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cigre United Kingdom

Security of supply challenges for a weather dependent GB electricity system

Cigré UK C1 Technical Liaison Meeting
April 3rd 2025

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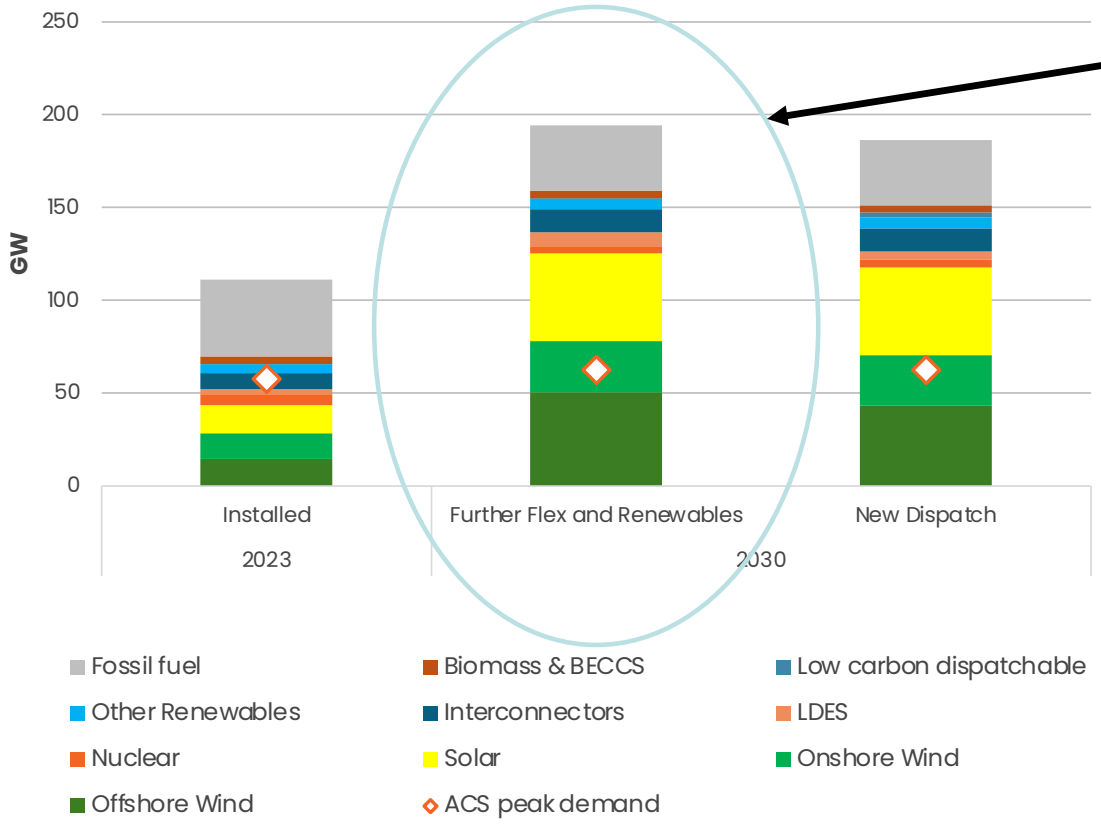
Clean Power by 2030 – What will it take?



Modelled in 'SEEMM'

Installed generation capacity ↑~75%
Driven by new build renewables

- 3x ↑ offshore wind
- 2x ↑ onshore wind
- 3x ↑ solar

Clean Power by 2030 is a paradigm shift to a renewables dominated electricity system

It's also the 1st step on the way to a fully decarbonised energy system by 2050.

Source: NESO: Clean Power 2030 workbook https://www.neso.energy/publications/clean-power-2030

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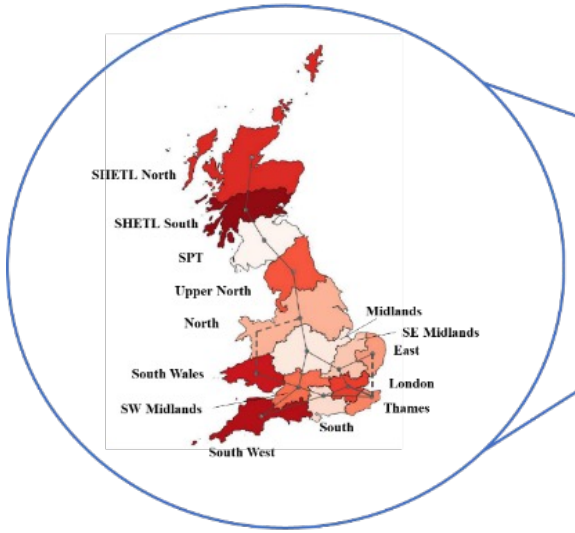
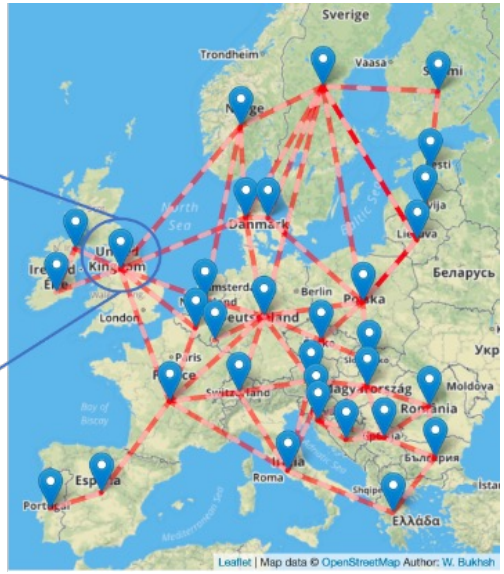
SEEMM – Strathclyde European Electricity Market Model

- Models generation and demand backgrounds across Europe and solves for lowest cost system dispatch for each hour of year
- GB disaggregated into 14 zones representing main transmission boundaries
- Requires spatially disaggregated wind, solar and demand profiles – important to examine different weather years
- Can examine future pathways for adequacy, emissions, curtailment, system cost, imports/exports etc





Useful tool for assessing the challenge facing the new government and sense checking their ambitions for ‘clean power’ by 2030!

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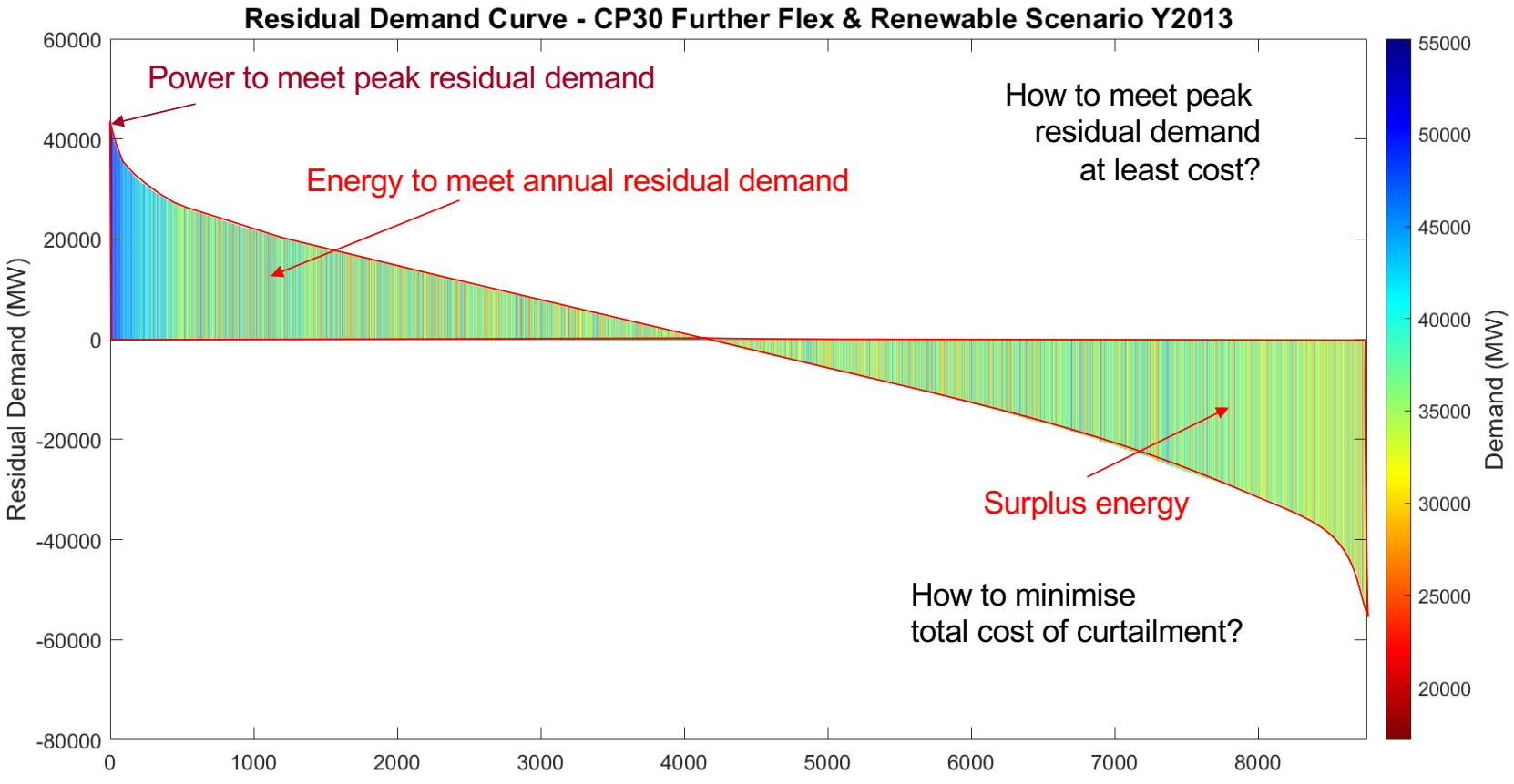
New paradigm: System no longer demand driven – 'residual demand' key metric



- In each hour residual demand = demand – (wind + solar)
- Does not include electrolysis demand

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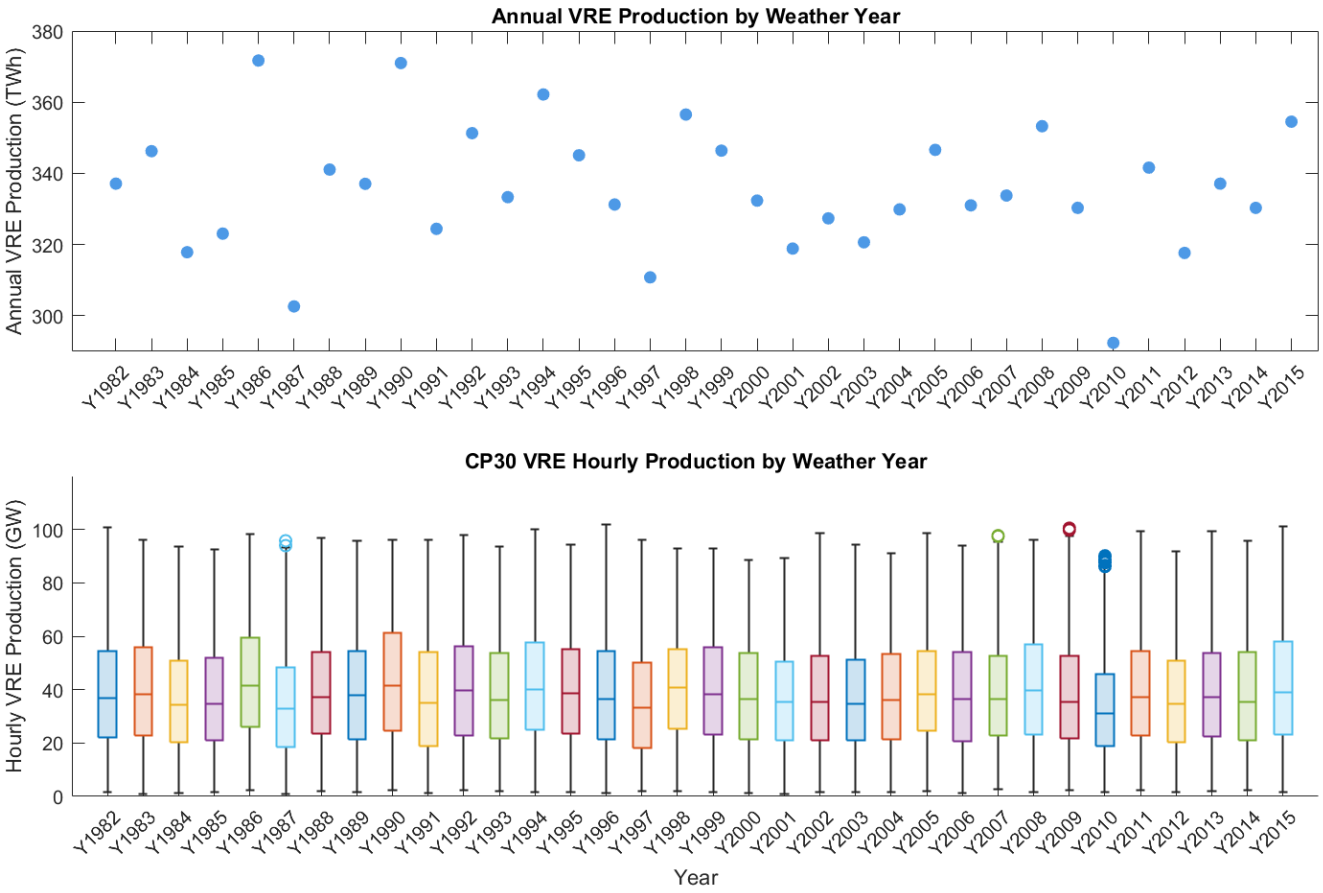
What is the impact of weather variability?



- Variable renewable energy output in GB modelled based on CP30 FFR scenario for 34 weather years (1982-2015)
- Builds on historical re-analysis data for wind and solar availability and heating demand by H. Bloomfield [1]
- Augmented with own view on EV and electrified heating profiles and with capacity factors matched to NESO
- Headlines:
  - ➢ Total VRE output on average similar to annual demand
  - ➢ But ~80 TWh variation in annual output
  - ➢ Large variation hour by hour between ~1 GW and ~100 GW

[1] H. Bloomfield, D. Brayshaw, and A. Charlton-Perez, “Era5 derived time series of european country-aggregate electricity demand, wind power generation and solar power generation,” https://doi.org/10.17864/1947.272, 2021

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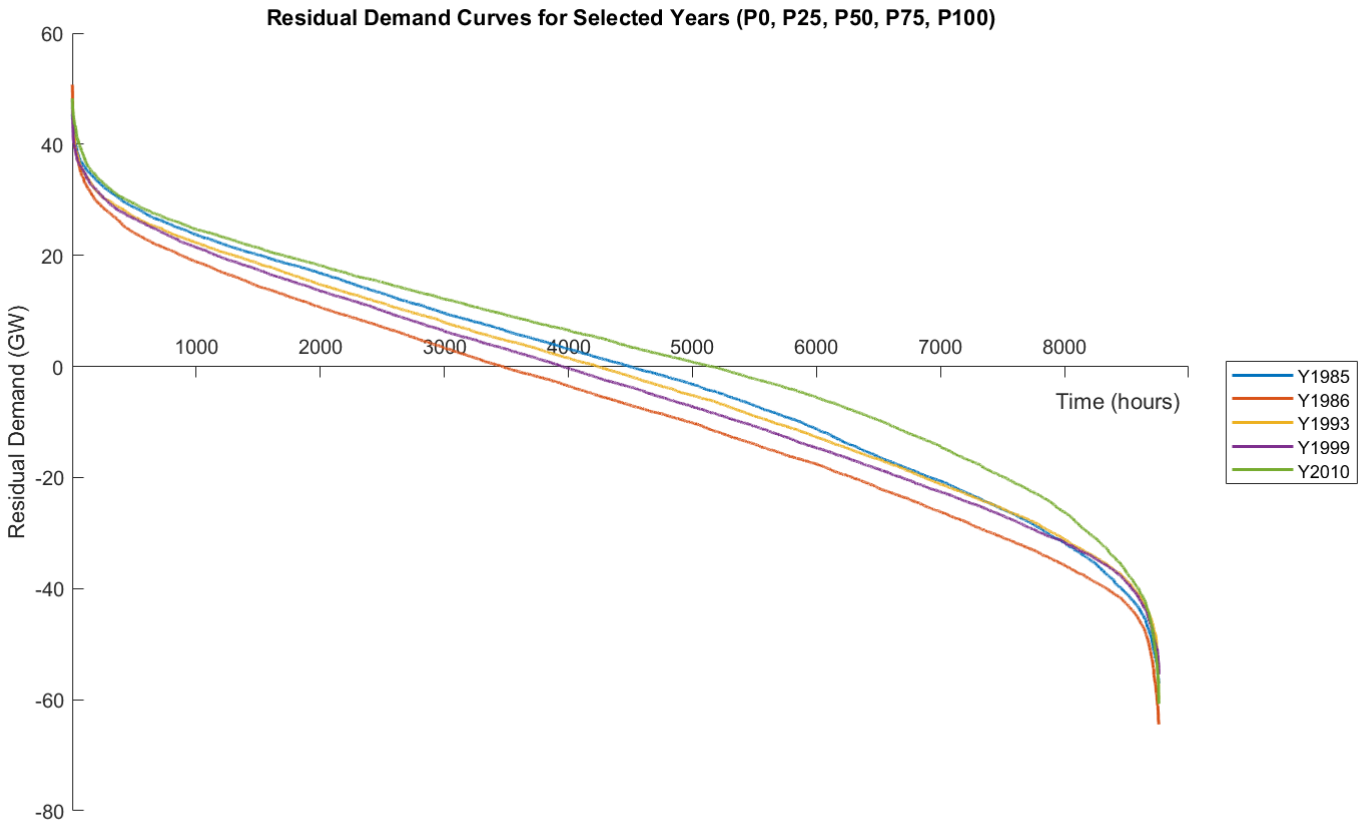
Impact of weather on residual demand?



- Taking P0, P25 … P100 VRE weather years shows significant variation in the resulting residual demand curves
- System operator must be able to plan for multiple outturn scenarios, not just a central case

How does this translate at different timescales?

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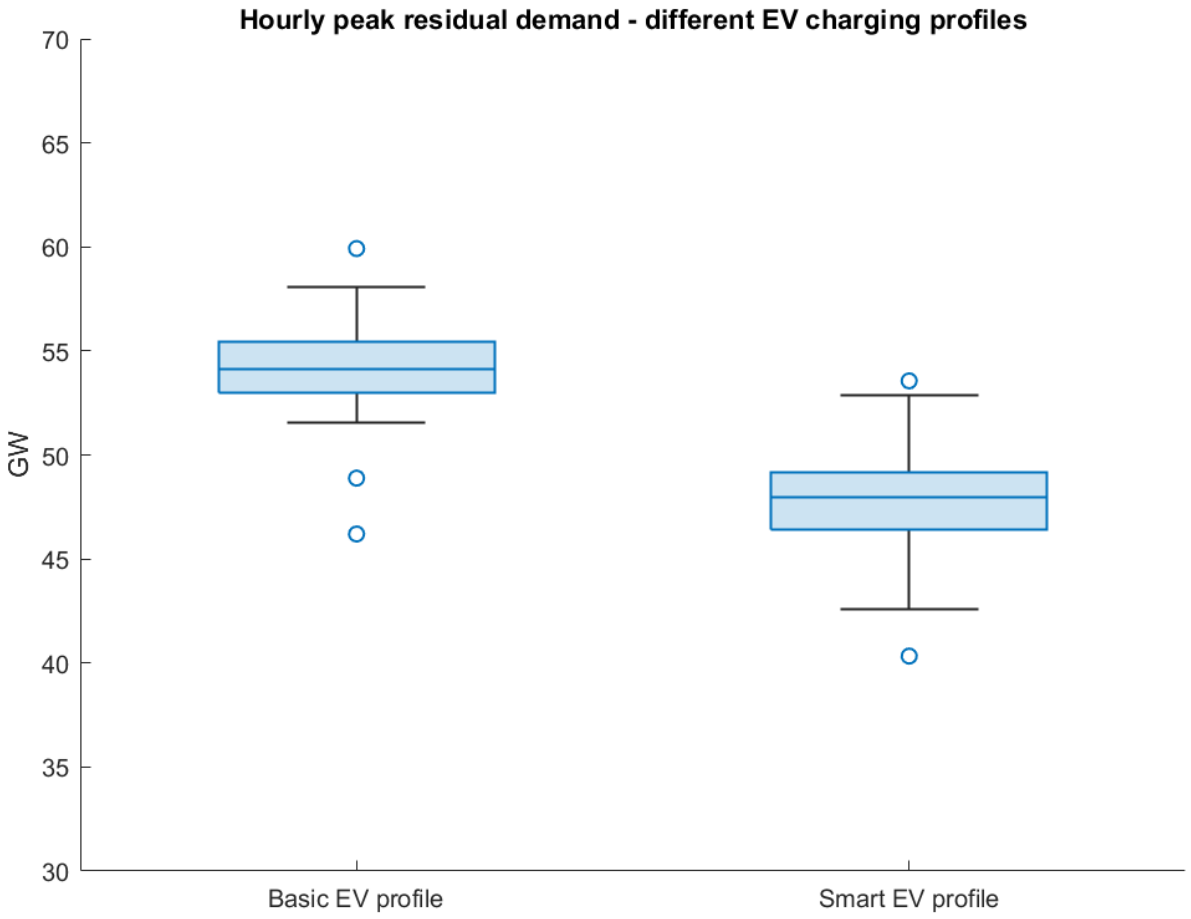
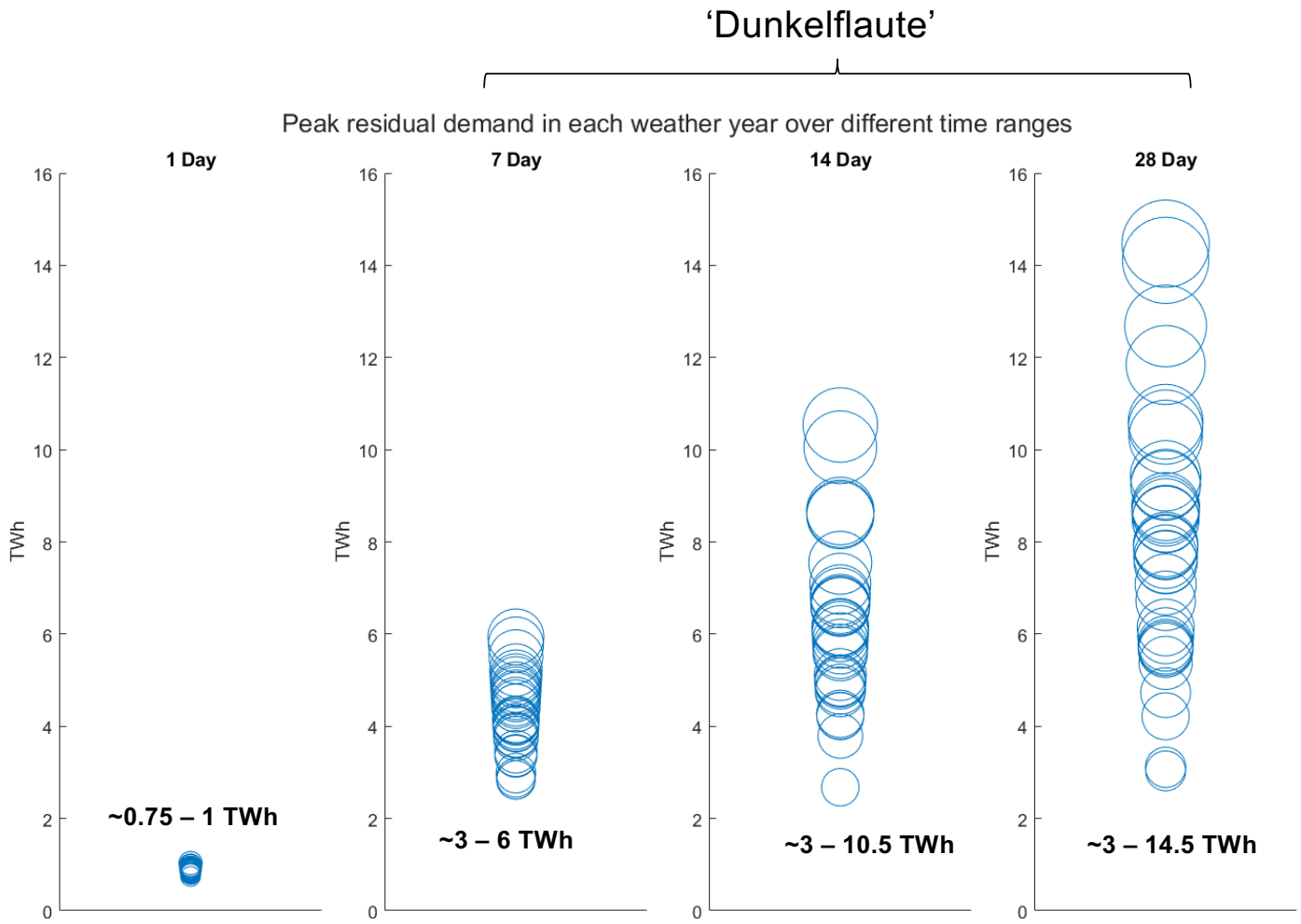
Peak hourly residual demand



- Critical for informing system dispatchable capacity needs
- ~15GW variation in peak hourly residual demand
- Overlap between low VRE periods and high demand periods varies significantly year on year
- Covering for a ‘normal’ year not enough

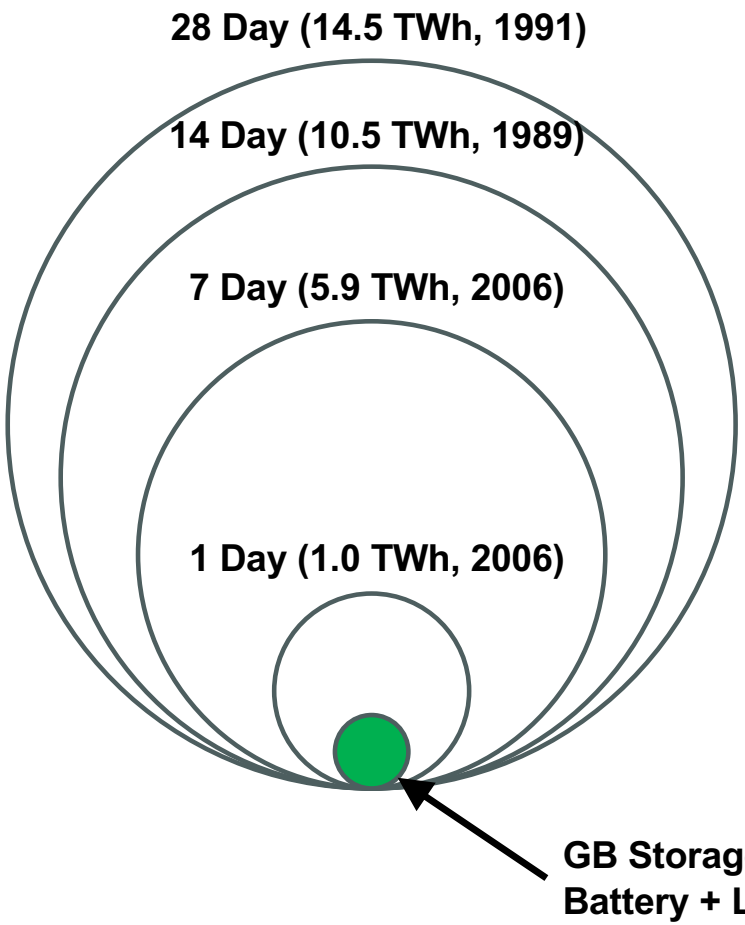
- <u>Demand assumptions also key</u>
- basic fleet EV charging profile adds significantly to peak residual demand
- If ‘smart’ charging shifts demand off-peak, reduces the dispatchable capacity requirements significantly

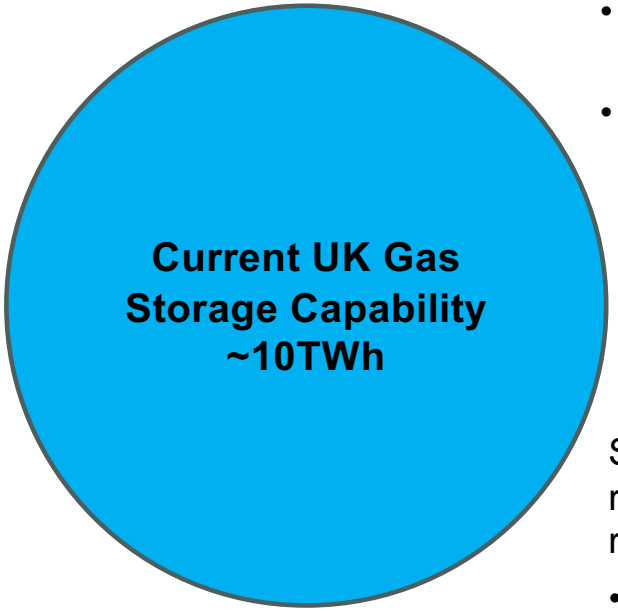
Residual demand at different timescales



- Large variation in ‘worst case’ energy requirements over longer timescales year on year
- Uncertainty over extent to which demand destruction would reduce burden in extreme periods
- High prices may lead to turn down of some industrial demand (total industrial demand ~7.5 TWh / month in 2030)

Energy requirements to ‘meet the peak’





Short term storage:

- Great for near term flexibility
- Won’t solve long term energy deficits

Seasonal scale storage or readily accessible fuel sources required:

- Key role for Gas + CCS or Hydrogen power in future

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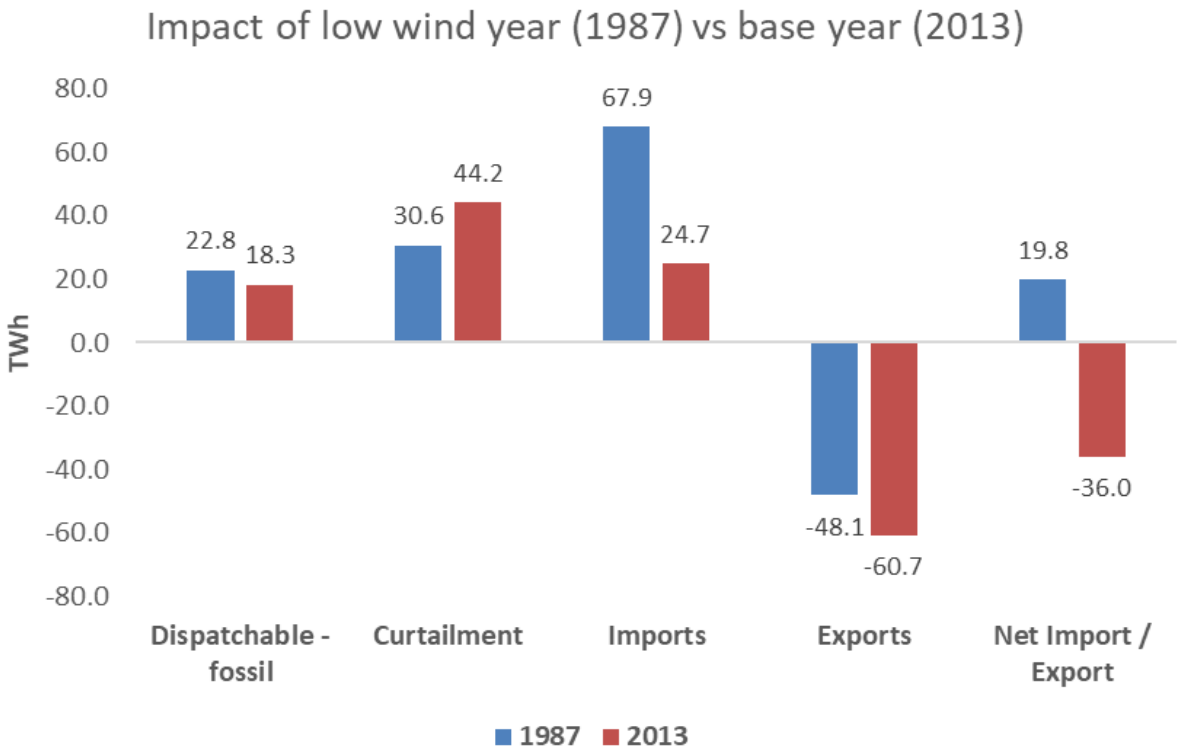
System Impact – low renewables year



- 25% increase in dispatchable gas burn
- Total emissions up 10%
- Curtailment down
- Imports up significantly (how clean?)
- Exports down
- GB net importer compared with large net exporter
- Large impact from interconnectors, driven by market prices and comparative renewables availability in rest of Europe.
- Recent history shows risks associated with reliance on imports.

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Conclusions

- Future GB electricity system to be dominated by weather dependent renewables
- Annual variability in renewable output can be large (> ±10% swings around the mean)
- Residual demand is key future metric
- Hourly peak determines requirement for instantaneous capacity
  - Peak capacity requirement varies significantly by year
  - Sensitive to shape of new demand vectors like EV charging and electrified heating
- 7, 14, 28-day residual energy deficits indicate scale of required storage or readily accessible fuel sources
  - Role for clean ‘dispatchable’ power sources like Gas CCS or Hydrogen for Power to replace continuing reliance on unabated gas.
- Annual weather variations lead to significant changes in modelled system behaviour
  - Impact on level of fossil fuel generation
  - Impact on system prices and therefore interconnector flows
  - Territorial emissions at mercy of weather and economics of wider system
- <u>Key point: single year analysis not adequate to understand system challenges</u>