Insights from model based studies on 24/7 CFE and green hydrogen regulation

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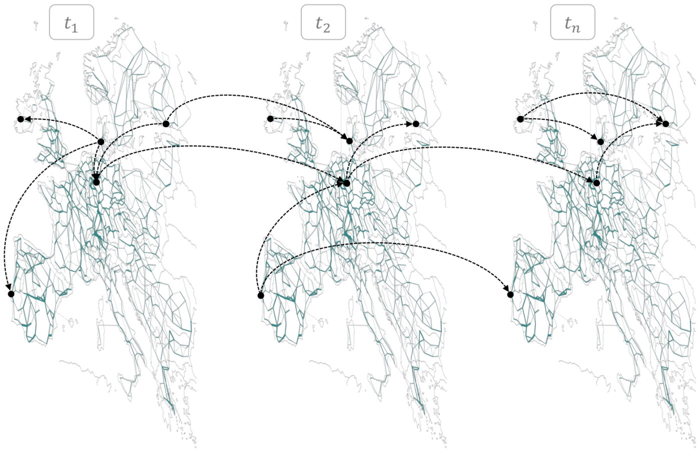
New study: The value of space-time load-shifting flexibility for 24/7 carbon-free electricity procurement (July 2023)

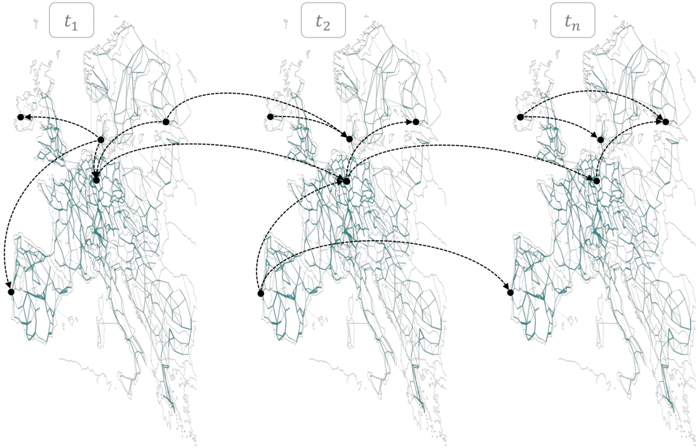


- Key focuses:
  - How can demand flexibility reduce the required **resources** and **costs** of 24/7 CFE matching?
  - What are the **signals** for optimal utilisation of demand flexibility?
  - What are the trade-offs and synergies from co-optimisation of **spatial** and **temporal** load shifting?
- Open-access research:

  study: **zenodo.org/records/8185850**
  code: **github.com/PyPSA/247-cfe**
- A follow-up research paper to be released in March 2024.

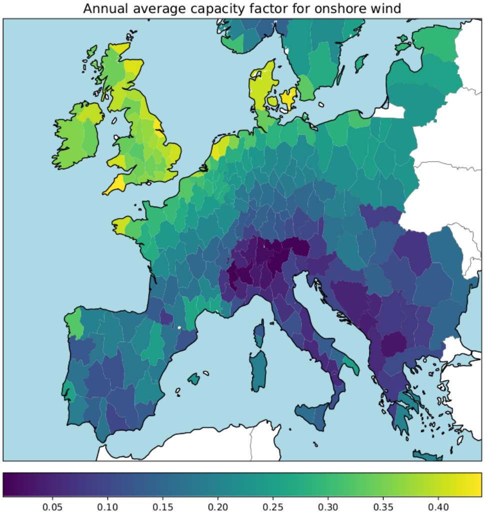
Methods and study design

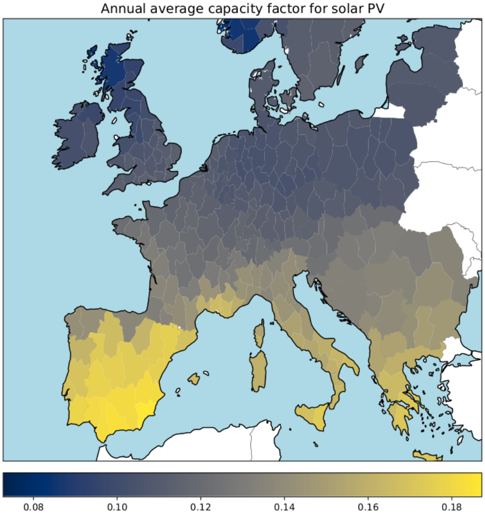
Technische Universität Berlin



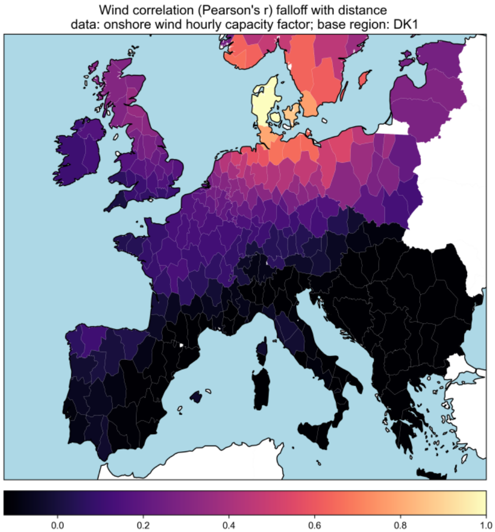
- The study is done with **PyPSA** – an open-source framework for modelling modern energy systems.
- Model scope: **ENTSO-E area** power system clustered to individual bidding zones, **hourly** temporal resolution.
- Geographically scattered datacenters that are managed collectively. An operating company follows **24/7 CFE strategy** in all locations.
- **Spatial** and **temporal** load shifting mechamisms.
- **"Flexible workloads"**, i.e. electricity loads that can potentially be shifted in space or in time, are assumed to be in a range of {0% .. 40%}.

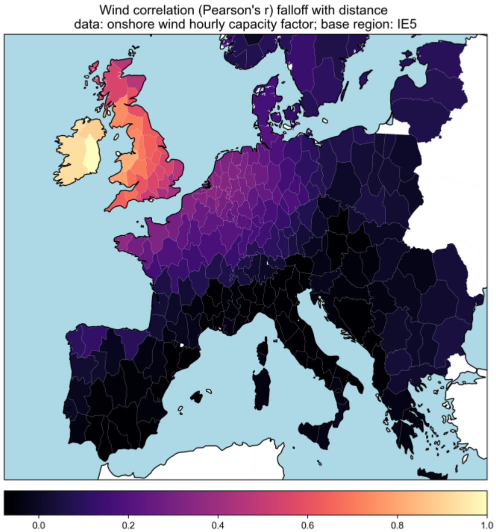
Signal 1: quality of local renewable resouces



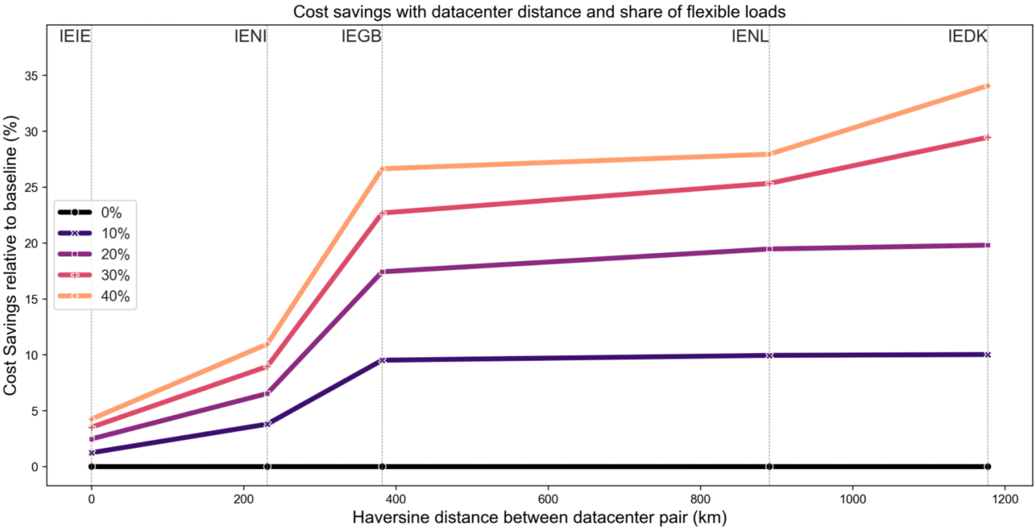


Signal 2: low correlation of wind power generation over long distances

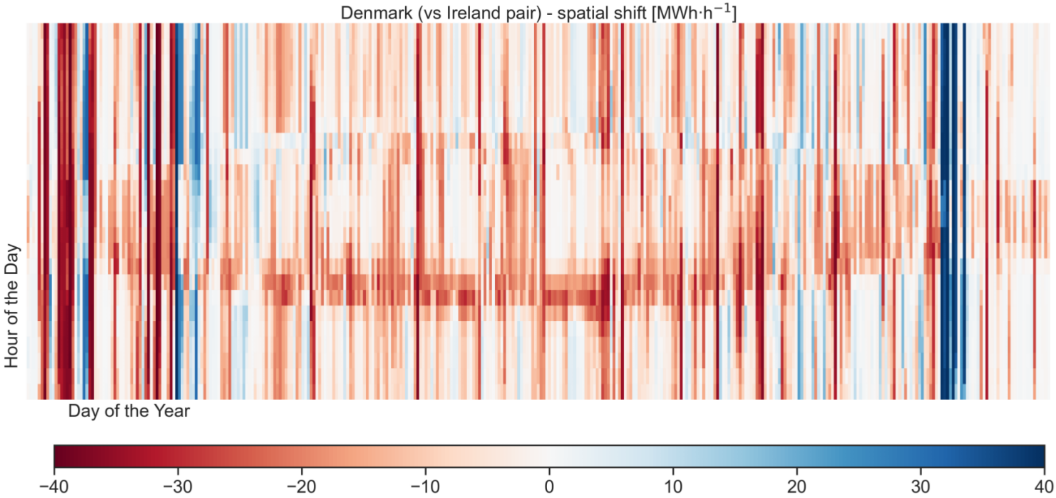




Cost savings as a function of distance between datacenter pair

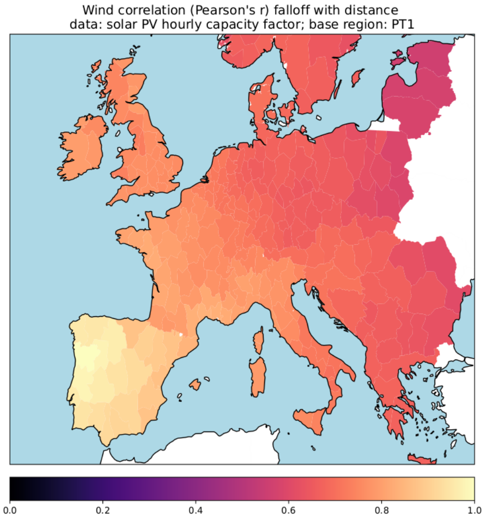


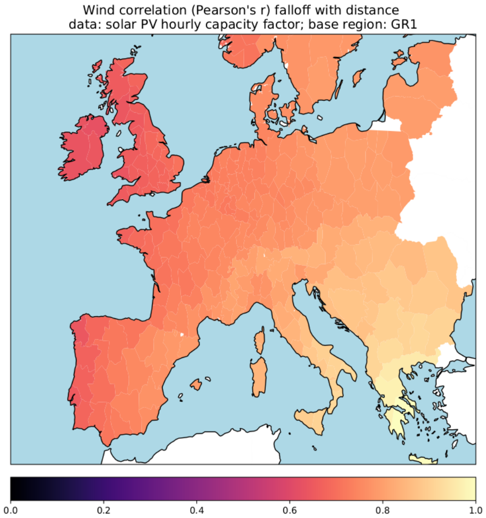
Time-series of optimized spatial load shifts (locations: DK-IE)



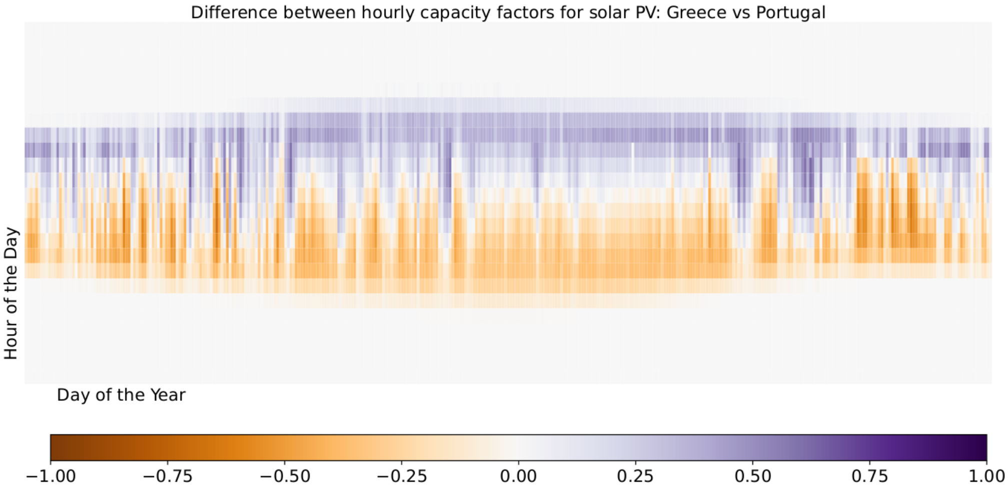
Negative values mapped to red color represent decrease of a load
Positive values mapped to blue color represent increase of a load

Signal 3: time lag in solar radiation peaks due to Earth's rotation (1/2)





Signal 3: time lag in solar radiation peaks due to Earth's rotation (2/2)



Also in the study

- Scenarios for **co-optimised** and **isolated** utilisation of space-time load-shifting;
- Scenarios for 24/7 CFE with **98% and 100%** matching targets;
- Scenarios with different **24/7 technology options** (e.g., Long Duration Energy Storage);
- 24/7 CFE **cost breakdowns** and **procurement strategies** for individual locations;
- **Synergies** and **trade-offs** between spatial and temporal load shifting;
- Analysis of **net load migration** across locations;
- Simulated **energy balances** for selected datacenters.

Take aways

There are **three signals** companies can factor into their procurement & load shaping strategies for 24/7 CFE matching:

– quality of local renewable resources;

– low correlation of wind power generation over long distances;

– time lag in solar radiation peaks due to Earth's rotation.

Overall, space-time load-shifting flexibility:

– enables **better access to clean electricity** and creates **more options** for consumers to match demand with carbon-free electricity around-the-clock;

– **lowers the costs** of 24/7 CFE matching and makes it **more attractive** to a wider range of companies.

Contacts, Resources, Acknowledgements

References: [Temporal regulation of renewable supply for electrolytic hydrogen (2023)]

References: [More about the 24/7 CFE research project (2022-2024)]

Code: This work done in a spirit of open and reproducible research:

code: github.com/PyPSA/247-cfe

code: https://zenodo.org/records/8324521

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