Dismiss local flexibility – overestimate the need for dispatchable fossil capacity

The Impact of Shortage Risk Tolerance on a Future European Net-Zero Electricity System

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Motivation

- Capacity expansion models often enforce strict no-shedding/shortage constraints, but real power systems have **local flexibility**.
- This could lead to **overdimensioned** systems, with expensive dispatchable capacity built to cover rarer scarcity events.
- How should we let a capacity expansion model delegate the modelling of **local buffers**?
- How sensitive is the system design to **strict reliability**?

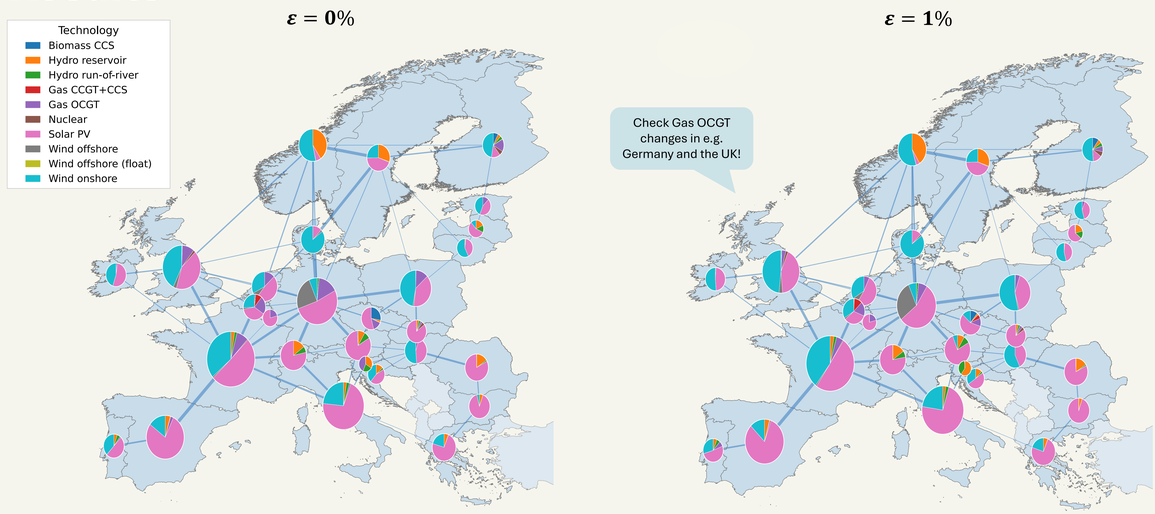
Methods

- We build on **highRES**, a least-cost capacity expansion model for Europe, optimising for the future year 2050.
- Minimise cost and shedding with an **epsilon-constraint** method.
- Shortage tolerance ε implemented as yearly upper bound on total unmet demand:

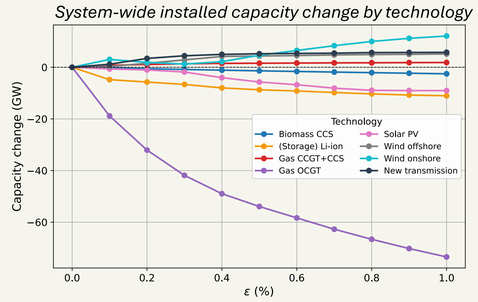
$$\sum_{h,z} \text{shed}(h,z) \leq \varepsilon \cdot \sum_{h,z} \text{demand}(h,z)$$

Hourly ε was also tested – ask me about it!

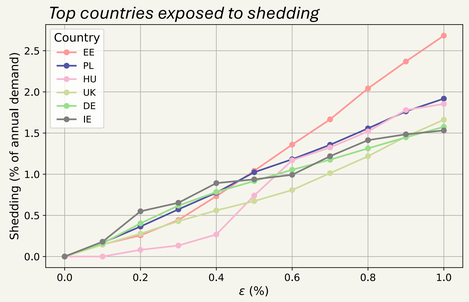
Results



System-wide installed capacity change by technology



Top countries exposed to shedding



Take Away

- Allowing just 1% yearly unmet demand covered by local buffers **reduces system costs** by **4.8%.**
- OCGT gas is a **reliability insurance**. Invested capacity collapses as soon as strict reliability is relaxed.
- CCGT gas with CCS competes with biomass with CCS to provide the required dispatchable capacity to the system.
- Investment in storage decreases, while new transmission increases slightly.
- **Ireland** faces the most exposure to shedding relative to local demand for low allowances. **Estonia** takes over as tolerance increases.

Future Direction

- Exploring further multi-objective formulations might provide deeper insights.
- Integrating additional representations of local flexibility and buffers.
- Incorporating weather uncertainty would strengthen the trade-off overview.
- *Ideas from **you**?*

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