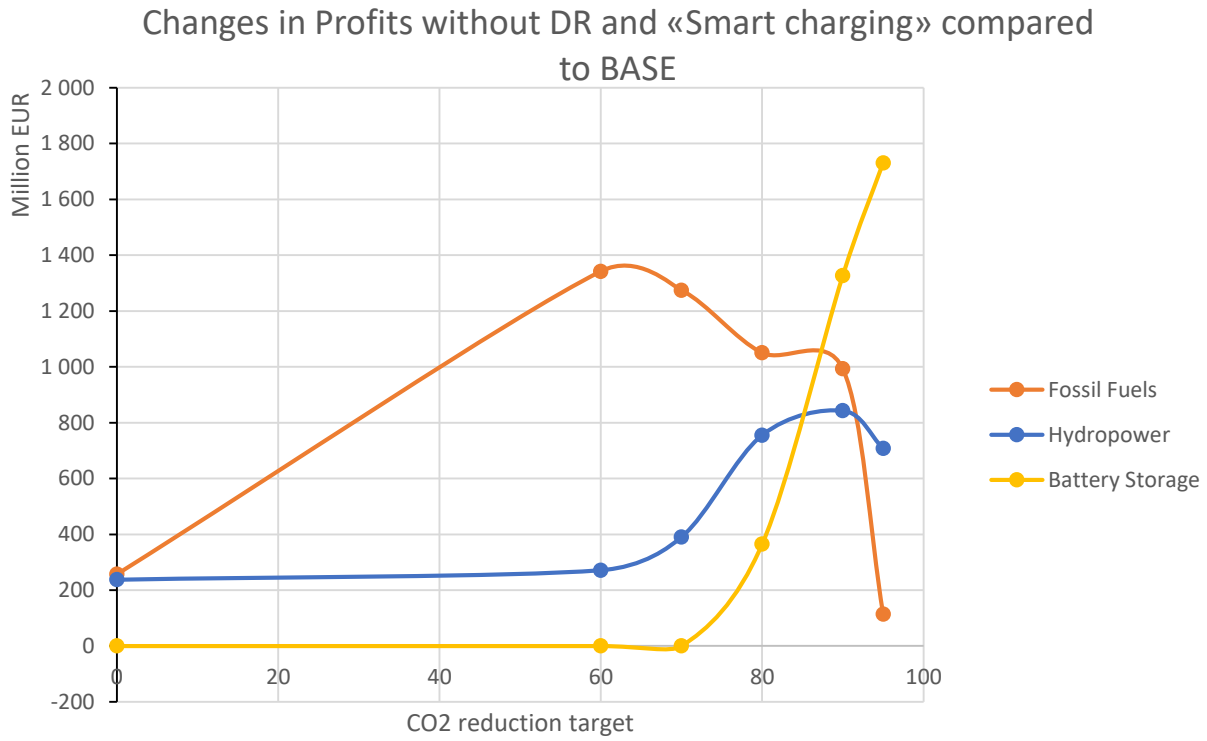
→ Is mainly in competition with dispatchable supply side flexibility in the heat sector (Biomass and fossil fuels)



Results - Competition between flexibility option

noDSM:

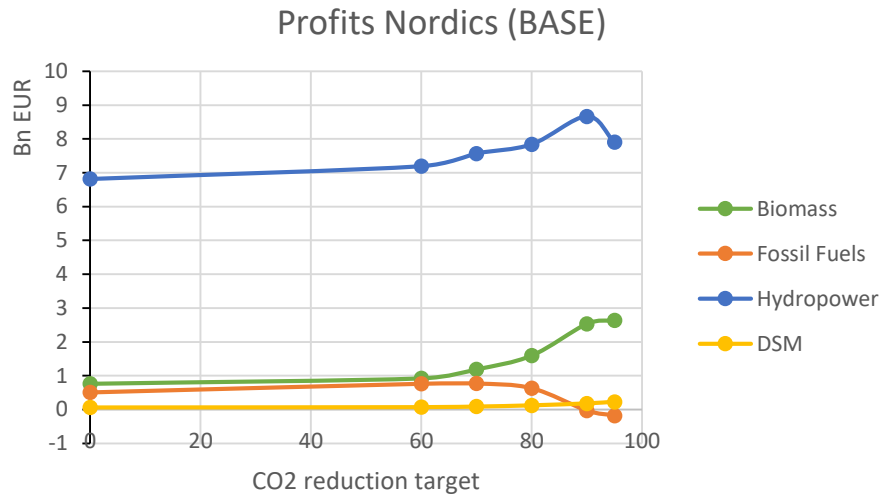
- Profits increase for battery storages, fossil fuels and hydropower
  - Competition between DR, “smart charging” and dispatchable el. generation
  - These flexibility sources are suited to decrease short term price volatility and peak loads in the el. sector
  - Battery storage is outcompeted by EV smart-charging and DR in the BASE scenario

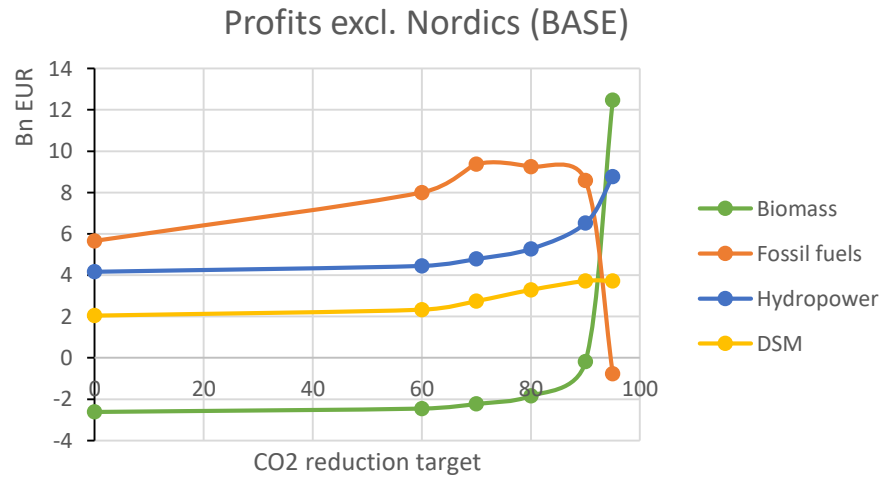


Difference between the total system and Nordics

Role of CO2 emission reduction pathway:

- Biomass profits in deep decarbonization from price volatility in heat sector in central Europe
- Fossil generation continues high profits in central Europe until 90% CO2 reduction
- Flexibility from hydropower gains more value in less flexible regions than the Nordics
- DSM increases profits more in central Europe where the provided flexibility is in higher demand





Difference between the total system and Nordics

Role of flexibility scenarios:

- Endogenous transmission investment
  - favors profits from wind generation in the Nordics
  - More solar PV generation in central Europe with less transmission
- Battery storage is only invested in in low flexibility scenarios in central Europe
- DSM plays a larger role in decreasing price volatility in central Europe as the Nordics are already highly flexible

Conclusion

- Value of flexibility for the system increases exponentially with CO2 reduction target
- No single best flexibility option
- Hydropower and Biomass profit comparatively strongly in deep decarbonization scenarios
- Transmission increases system efficiency but decreases profits for flexibility options (excl. hydropower)
- Flexible generation from natural gas will be profitable until 90% CO2 reduction
- DSM outcompetes battery storage (modelled system grid level) until 95% CO2 reduction