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The Impact of Cross-Border Capacity on Electric and Thermal Storage Investments in Hydro-Dominated Power Systems: A Swiss Case Study

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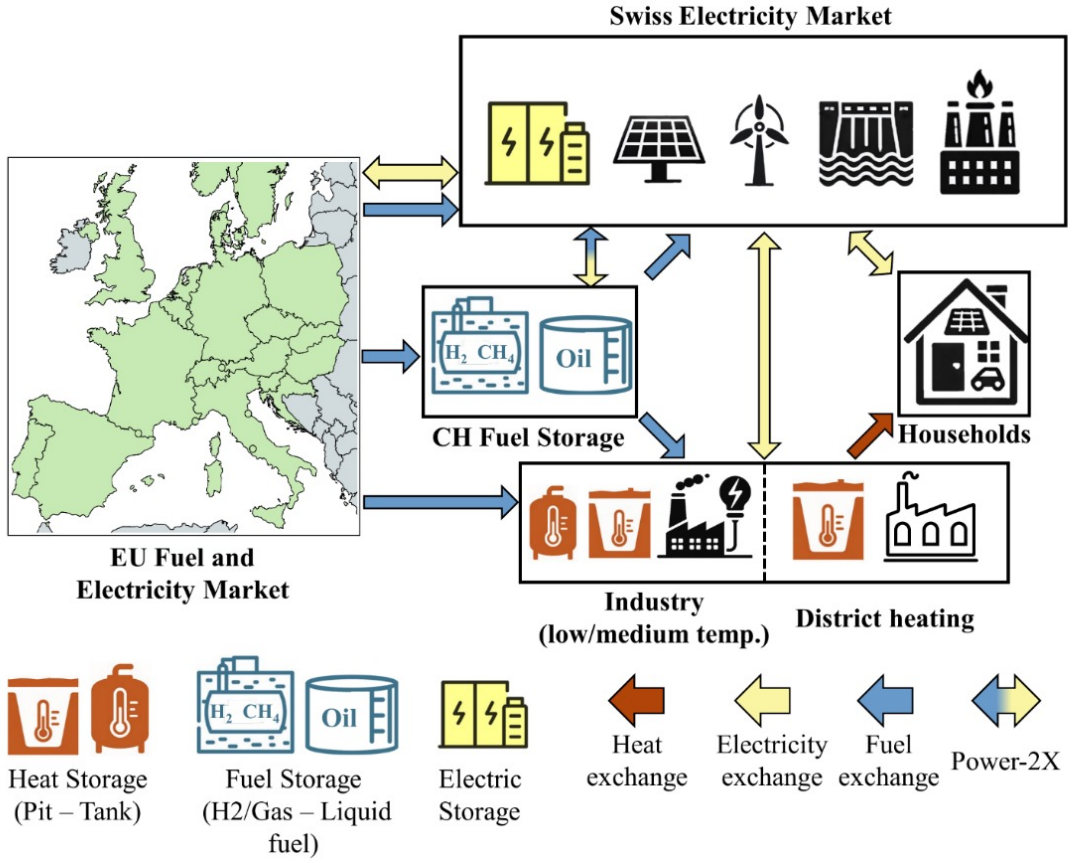
FEM: «Future Energy Market» - Model



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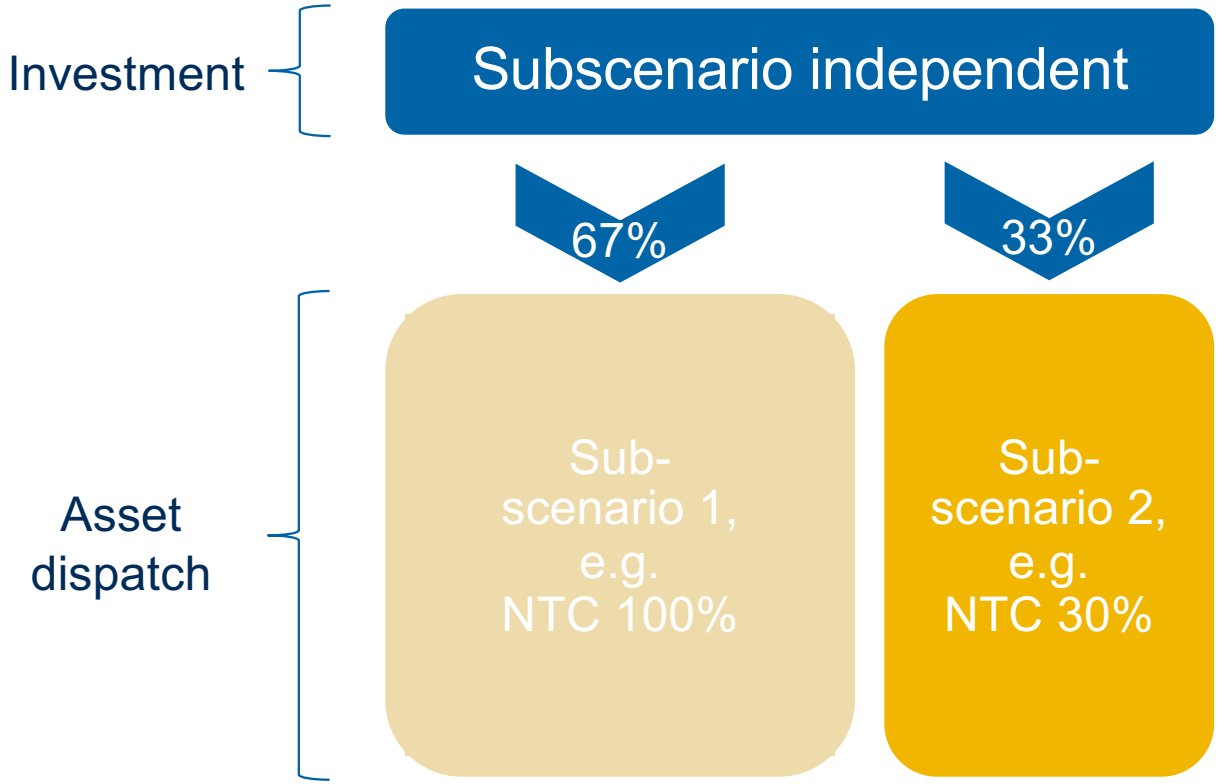
Stochastic optimization models consider multiple scenarios simultaneously and are therefore more robust against uncertainty

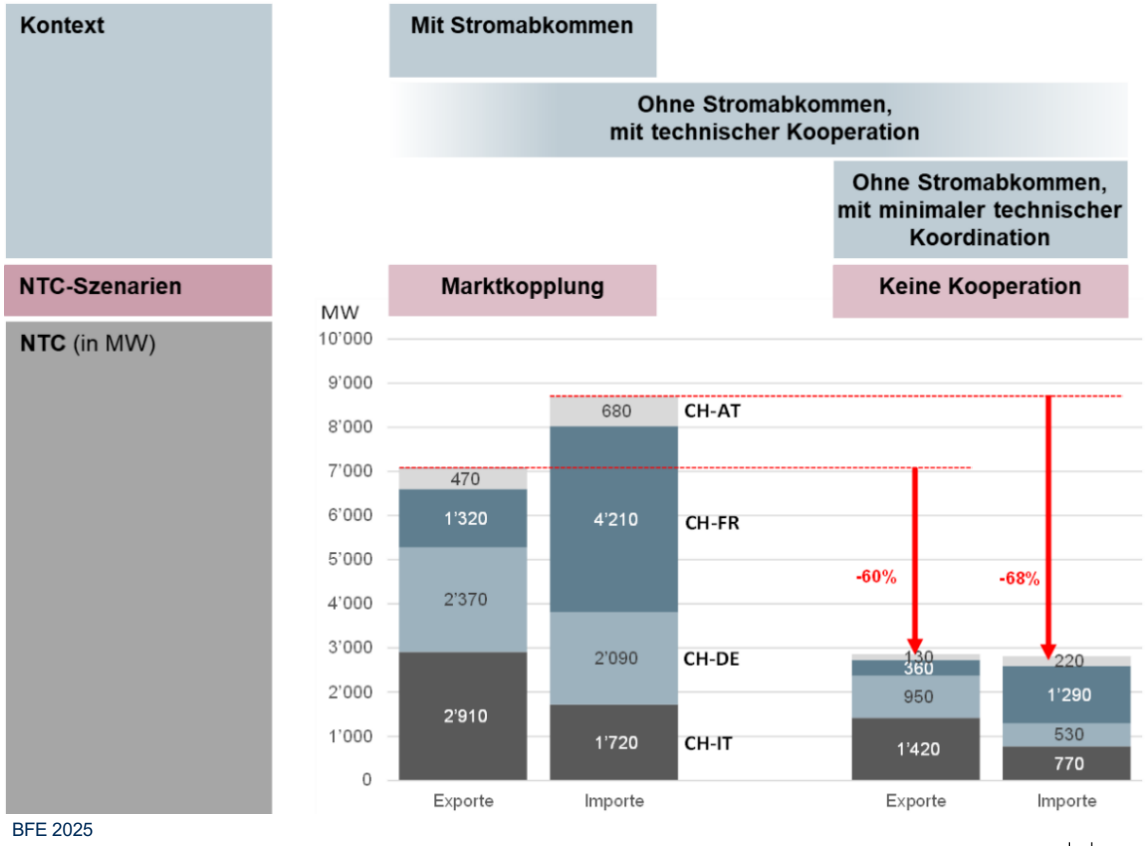
$Objective\ function$:

$$min \quad C^{inv} + \sum_{s \in S} p_s \cdot C_s^{op}$$

s	$Subscenario$
p_s	$Probability$
C_s^{inv}	$Investment\ costs$
C_s^{op}	$Operational\ costs$



Due to the EU's "70%" rule, in the worst case, a reduction by roughly 64% for the NTC can be expected



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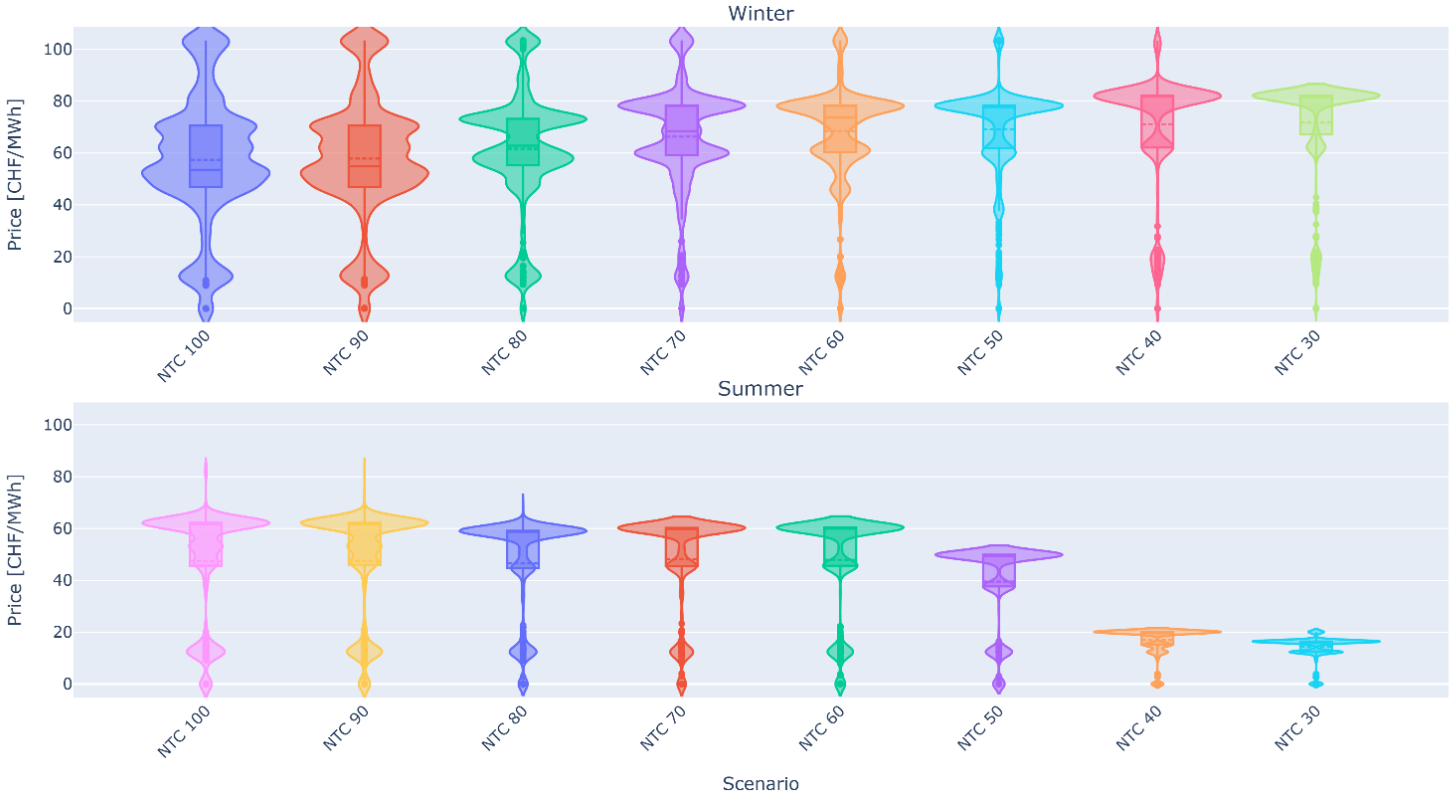
In 2035, limiting the NTC leads to less volatile prices



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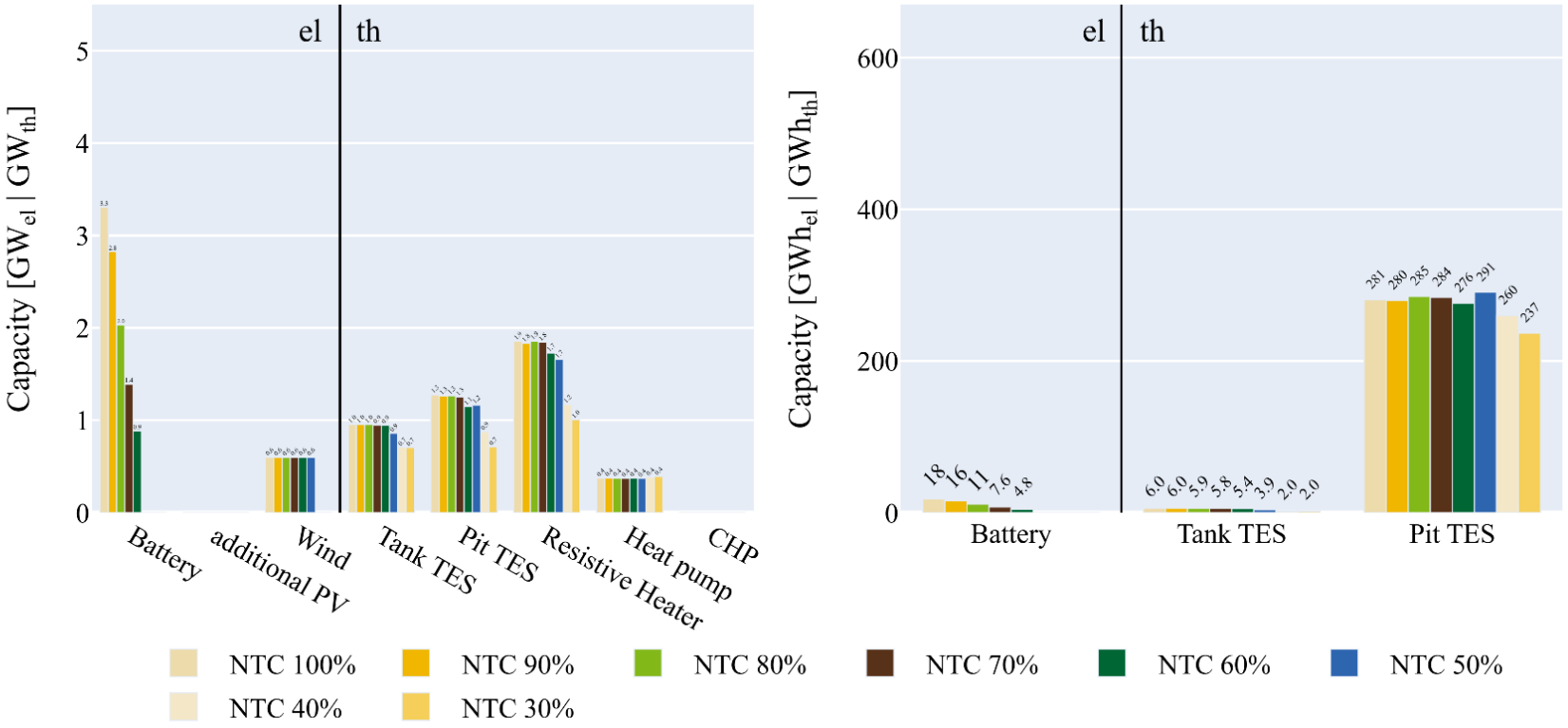
Reduced NTC lead to a diminished price volatility decreasing the battery storage capacity



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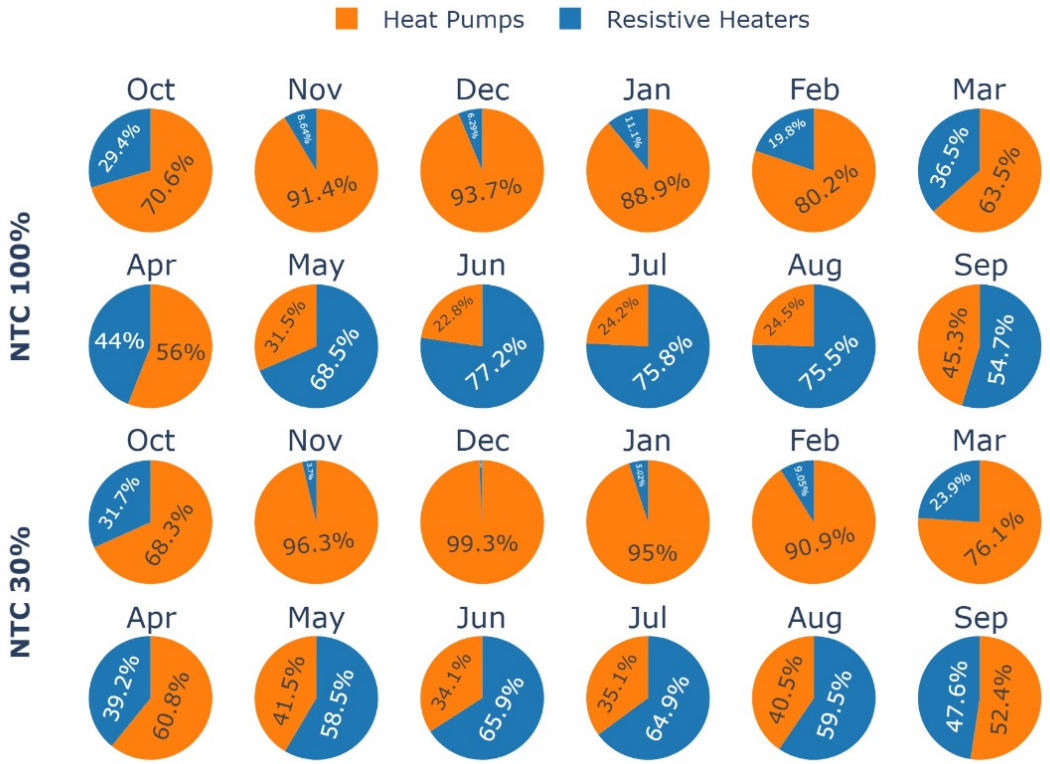
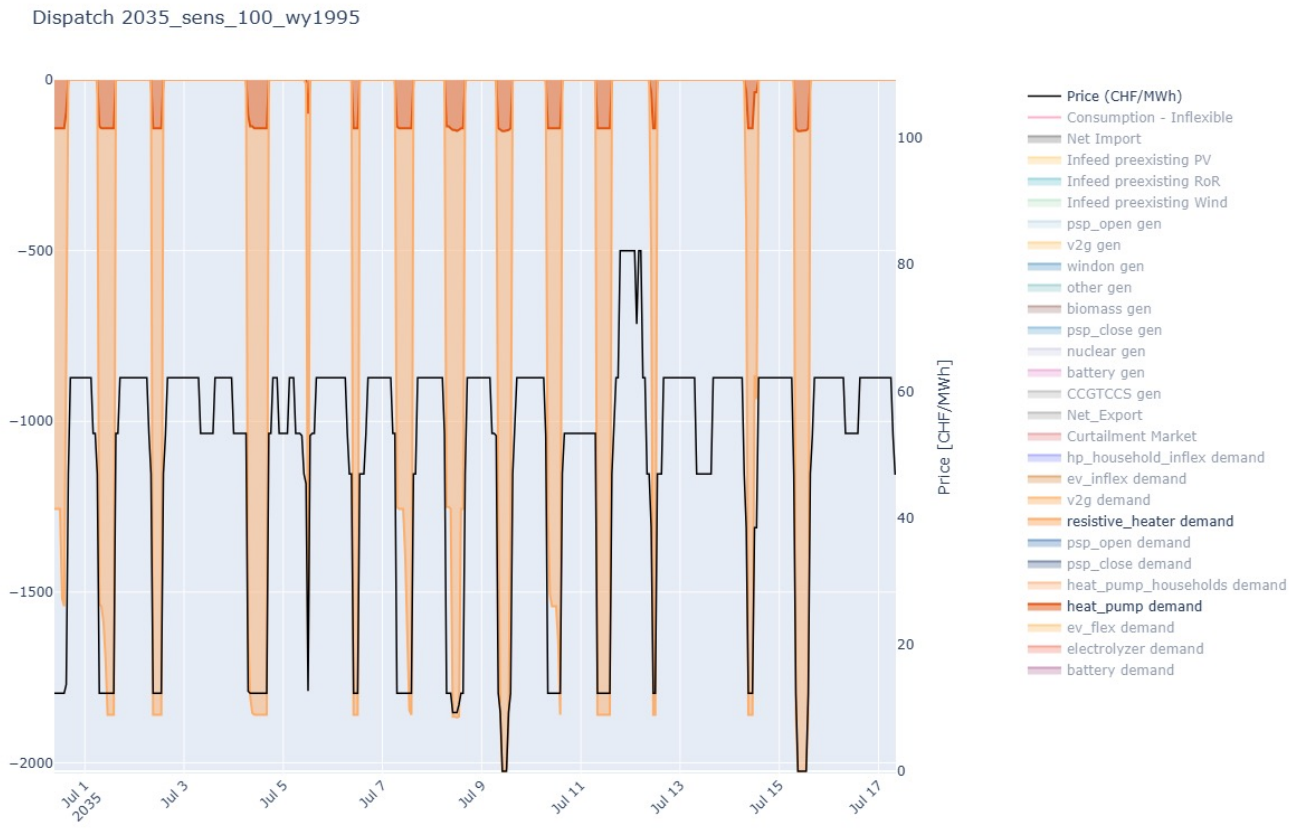
In winter, mostly efficient heat pumps are used. In summer, resistive heaters are used with heat pumps to exploit zero price hours



Surprisingly, Switzerland requires fewer storages with an increased autonomy in 2035



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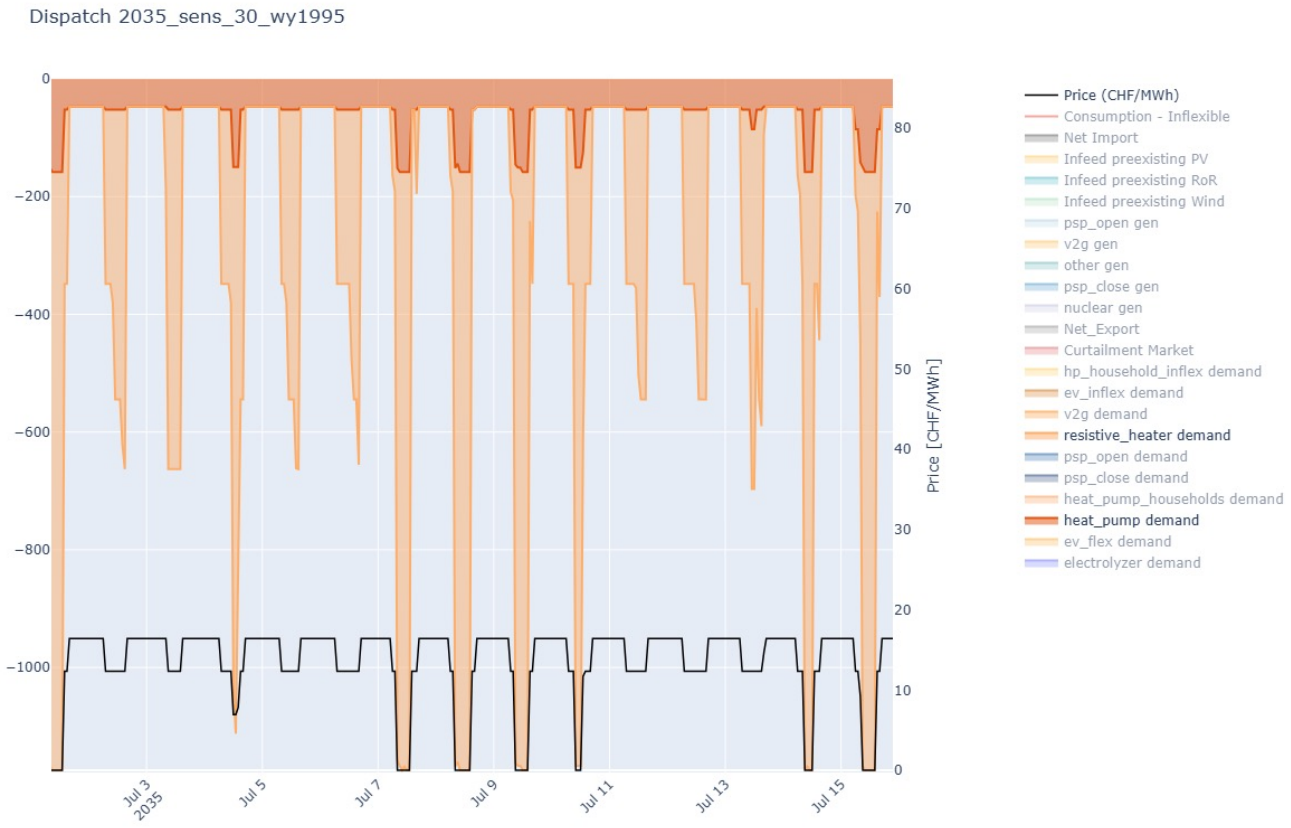

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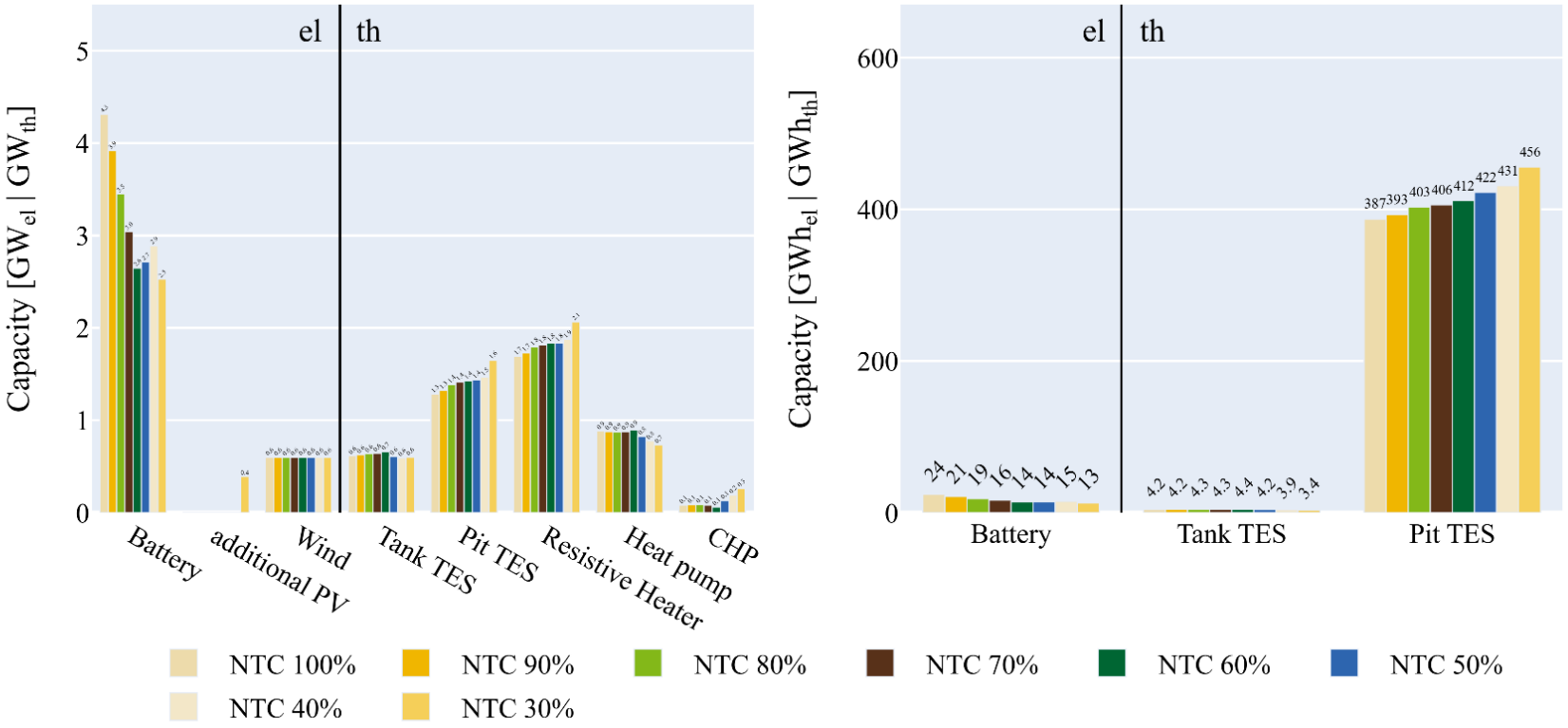
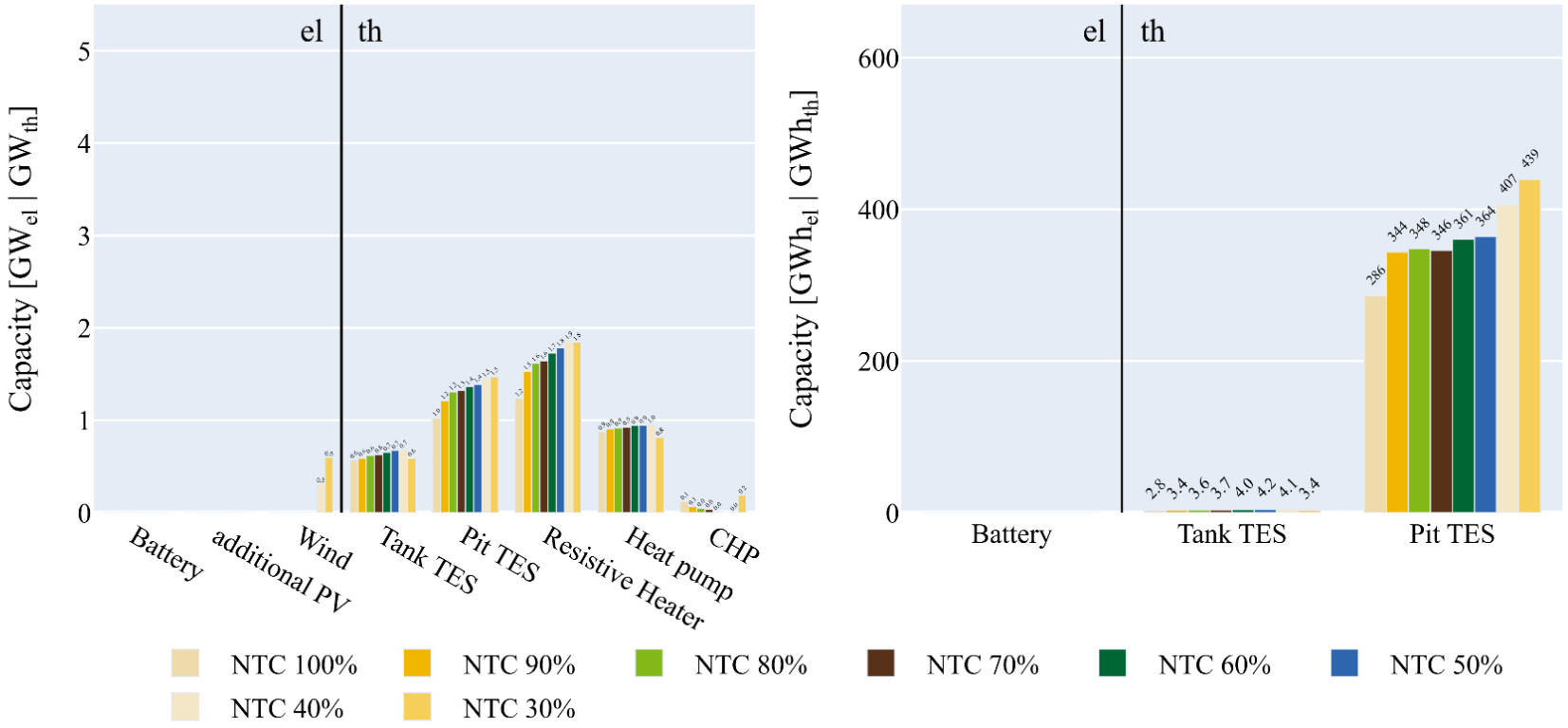
In 2050, battery investments do not show a clear pattern as they did in 2035. Thermal investments are reversed follow the same logic



When AT, DE, FR, IT can invest in batteries too, batteries in CH vanish indicating that before, they addressed arbitrage abroad



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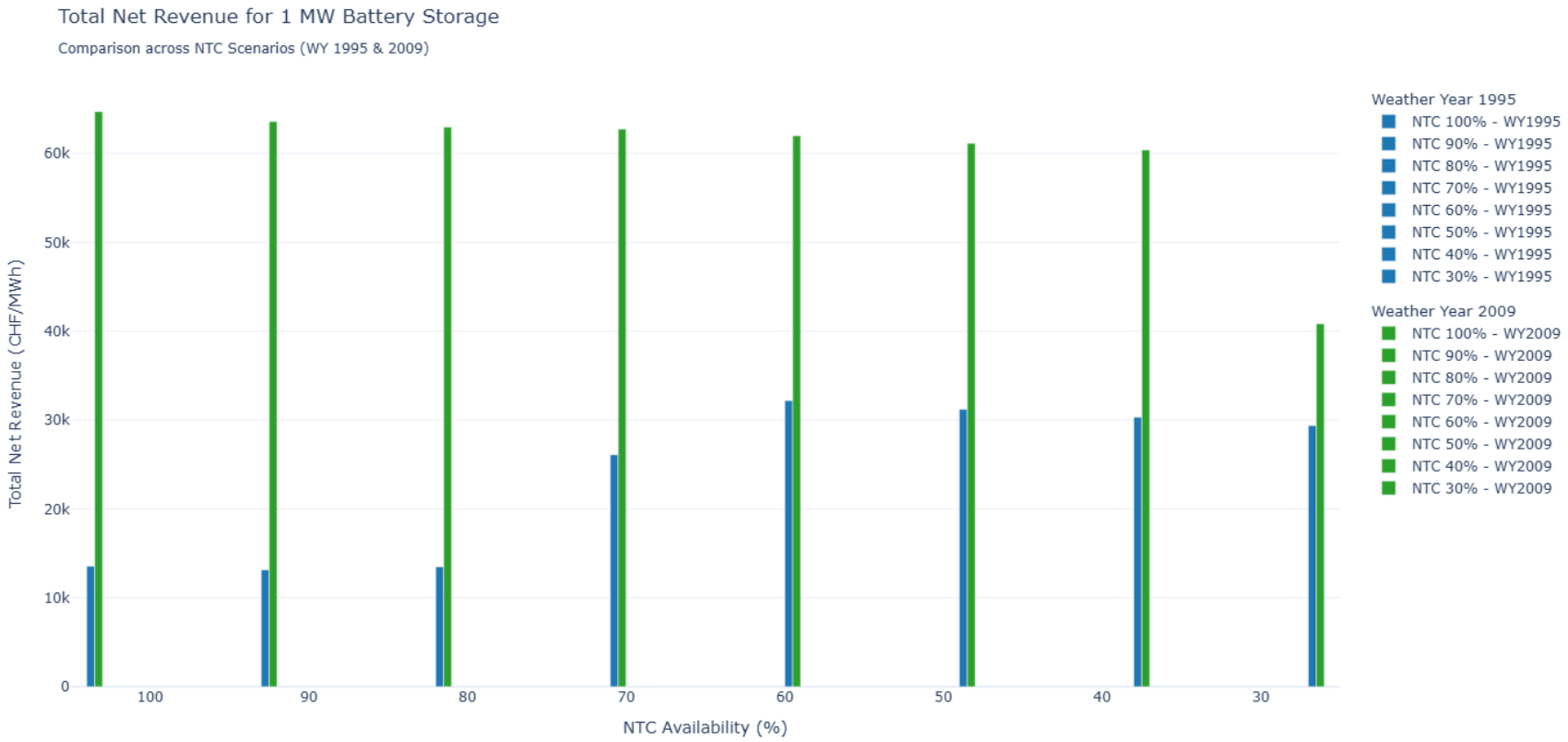
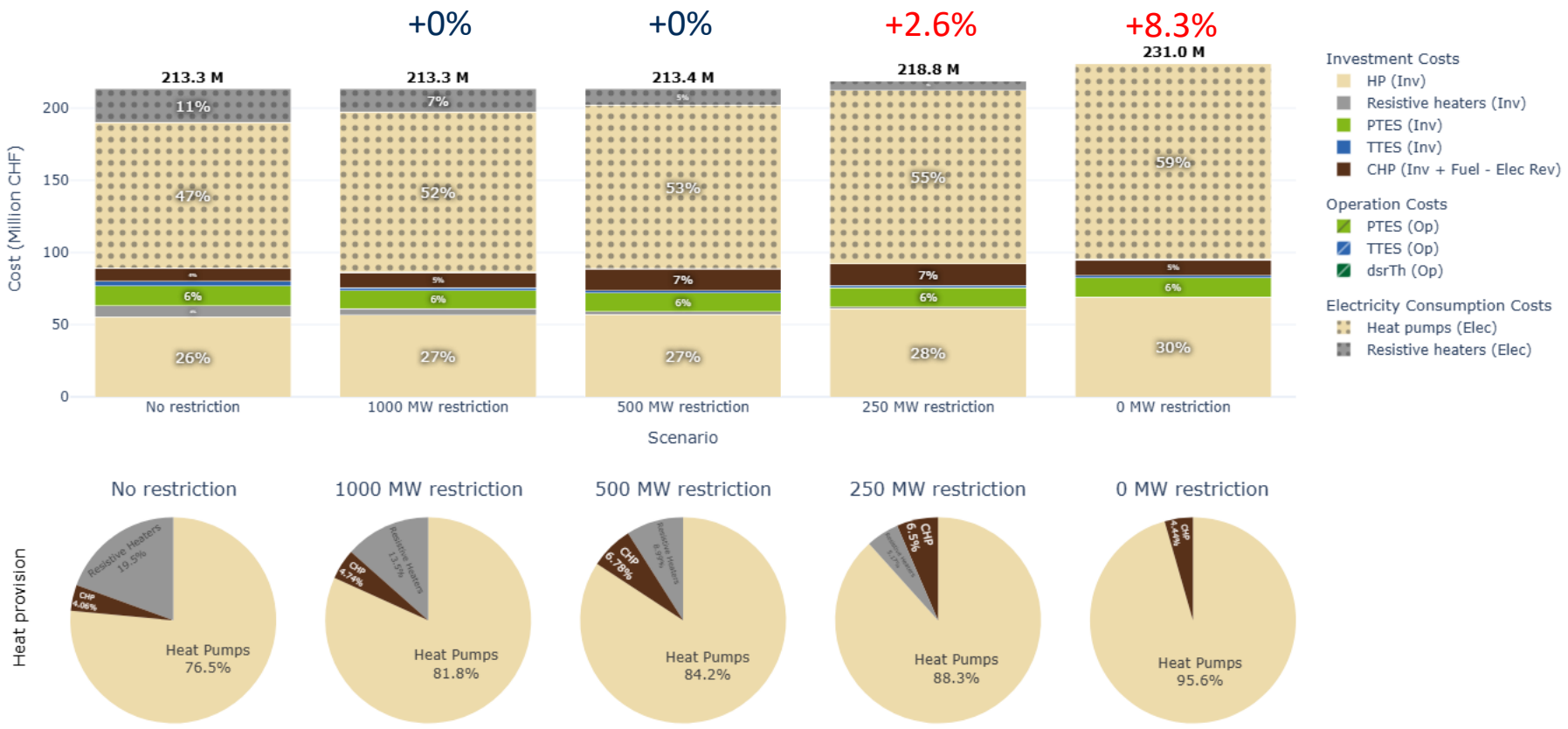
In 2050, 1995 is a surprising weather year with a decreasing profitability of battery storages

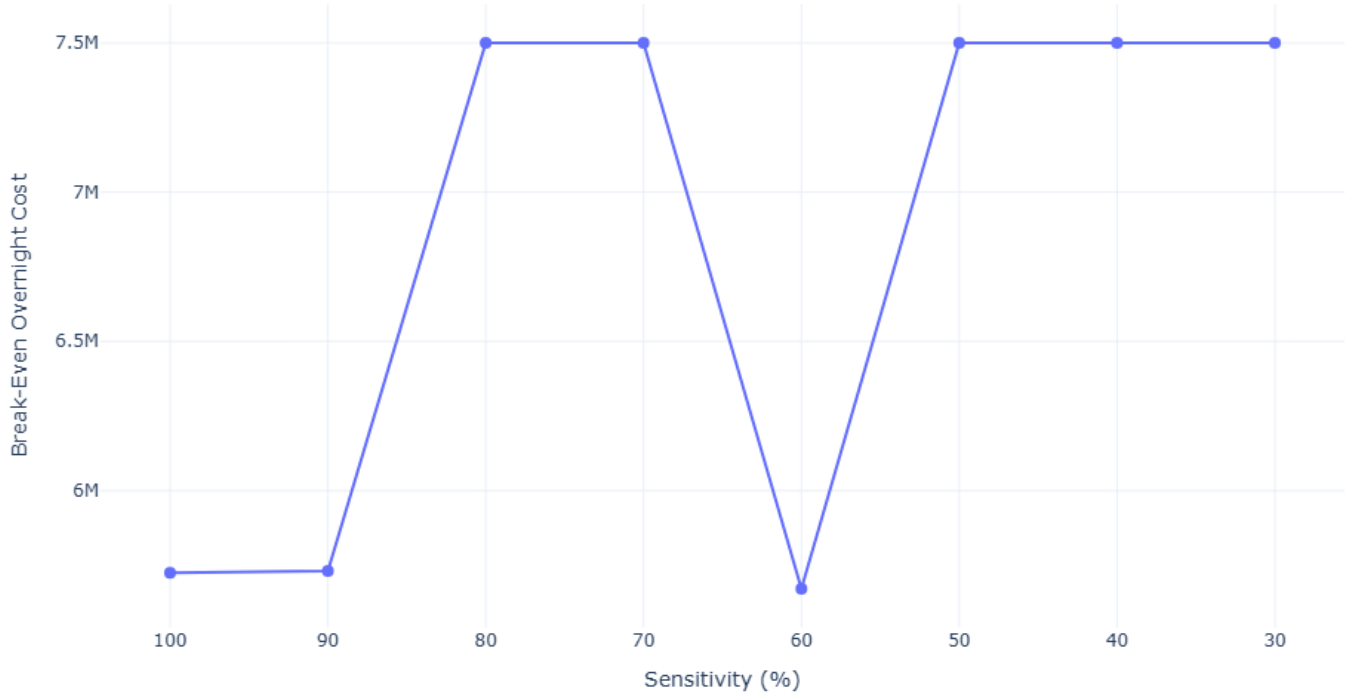


In the 100% NTC 2050 scenario, banning resistive heaters increases the district heating costs by 8.3%



Returning the reduced costs of the solver's nuclear investment variable could reveal nuclear's break-even overnight costs

Work in progress!



Conclusions

- **What is the NTC's effect on the Swiss electric and thermal storage demand?**

- Generally, reduced NTC lead to less battery storage need because of diminished arbitrage opportunities with the neighboring countries, unless:
  - The neighbors have a particularly high renewables penetration (depends also on the weather).
  - The neighbors invest in large storage capacities on their own, using up their own arbitrage opportunities already.
- Heat pumps provide heat in winter. In summer, heat pumps and resistive heaters in combination with thermal storage work together to provide heat. The exact share depends on the general price level.
- Banning resistive heaters in district heating systems entirely can lead to 8.3% higher heat provision costs.
- Nuclear power plants are not profitable at costs >5.7 million CHF/MW, perhaps even significantly lower.


Thank you.
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