Conflicts arising from the interdependency of air conditioning, energy supply, and heat risk in the United Kingdom

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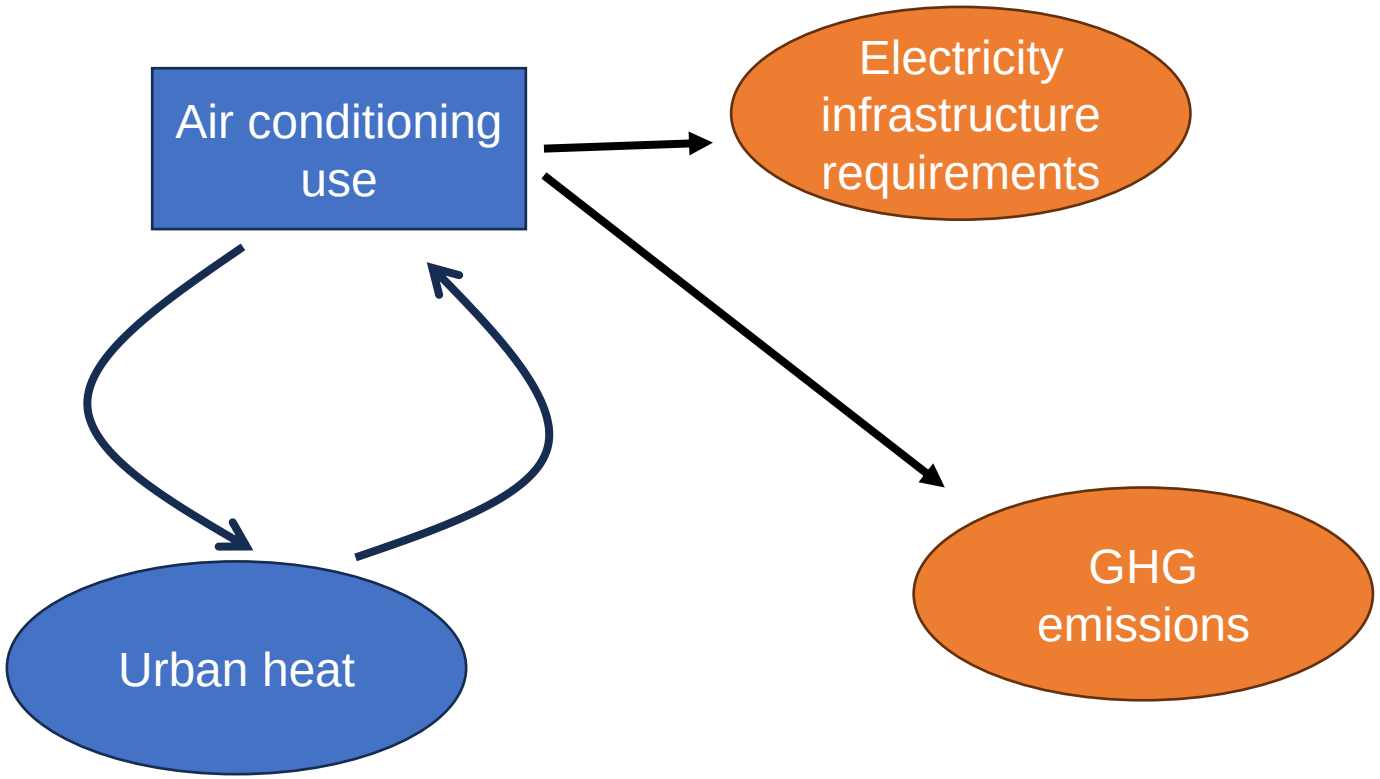
Emissions and strain on electricity grids are often highlighted as problems with air conditioning



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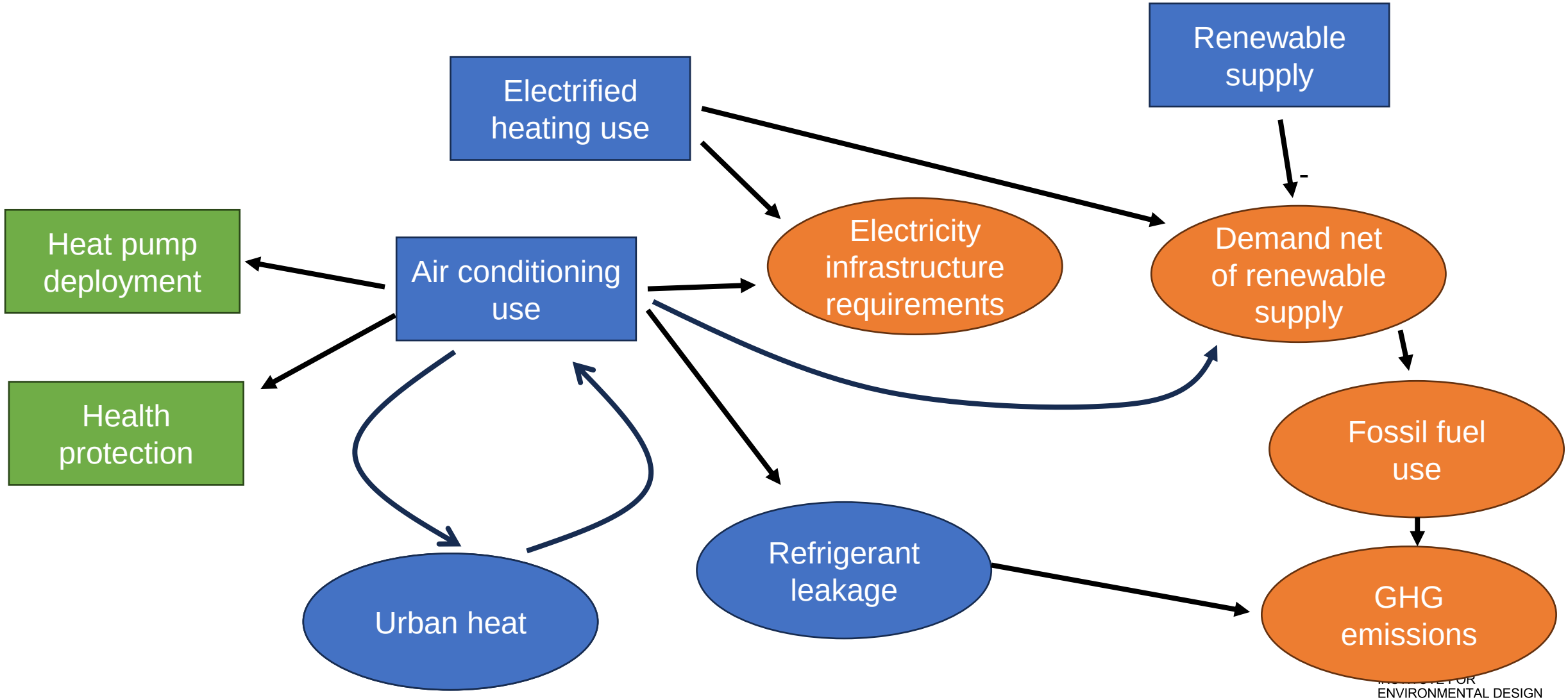
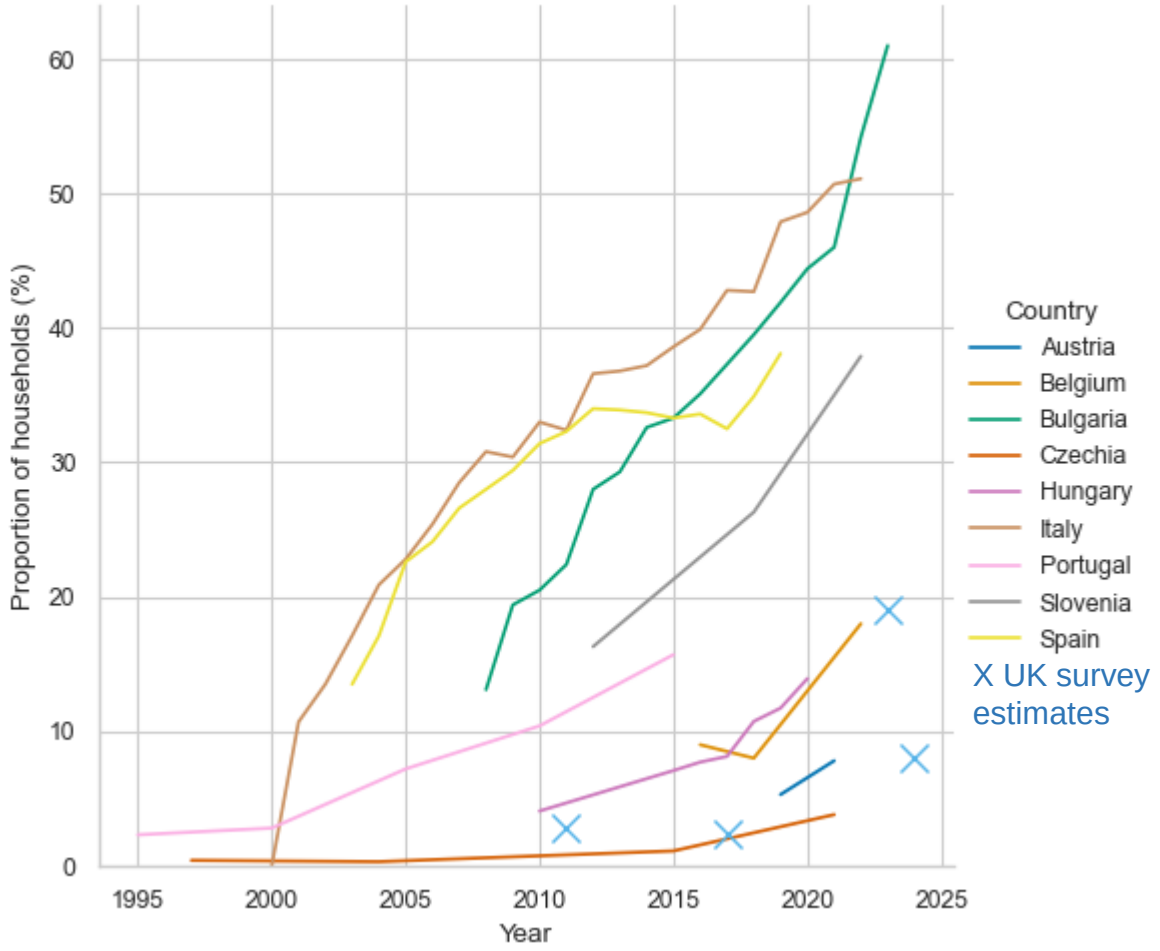
Do we miss out on potential benefits by "minimising" air conditioning use?



Air conditioning ownership may be growing quickly in the UK

- Growing in all European countries that report data.
- Recent UK surveys suggest higher estimates than older surveys.



Source: Various microcensus data

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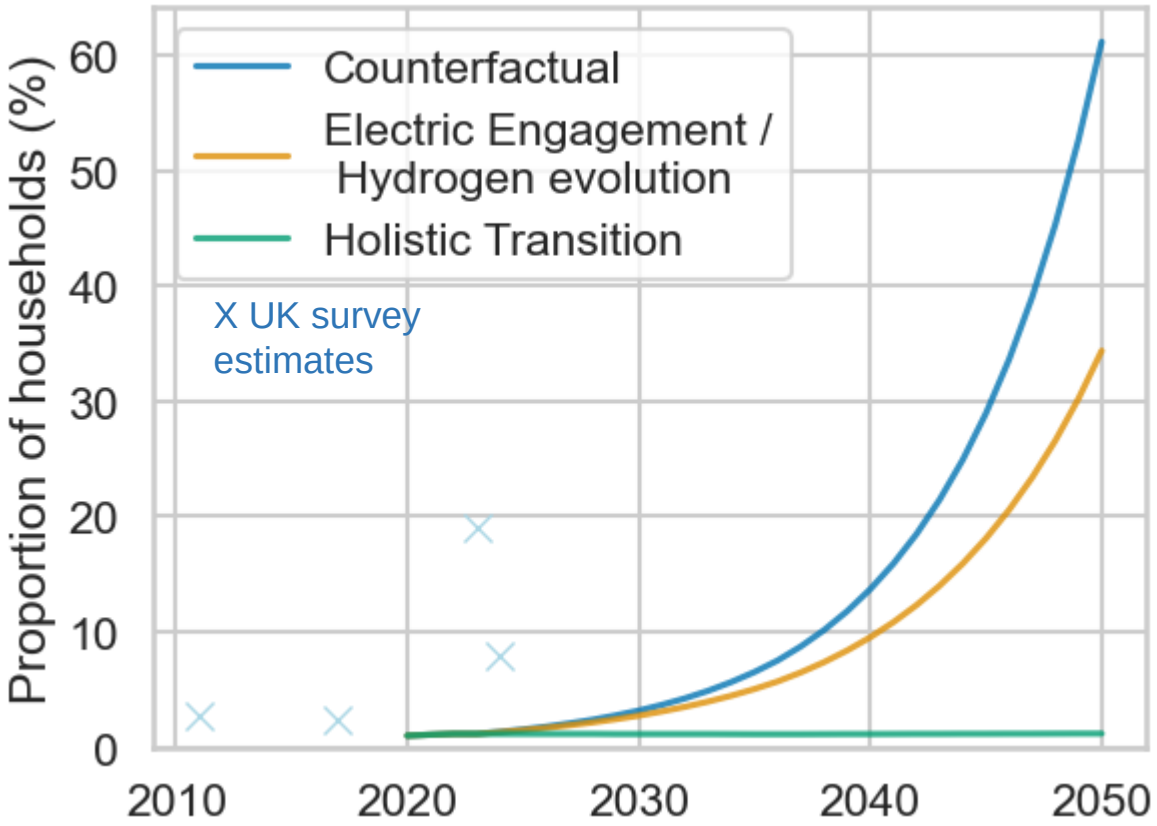
Official scenarios assume slow growth in the short term

- Exponential growth assumed.
- Differences between the scenarios only appear late in the period.
- **Already ahead of these projections!**
- Official plans out to 2030 appear to be based on the low demand scenario.
- Peak demand not modelled.



Source: NESO FES 2020 Data Workbook

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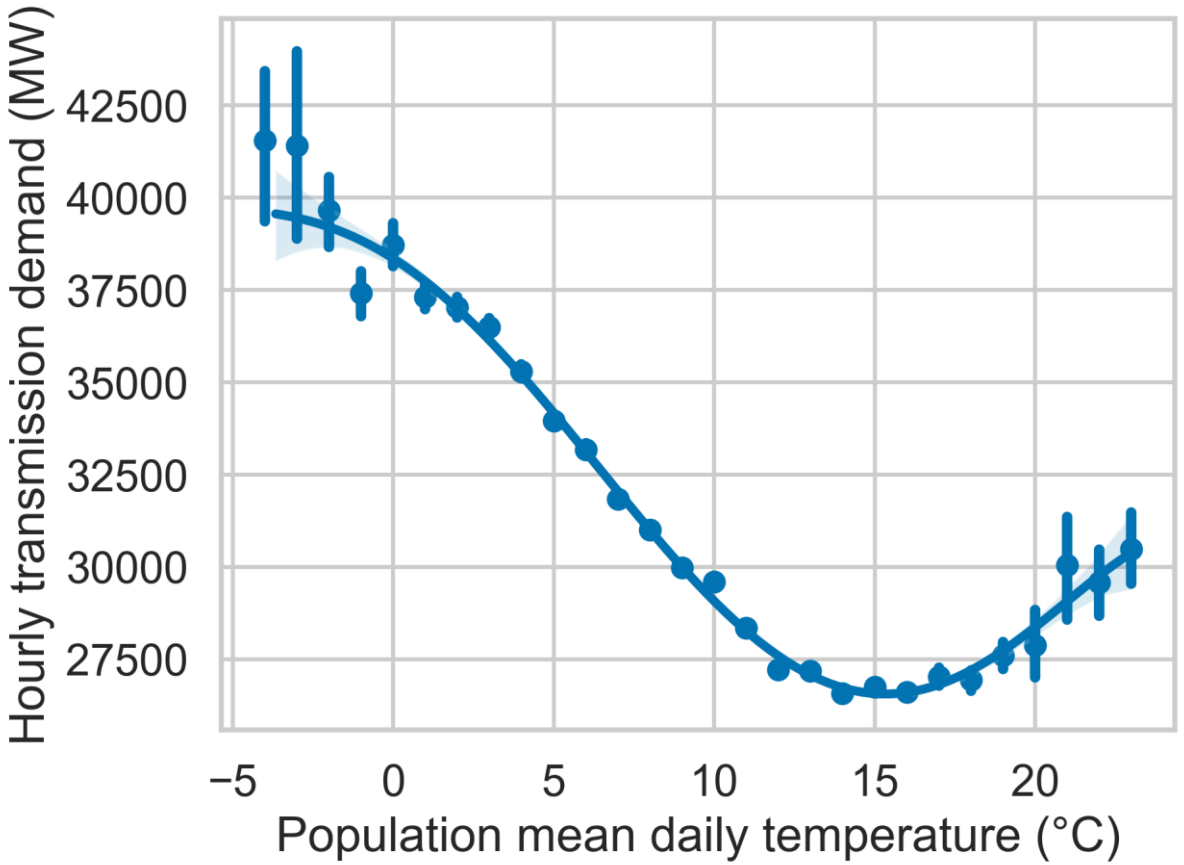
Cooling load much smaller than heating load in the UK

- Heating load will increase in future
- Will infrastructure built for heating load be adequate for cooling load?



NESO 2015-2023
ERA5 reanalysis

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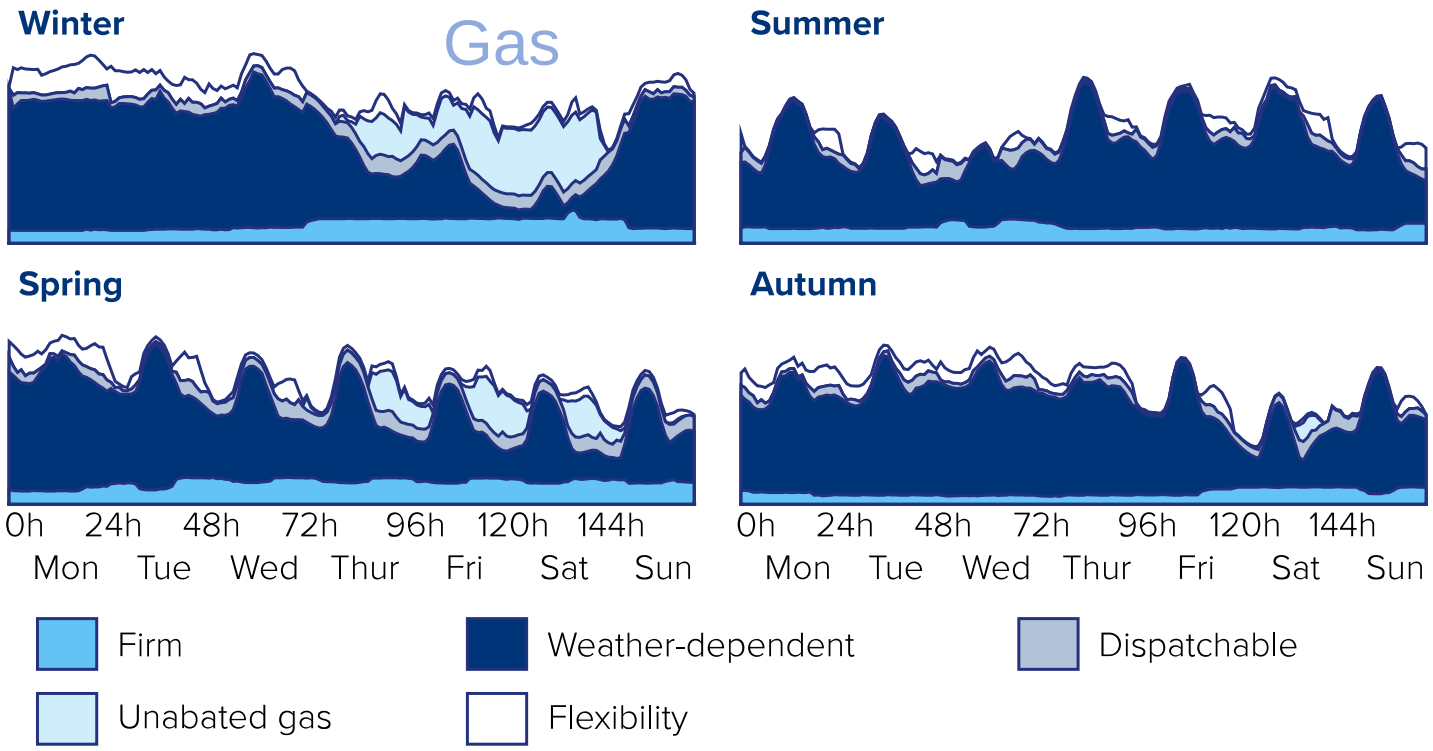
Generation in the future energy system

Sample generation weeks in NESO modelling show no gas in summer, relatively small flexibility and dispatchable compared to winter.

But peak demand from air conditioning is not considered!

Modelled 7-day hourly generation profile in 2030 in the NESO 'New Dispatch' Scenario (MW)



https://www.gov.uk/government/publications/clean-power-2030-action-plan/clean-power-2030-action-plan-a-new-era-of-clean-electricity-main-report

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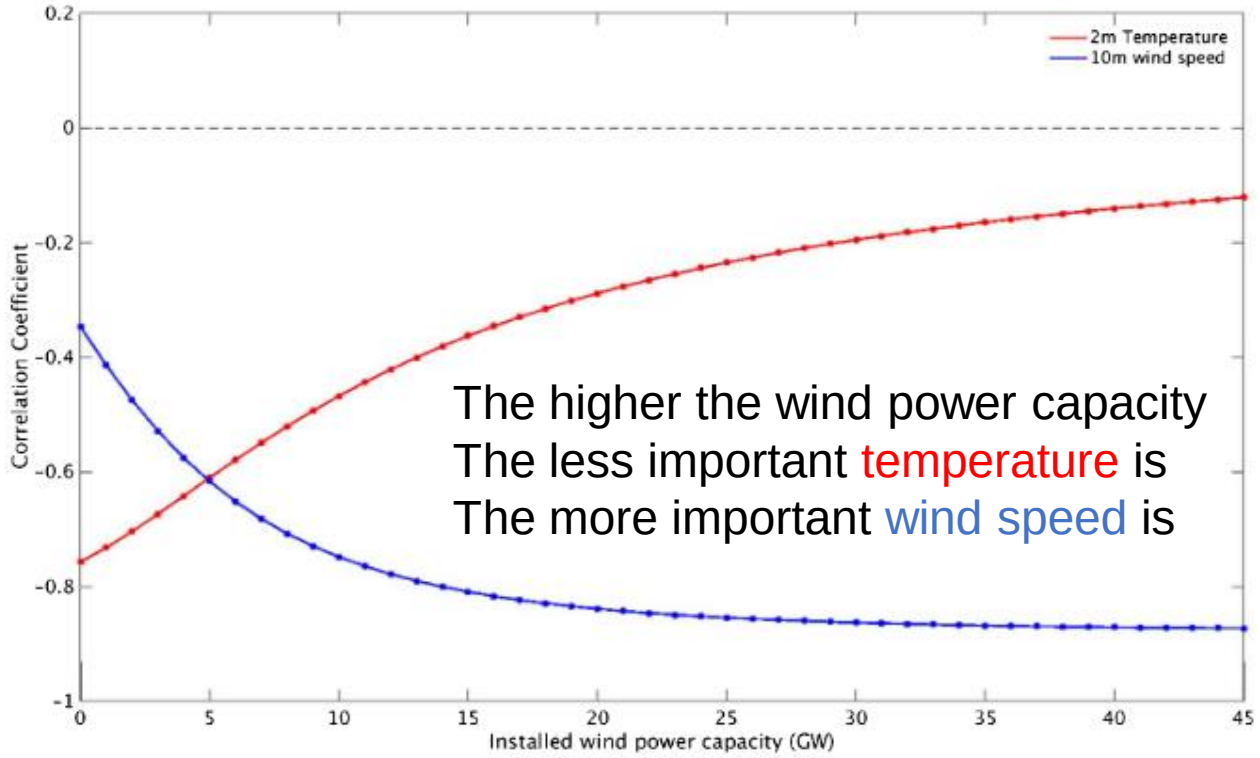
Variable renewables mean that correlation of supply and demand is increasingly important

E.G. challenging winter days shift from **coldest** days to **cold days with low wind** as wind power capacity is increased

Concept of **demand net of renewables (DNR)** becomes important

Summer DNR less well studied in GB



Bloomfield, H.C. *et al.* (2018) 'The changing sensitivity of power systems to meteorological drivers: a case study of Great Britain', *Environmental Research Letters*, 13(5), p. 054028. Available at: https://doi.org/10.1088/1748-9326/aabff9.

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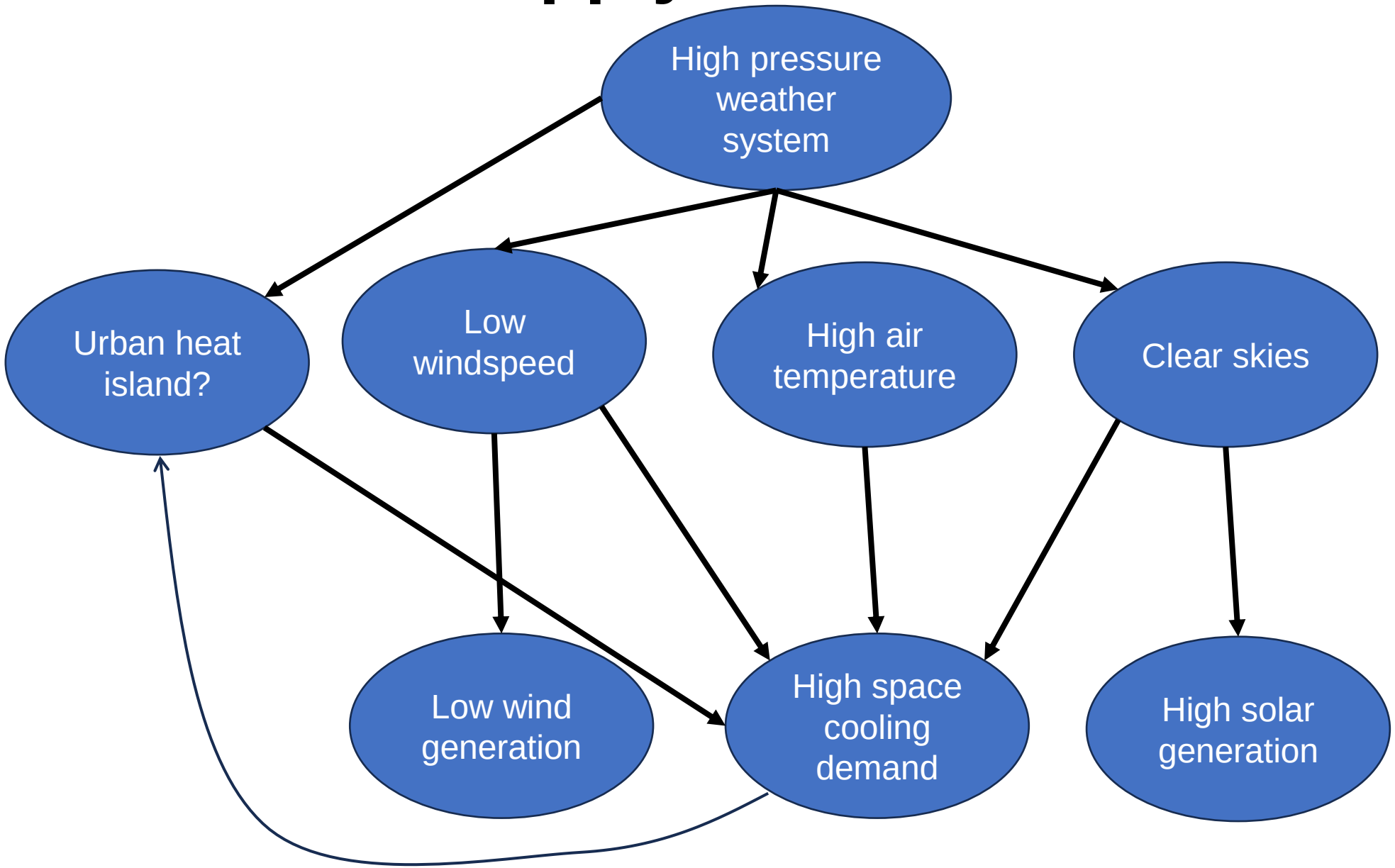
Correlated supply and demand?



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Analysis plan

- ✓ Estimate generation capacity factors from ERA5 data
- ✓ Estimate peak demand time series with high air conditioning from other country data
- ❑ Apply capacity factors to planned capacity to get supply time series
- ❑ Compare supply and demand time series to identify days with challenging conditions
- ❑ Summarise weather of those challenging conditions
- ❑ Repeat with climate projections

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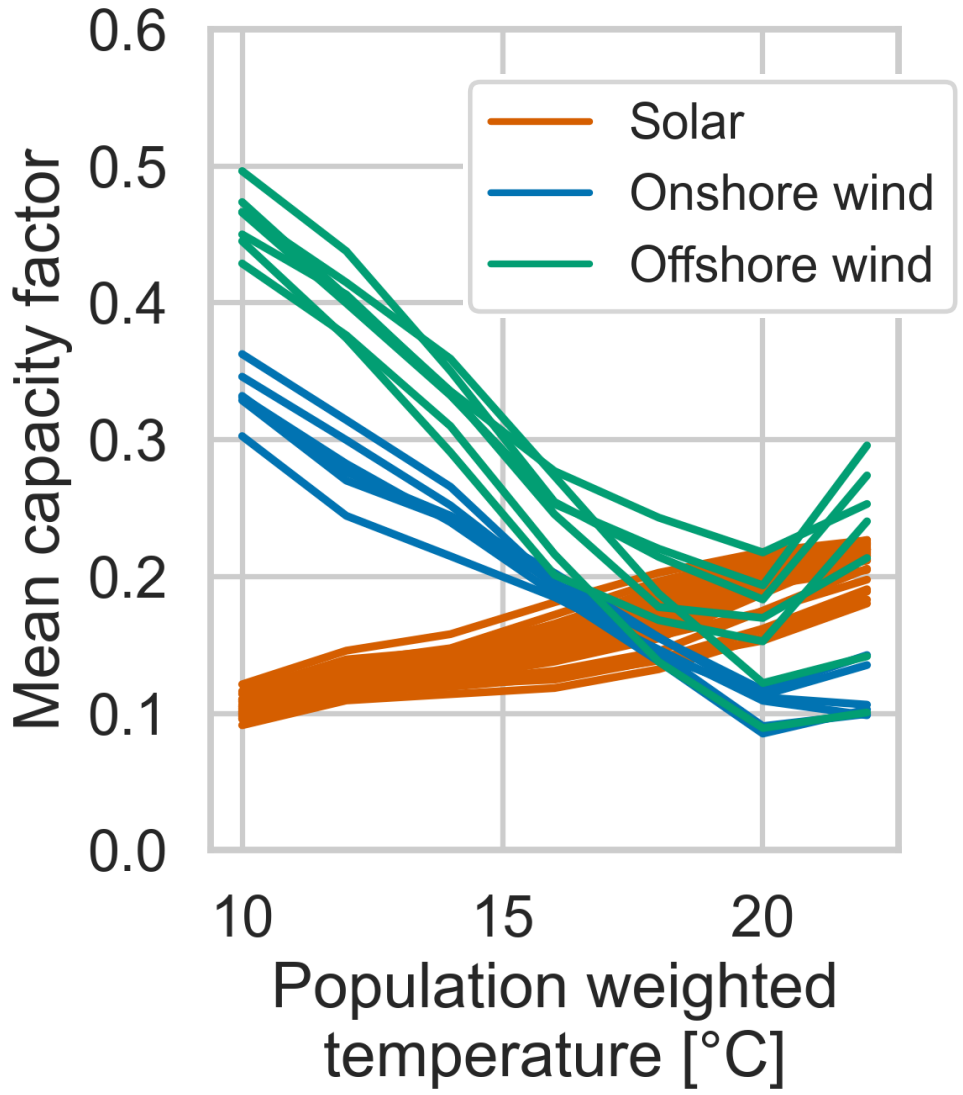
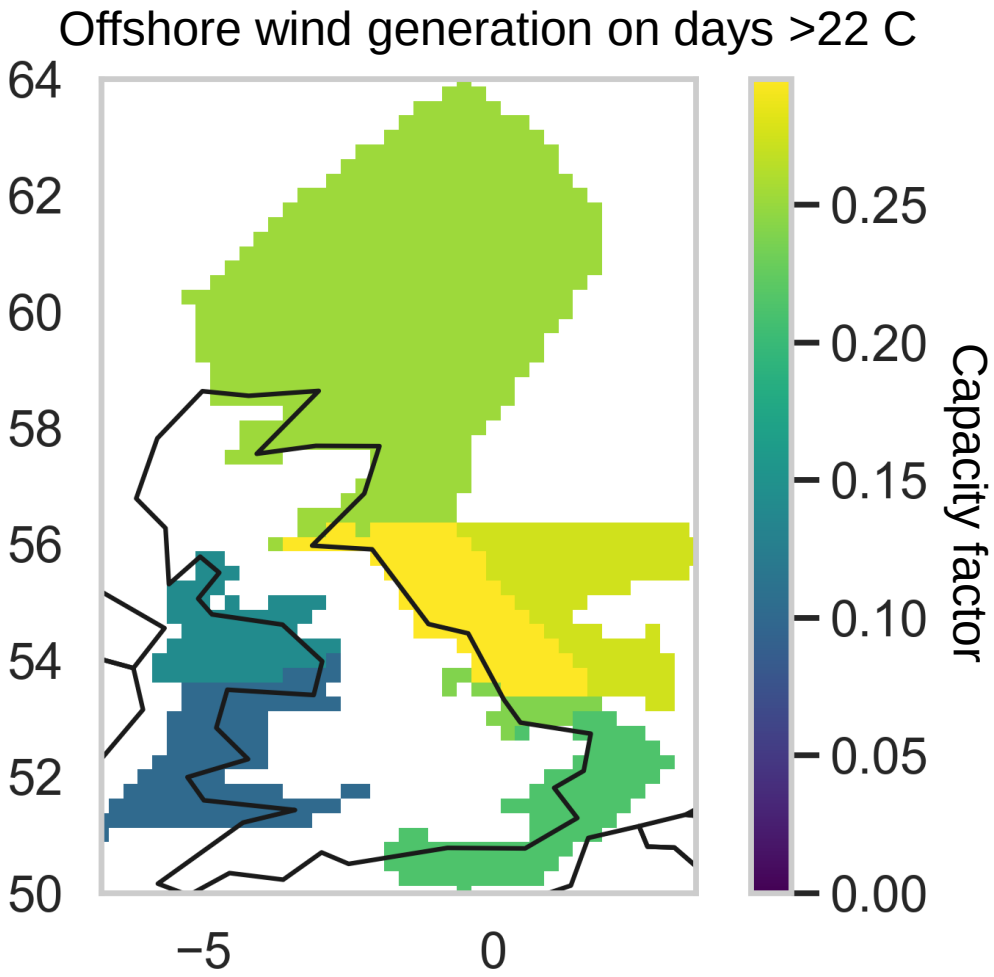
Daily mean renewable supply and temperature in ERA5 reanalysis





ERA5 reanalysis 1980-2020 via Copernicus PECD

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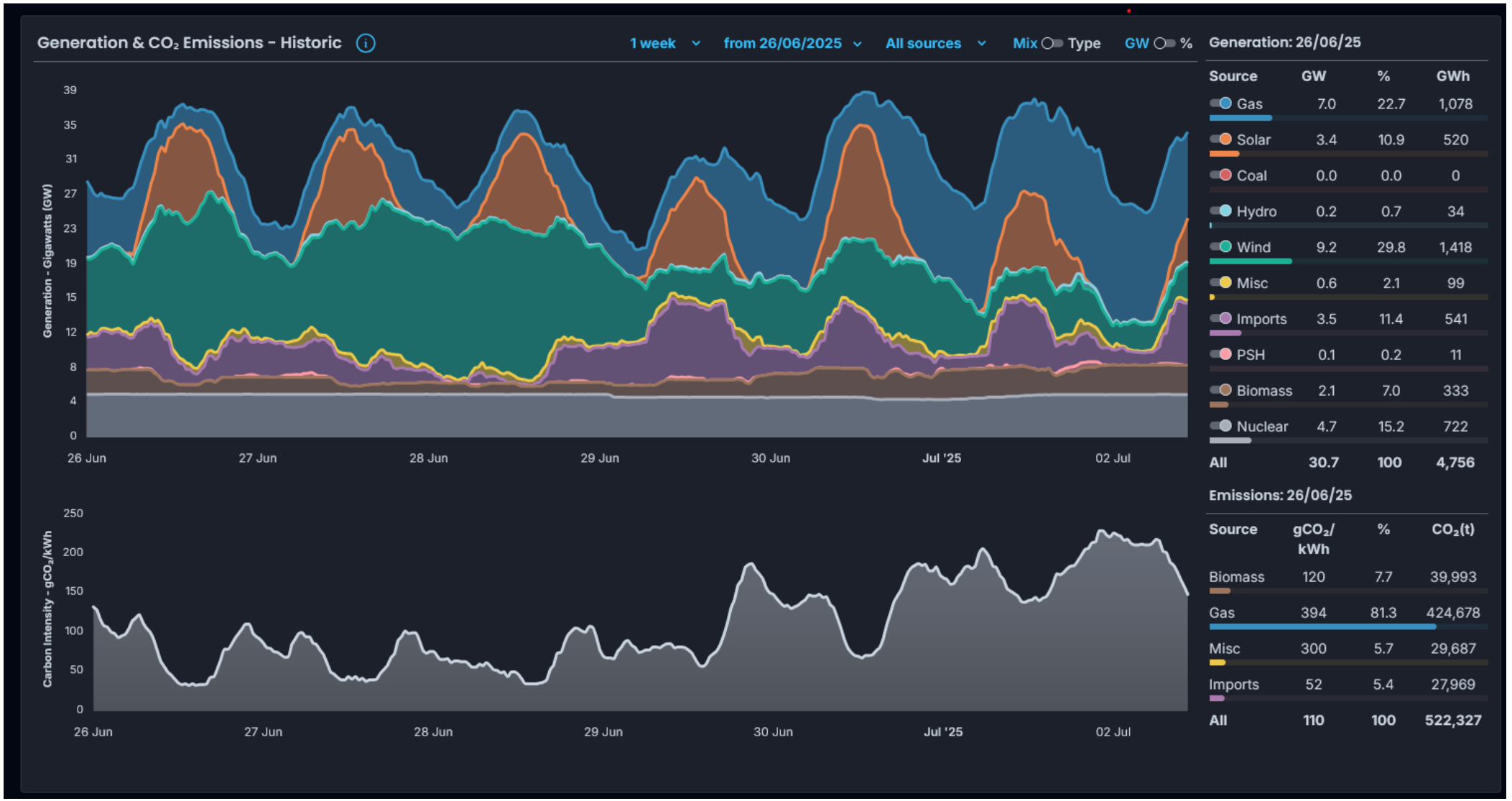
Energy mix during the July 2025 heatwave



Gas
Solar
Wind

https://www.energydashboard.co.uk/historical

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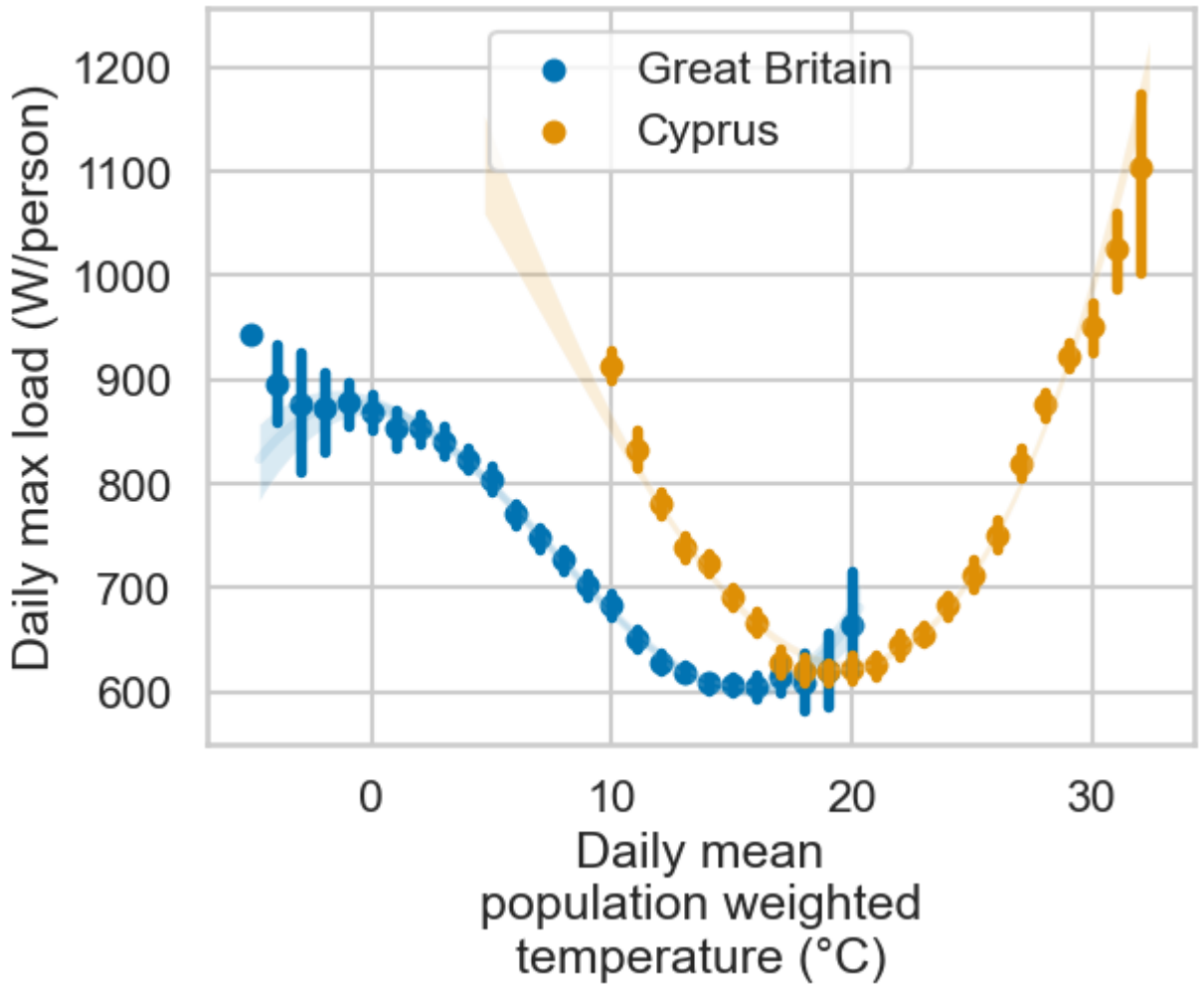
Using data from other countries to model peak demand

- ~85% of households have air conditioning in Cyprus
- Can we apply this load to the UK to represent a future with a scaled amount of load?



Source: ENTSO-E and ERA5

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Summary

- Residential air conditioning is growing rapidly in the UK
- Unclear what the additional requirement on electricity system is, because GB system dominated by heating
- We aim to quantify demand net of renewables

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Misestimating demand may create risks

- Distribution failures due to high peak demand
- Load not supplied / load shedding due to lack of flexiblity
- Not enough variable renewable generation -> carbon emissions or expensive flexible generation
- Inadequate system design
  - Higher emissions or flexibility costs
  - Distribution failure. Load shedding?

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Contrasting stakeholder perspectives

We need to avoid air conditioning as much as possible.

The other Air conditioning is not resilient to power cuts

There will be enough power, there will only be local issues with distribution.

Peak loads from heating will be much larger than from cooling, so the infrastructure should generally be sufficient.

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