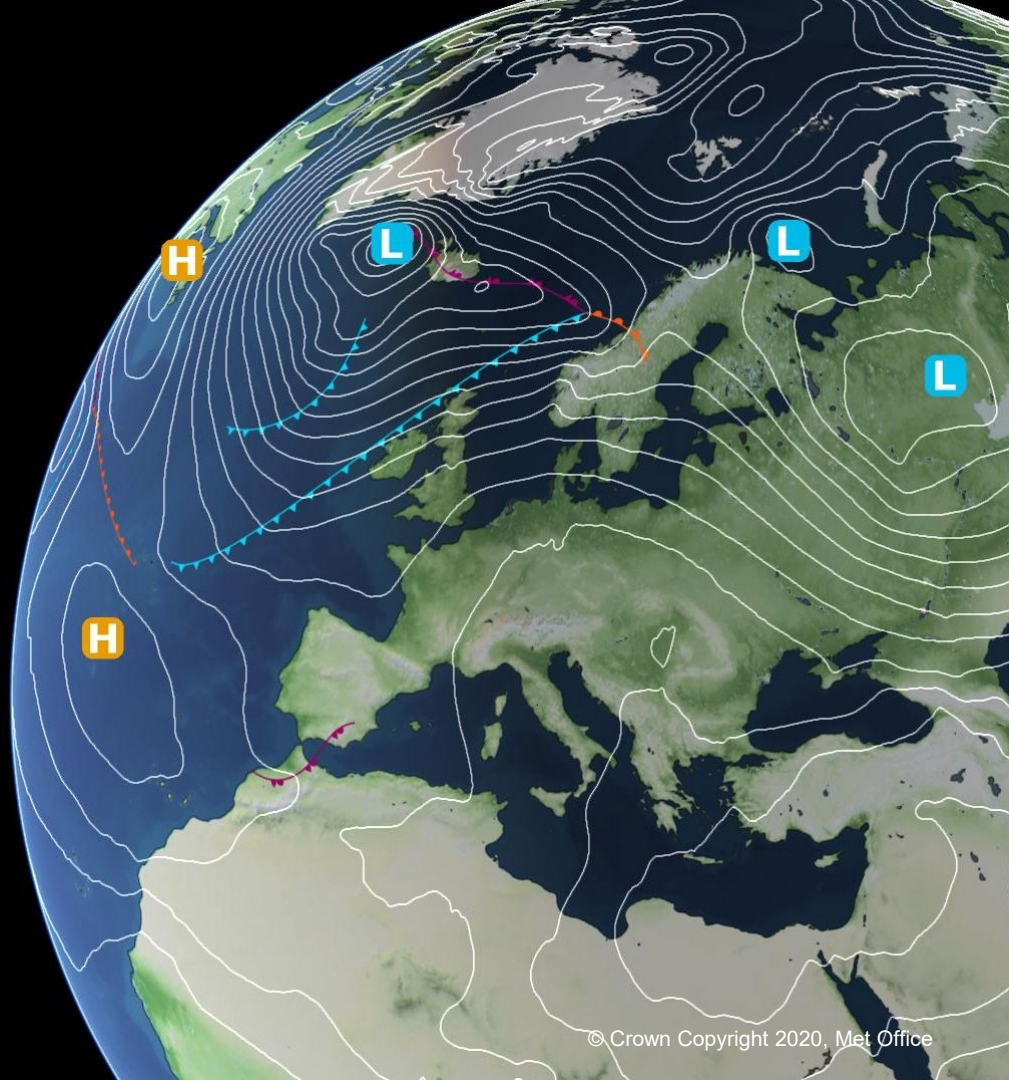
Affordable, low-carbon and resilient: how weather and climate insights can improve energy sector decision-making

Dr Emily Wallace CMet

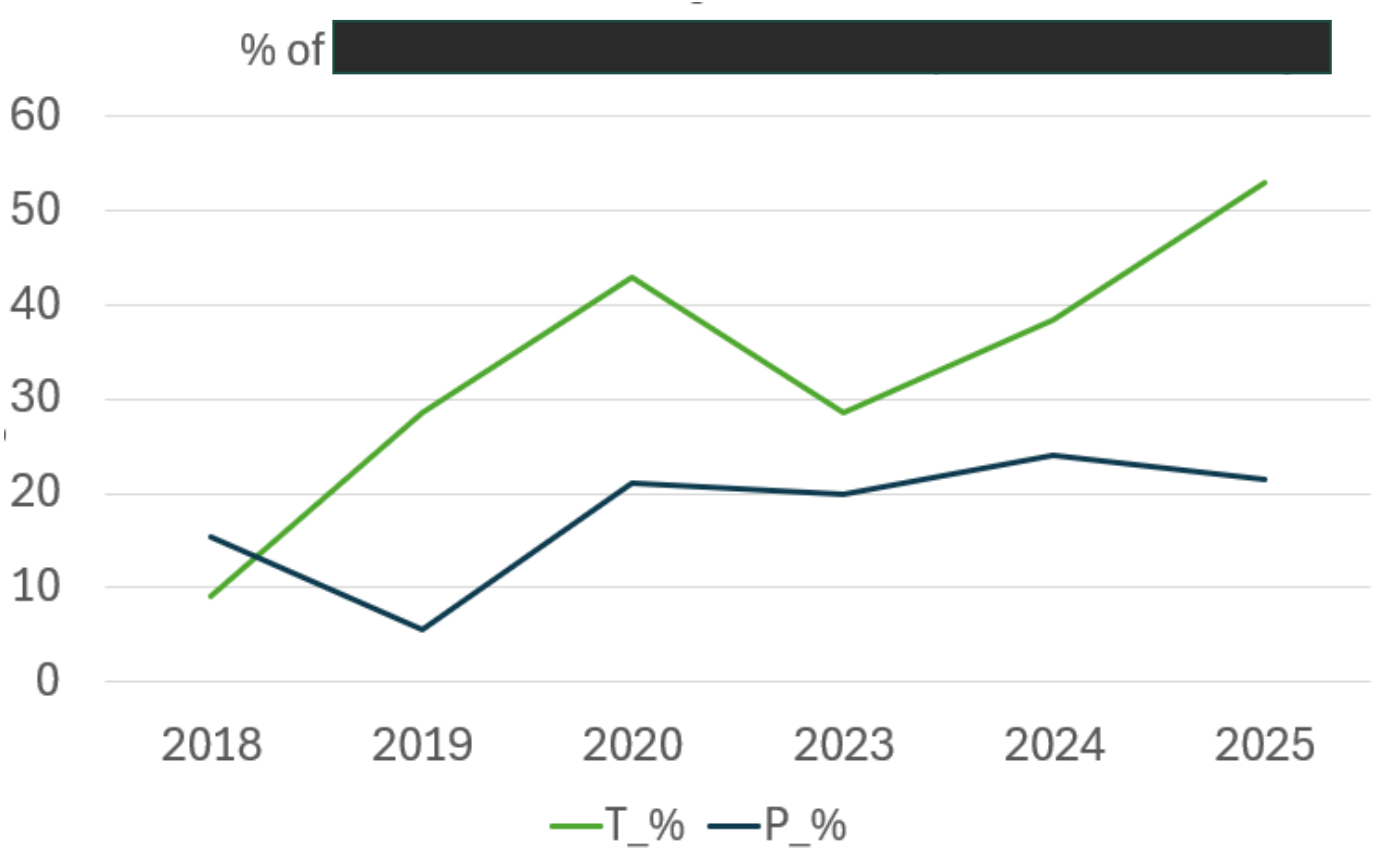
Fellow in Weather and Climate Extremes at the Met Office

Visiting Professor University of Strathclyde

March 2025

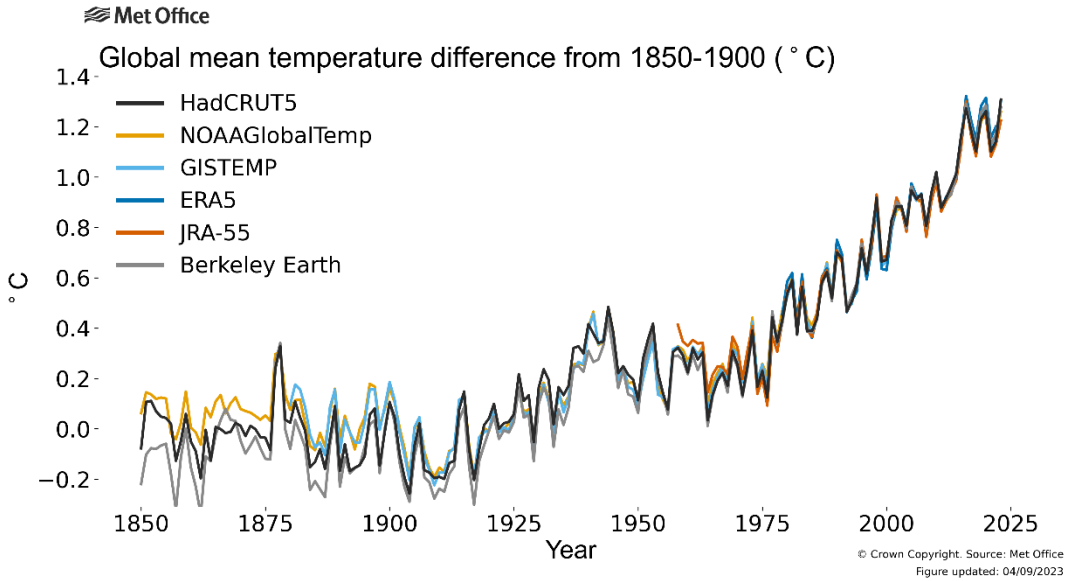


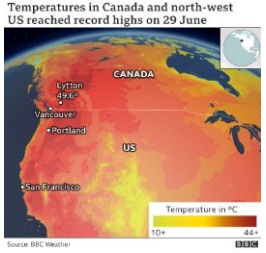
Met Office



* [redacted]

Global temperatures have risen by ~1.1°C





Met Office

Total GHG emissions in 2023

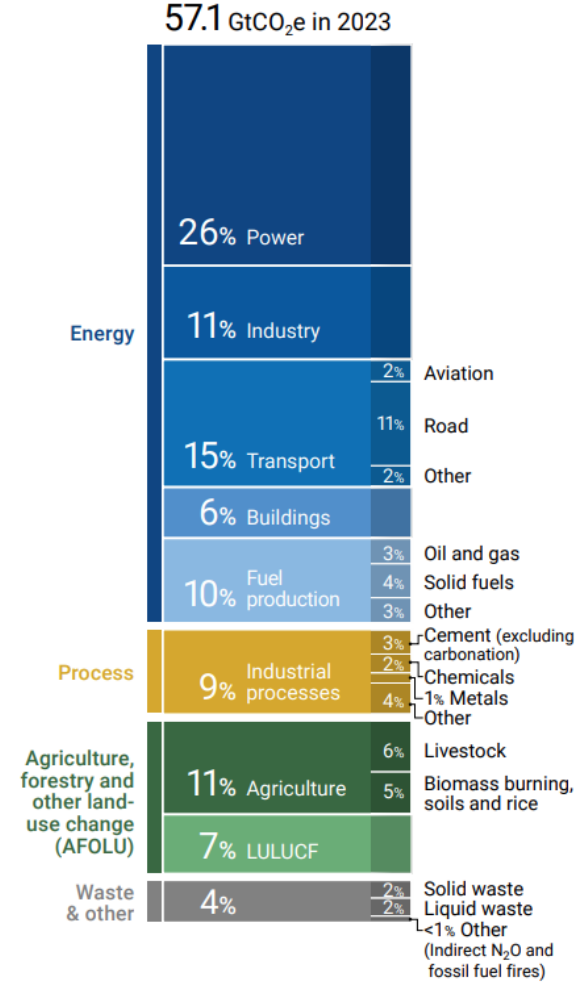
Energy: 68%

- 26% Power
- 11% Industry
- 15% Transport
- 6% Building
- 6% Fuel production

Source: **Emissions Gap Report 2024**

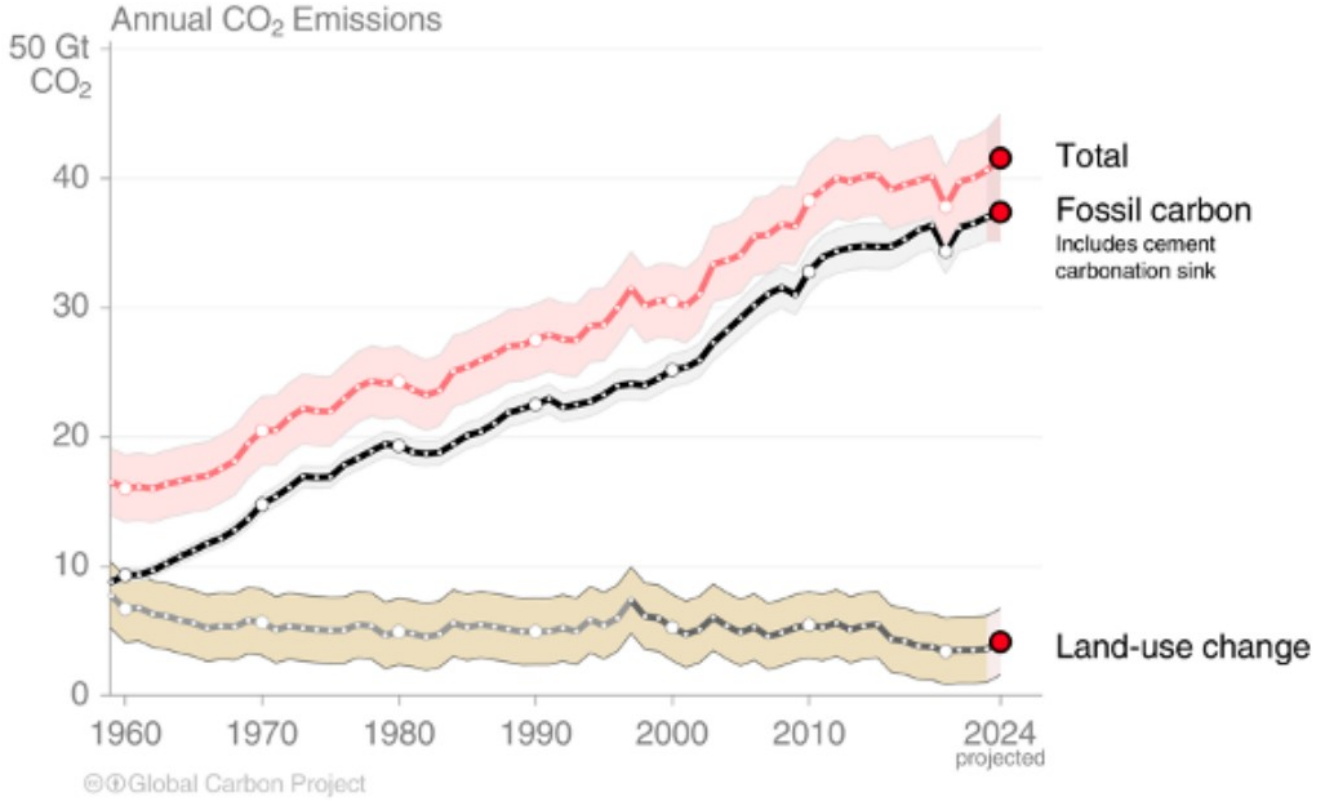
UN environment programme

Figure ES.1 **Total GHG emissions in 2023**



Met Office

Global annual CO_2 emissions

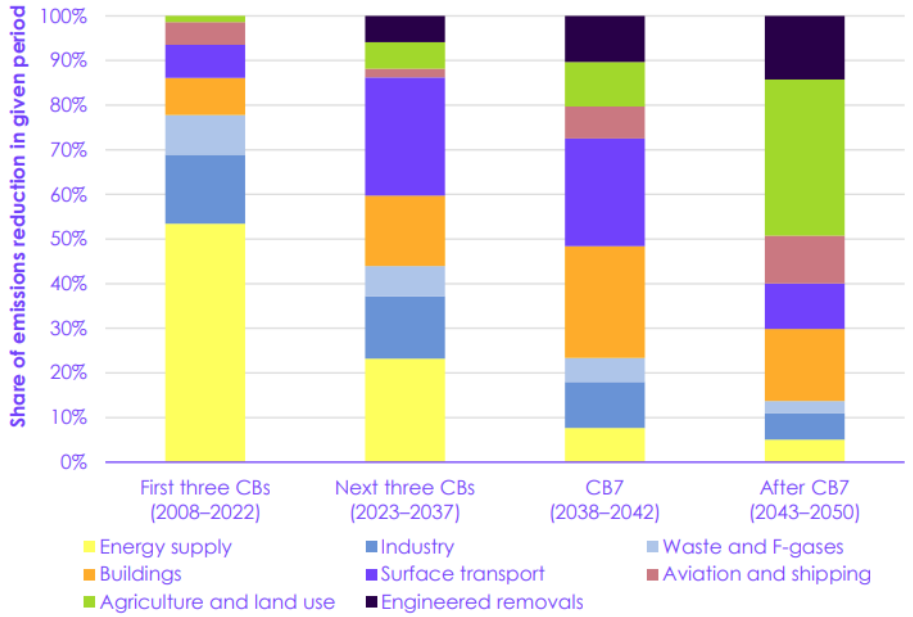


Source: GLOBAL CARBON project

Met Office

- GHG emissions approximately half 1990 levels
- Over half the emission reduction since 1990 is from energy supply.
- Much of the following decade is recommended to come from electrification of heating and transport.

Figure 2 Distribution of emissions reductions during each carbon budget period



Description: Over half of the emissions reduction to meet the first three carbon budgets came in the energy supply sectors. Looking forward, the majority of reductions to meet future carbon budgets will need to come from other sectors. Around half of the reduction during the Seventh Carbon Budget period will come from surface transport and buildings.
Source: CCC analysis.
Notes: See Chapter 3. 'CBs' refers to UK carbon budgets and 'CB7' refers to the Seventh Carbon Budget.

Source: Climate Change Committee, 7th Carbon Budget

Met Office

UK Clean Energy Targets

Mission on clean energy:

WE ARE ON A MISSION TO ACHIEVE CLEAN POWER BY 2030..I WANT TO GET AHEAD OF THE GAME.

WE ARE DELIVERING ON OUR PROMISE FOR GOOD JOBS, CHEAPER BILLS, AND HIGHER GROWTH.

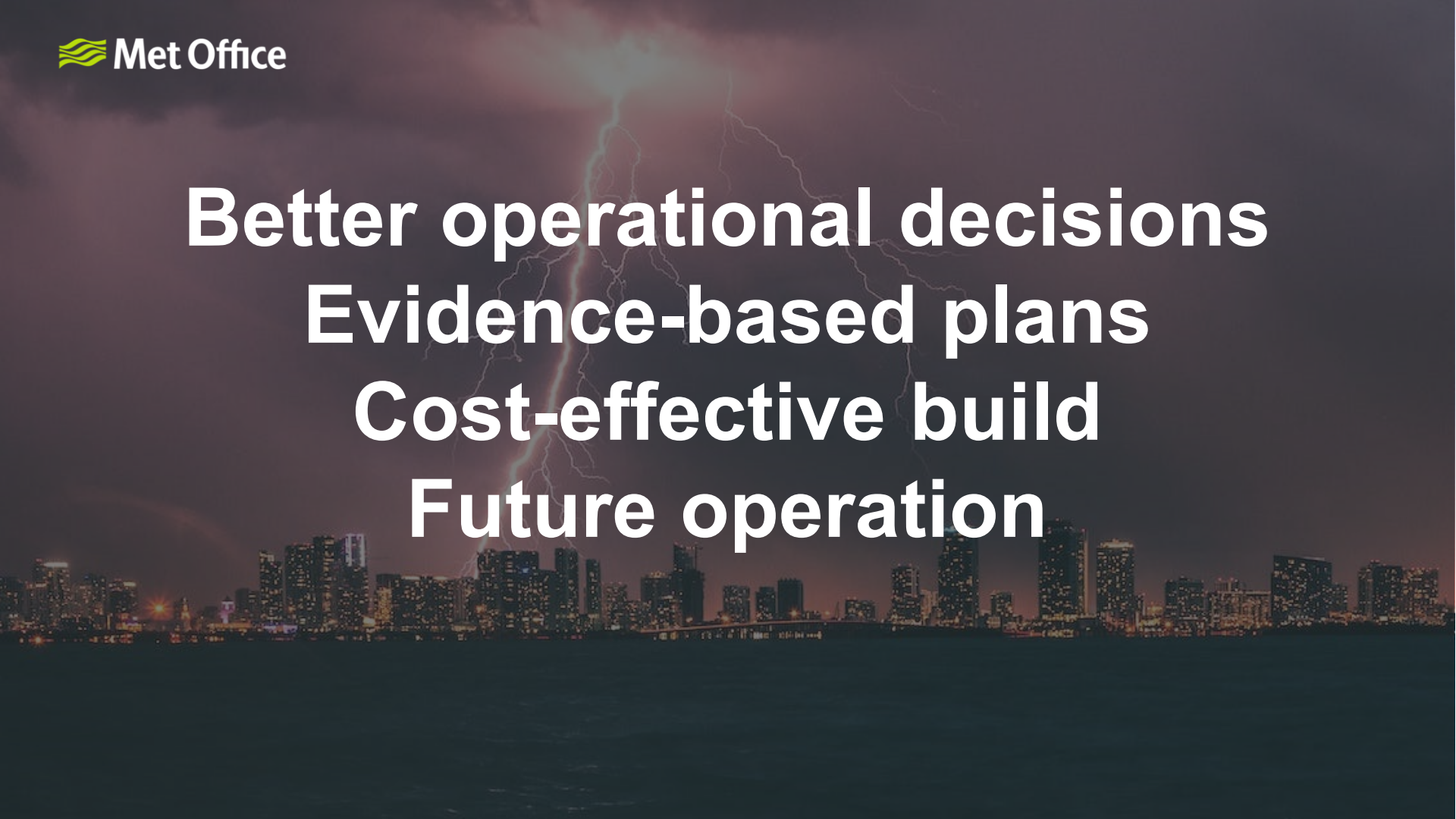
Keir Starmer, COP29 Baku, Azerbaijan, 12th Nov 2024

Each positive tipping point we pass increases the chances of activating others

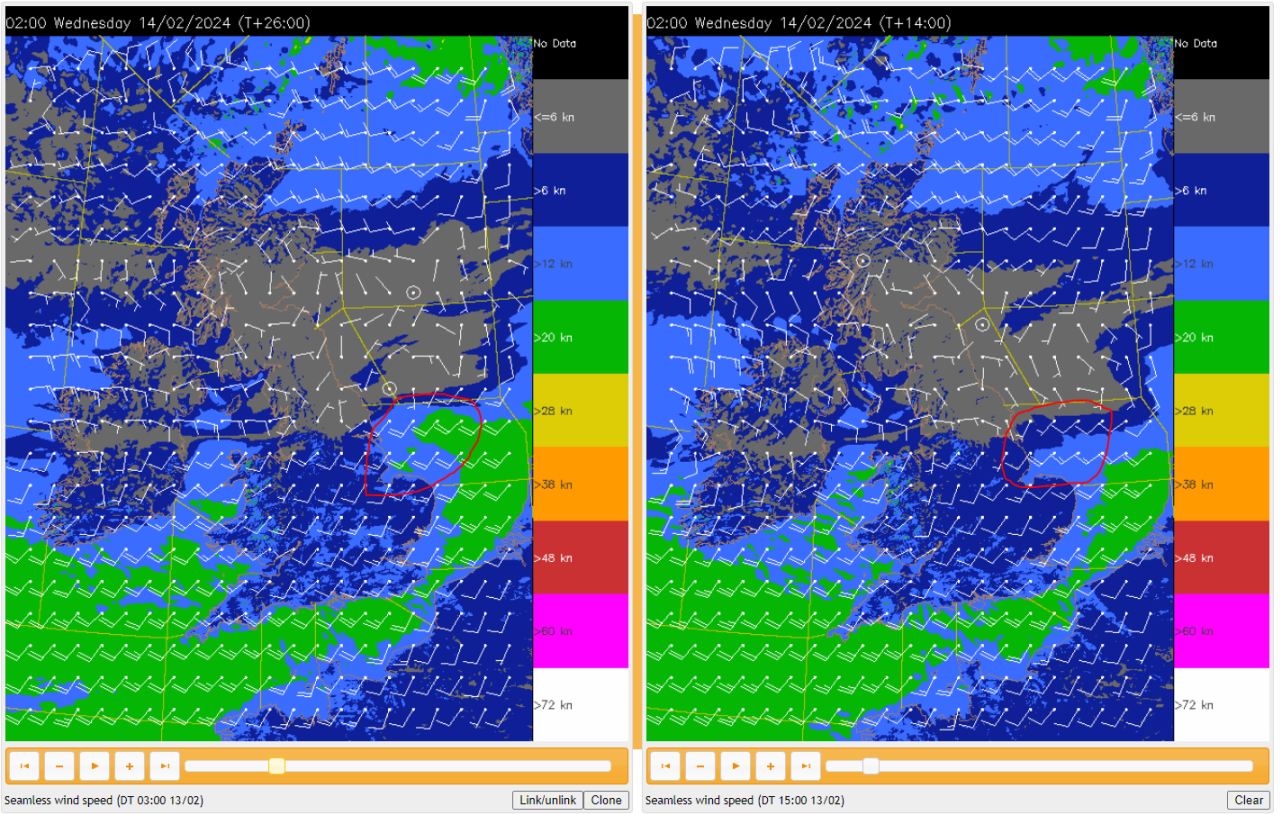
Adapted from Meldrum, Sharpe, Lenton, et al, *'The Breakthrough Effect'* (2023)

Five Times Faster: Rethinking the Science, Economics, and Diplomacy of Climate Change. Simon Sharpe, 2023. Info at fivetimesfaster.org

Source: **Slides for public use, accessible at fivetimesfaster.org**
With illustrations by Dionne Kitching


Met Office
Better operational decisions
Evidence-based plans
Cost-effective build
Future operation

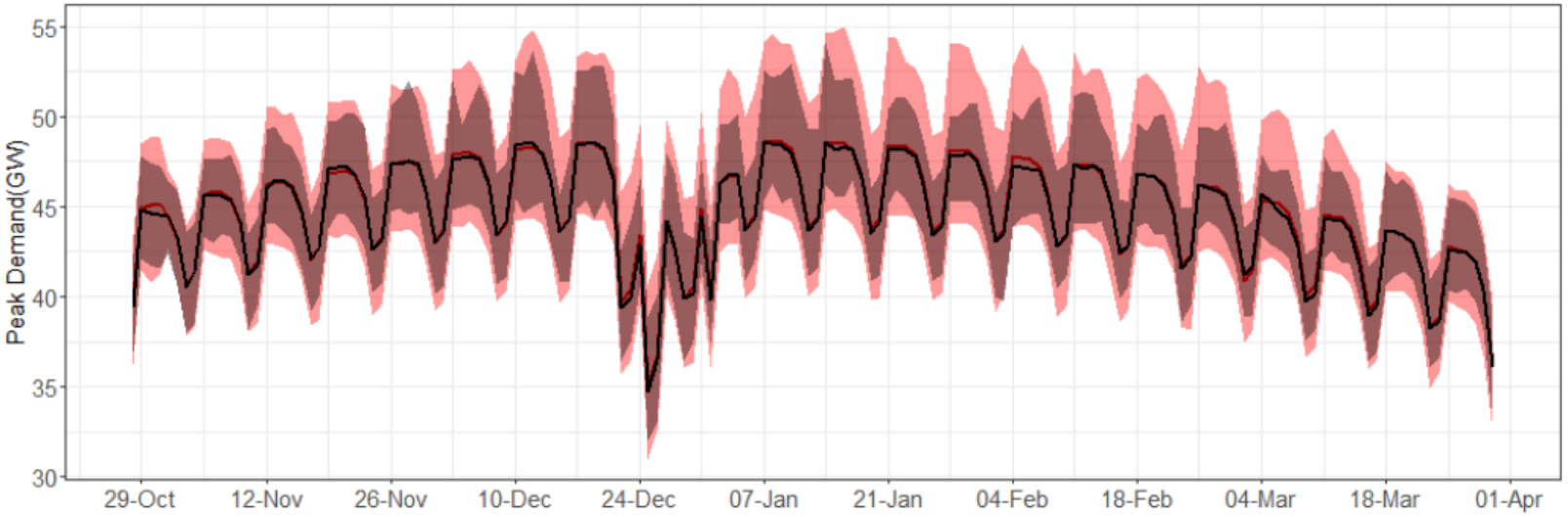
Improving shared understanding



- Identified a trend to weaken winds across a key windfarm area
- wind speeds at a level such that power output would be very sensitive to small changes

Integrated teams

Report: Climate data for energy modelling



Network Innovation Allowance (NIA)

Credit: Katie Chowienczyk, Dan Drew, Paula Gonzalez, Eloise Matthews, Joshua Parkin, Fiona Rust, Ben Sloman

Met Office Reaching the masses

ELSEVIER

Journal of Building Engineering
Volume 44, December 2021, 102594

Impact of climate change on the carbonation in concrete due to carbon dioxide ingress: Experimental investigation and modelling

Abbas S. AL-Ameeri [a b], M. Imran I

ISSN 1831-9424

European Commission

Impact of climate change on the corrosion of the European reinforced concrete building stock

Dimova, S., Polo López, C.S., Sousa, M.L., Rianna, G., Bastidas-Arteaga, E., Nogal, M., Gervásio, H., Martorana, E., Reder, A., Athanasopoulou, A. author(s)

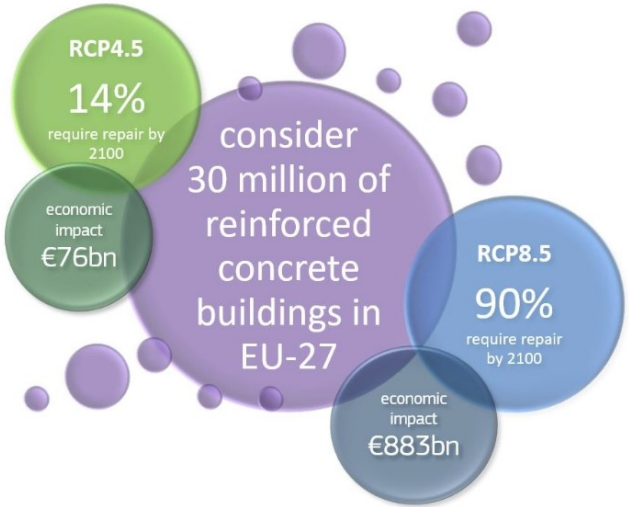
Dimova, S., Polo López, C.S., Sousa, M.L. editor(s)

2024

European Commission

Impact of climate change on the corrosion of the European reinforced concrete building stock

Discover the recent JRC study examining the impact of climate change on concrete buildings in Europe, including projections for corrosion onset, repair costs, and welfare loss by 2100.



IMPACT OF CLIMATE CHANGE INDUCED CARBONATION OF CONCRETE

European Commission

Met Office

Affordable, low-carbon and resilient: how weather and climate insights can improve energy sector decision-making

When it helps make relevant technologies **affordable**, **attractive** and **accessible**

Only with full integration between disciplines and organisations: learning from each other and reaching the right audiences

Met Office

Power cuts hit Hull, Beverley and Driffield as Storm Babet batters Hull and East Yorkshire

Northern Powergrid offi

NEWS By James Campbell Re

12:01, 20 OCT 2023

Power cuts across East Yorks

Northern Ireland clear up continues after thousands cut off in Storm Éowyn

UTV | NORTHERN IRELAND | WEATHER | REPUBLIC OF IRELAND | Monday 27 January 2025 at 4:01pm

Work on restoring power continues in Northern Ireland after Storm Éowyn.
Credit: Presseye

Jan 2025

id t

ations

July 2022

The extreme hot weather caused power cables to expand, reducing their ability to carry electricity (Photo: Chris Ratcliffe/Bloomberg via Getty)

Mirror

Oct 2024

Corfe Castle in Dorset, low mist and cloud has covered much of the UK the past few days (Image: PA)

NEWS | POLITICS | FOOTBALL | CELEBS | TV | SHOPPING | ROYALS

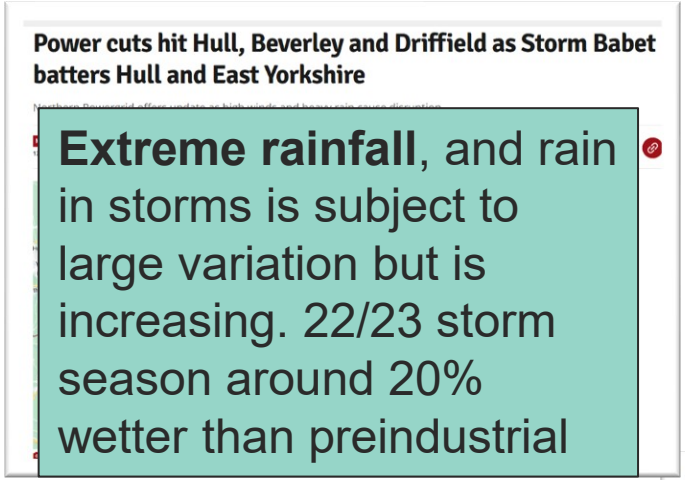
What is 'anticyclonic gloom' and why is it making UK weather more miserable than usual?

The last time there was any significant sunshine seen in these isles was Sunday October 27, more than 10 days ago, according to the Met Office, with the strange weather phenomena set to continue

g parts

PAUL FAITH/PA

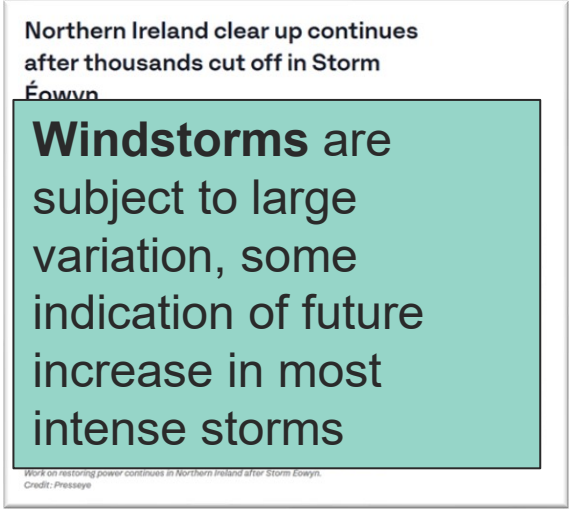
Oct 2023



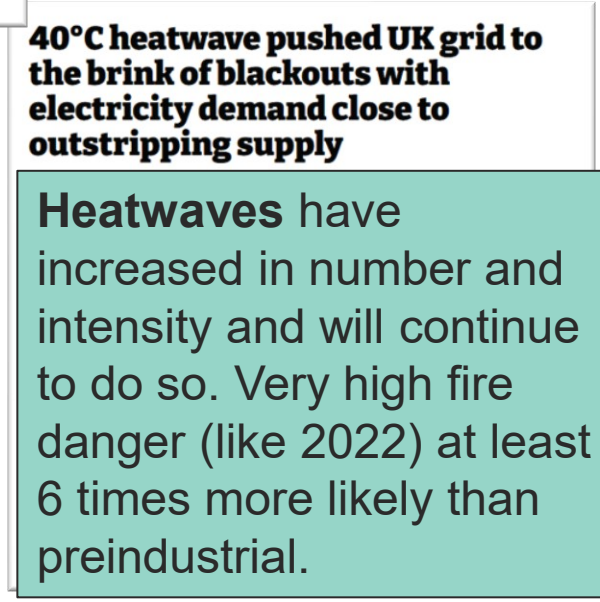
Extreme rainfall, and rain in storms is subject to large variation but is increasing. 22/23 storm season around 20% wetter than preindustrial

UK picture of extreme weather: Warmer wetter winters, hotter drier summers and…

New compound hazards are relevant and many not well understood



Windstorms are subject to large variation, some indication of future increase in most intense storms



Heatwaves have increased in number and intensity and will continue to do so. Very high fire danger (like 2022) at least 6 times more likely than preindustrial.

Coastal hazards will increase with rising sea-levels

Met Office

outages

low margin

low generation

inefficiency

constraints

unexpected demand

asset damage

health and safety compromised

Power cuts hit Hull, Beverley and Driffield as Storm Babet batters Hull and East Yorkshire

Northern Powergrid offers update as high wind

NEWS By James Campbell Reporter

12:01, 20 OCT 2023

Power cuts across East Yorkshire due to Storm Babet (Image: Northern Powergrid)

40°C heatwave pushed UK grid to the brink of blackouts with electricity demand close to outstripping supply

ring temperatures caused cables to swell and power stations to struggle, almost sparking widespread power cuts

The extreme hot weather caused power cables to expand, reducing their ability to carry electricity (Photo: Chris Ratcliffe/Bloomberg via Getty)

Castle in Dorset,

POLITICS

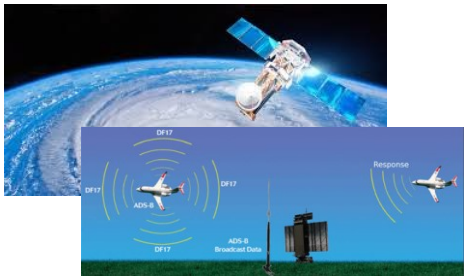
Storm Pia: Strong winds hitting parts of Northern Ireland

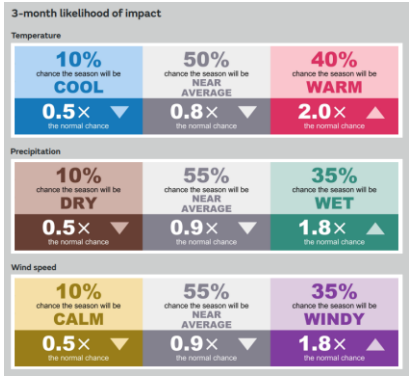
21 December 2023

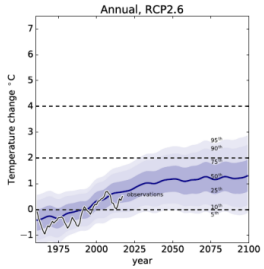
PAUL FAITH/PA

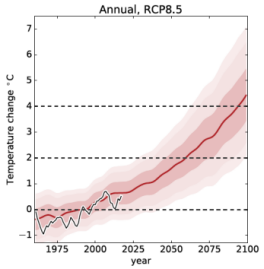
Met Office

Weather and climate





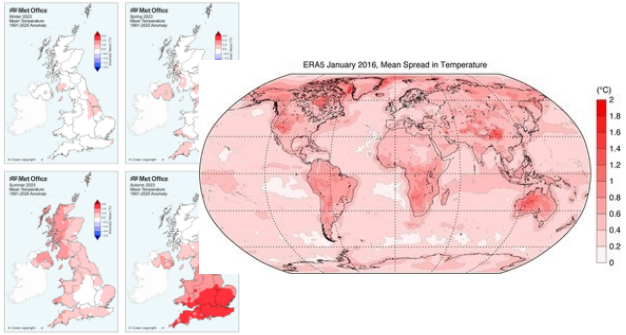


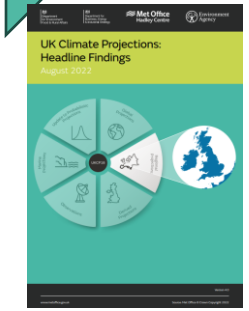


PAST

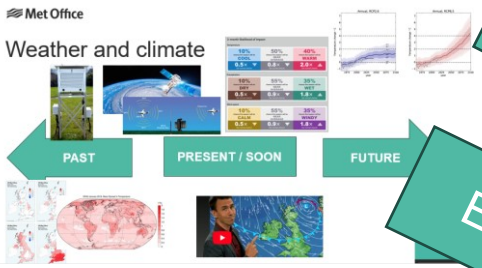
PRESENT / SOON

FUTURE





Met Office



Science & consultancy

Expert advice

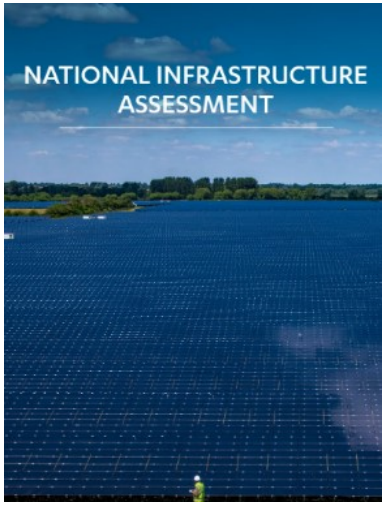
Data

Regulators

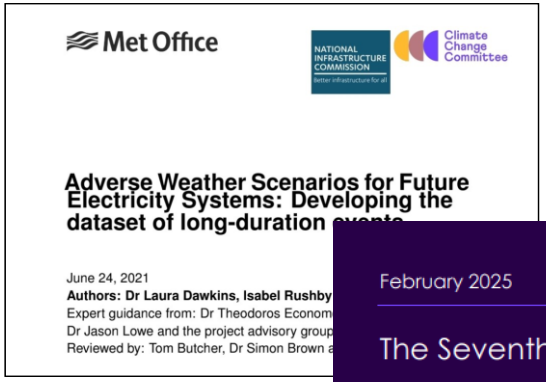
Industry

Government

Academia



National Infrastructure Assessment, NIC (2018)


Met Office

Adverse Weather Scenarios for Future Electricity Systems: Developing the dataset of long-duration events

June 24, 2021

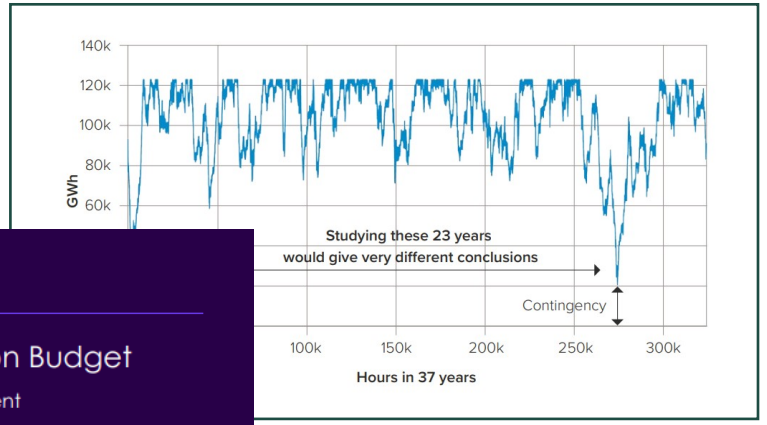
Authors: Dr Laura Dawkins, Isabel Rushby

Expert guidance from: Dr Theodoros Econom

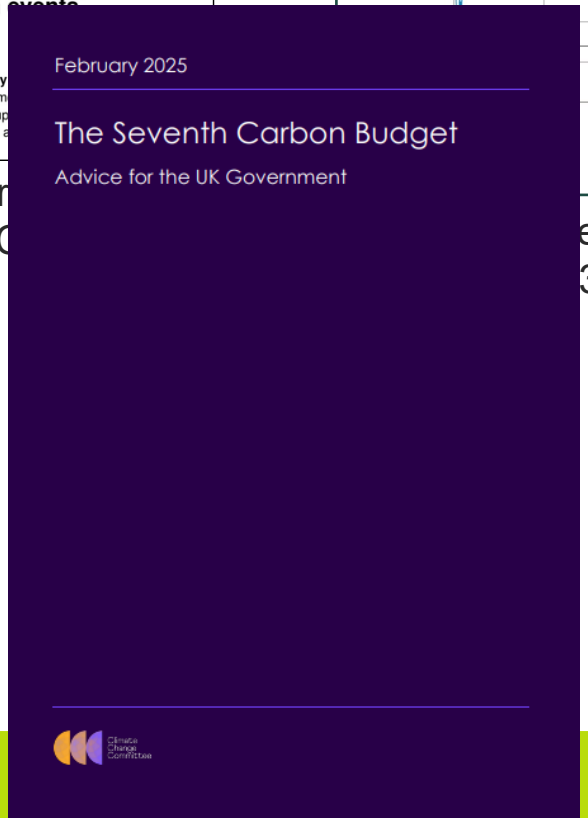
Dr Jason Lowe and the project advisory group

Reviewed by: Tom Butcher, Dr Simon Brown a

Adverse Weather
Met Office, NIC, C



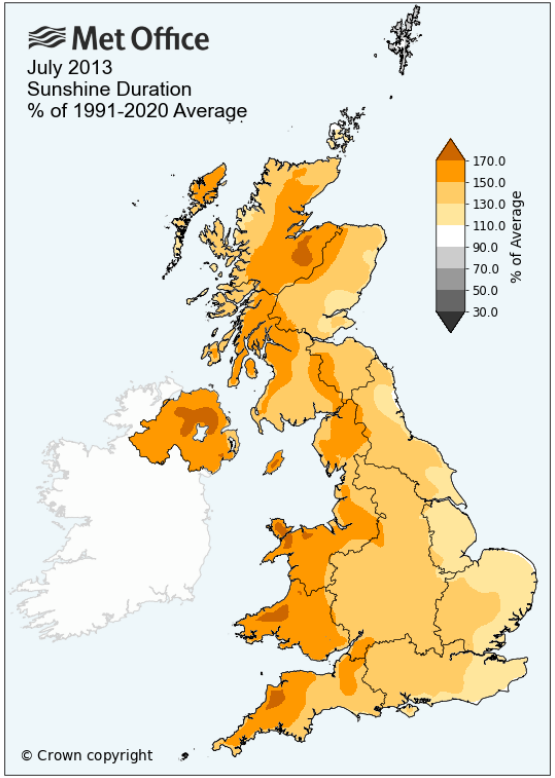
electricity storage, Royal
3)


February 2025

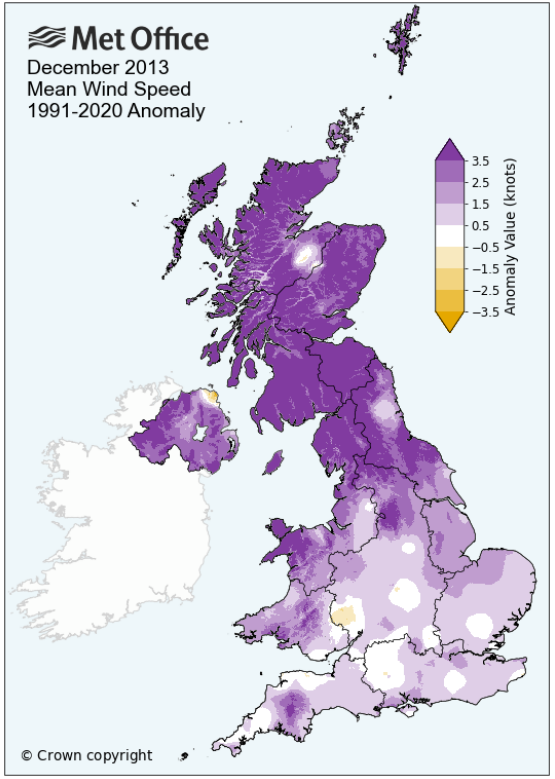
The Seventh Carbon Budget

Advice for the UK Government

A ‘representative’ weather year, like 2013 includes…



One of the sunniest summer months in SW and Wales in recent decades



The windiest month in Scotland since 1997

Reliability analysis of system assets

Control and optimisation of uncertain power systems

Modelling and quantifying uncertainty in energy systems

Analysing system resilience and high impact low probability events

Planning future energy systems under uncertainty

Communicating risk to energy system stakeholders and policy makers

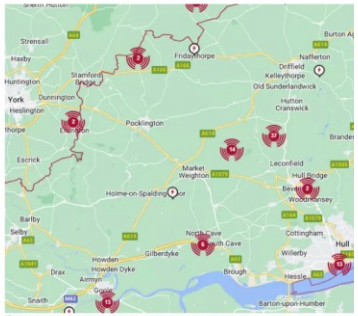
Met Office Was that a climate change extreme?

Power cuts hit Hull, Beverley and Driffield as Storm Babet batters Hull and East Yorkshire

Northern Powergrid offers update as high winds and heavy rain cause disruption

NEWS By James Campbell Reporter
12:01, 20 OCT 2023

Bookmark



Power cuts across East Yorkshire due to Storm Babet (Image: Northern Powergrid)

40°C heatwave pushed UK grid to the brink of blackouts with electricity demand close to outstripping supply

Searing temperatures caused cables to swell and power stations to struggle, almost sparking widespread power cuts


The extreme hot weather caused power cables to expand, reducing their ability to carry electricity (Photo: Chris Ratcliffe/Bloomberg via Getty)

Mirror

Castle in Dorset,

POLITICS

hat is '
making
an usu

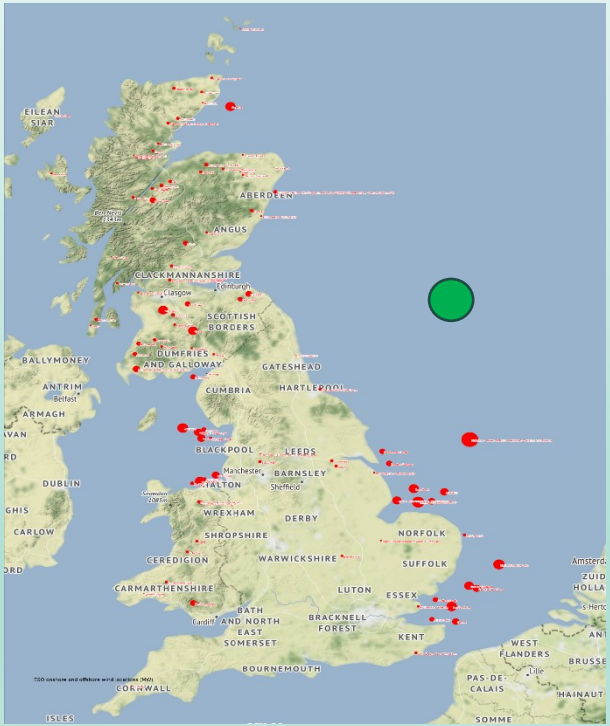
Storm Pia: Strong winds hitting parts of Northern Ireland

21 December 2023


PAUL FAITH/PA


Met Office
Better decisions now
Evidence-based plans
Cost-effective build
Future operation

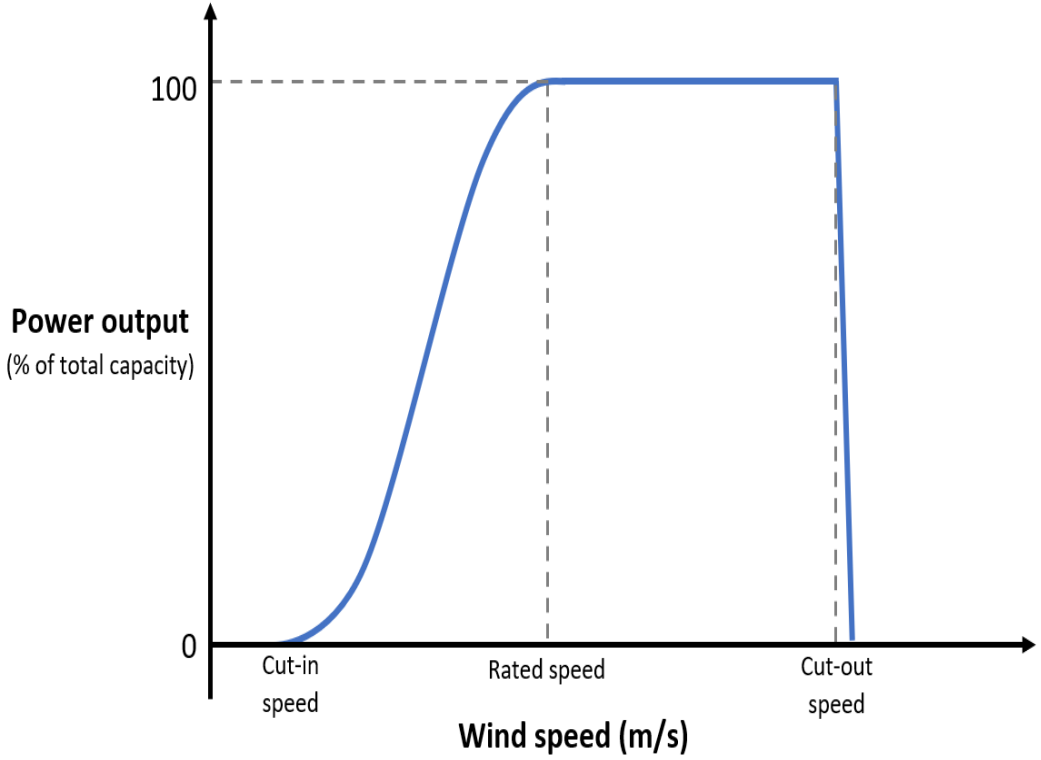
Wind generation – key wind farm distribution

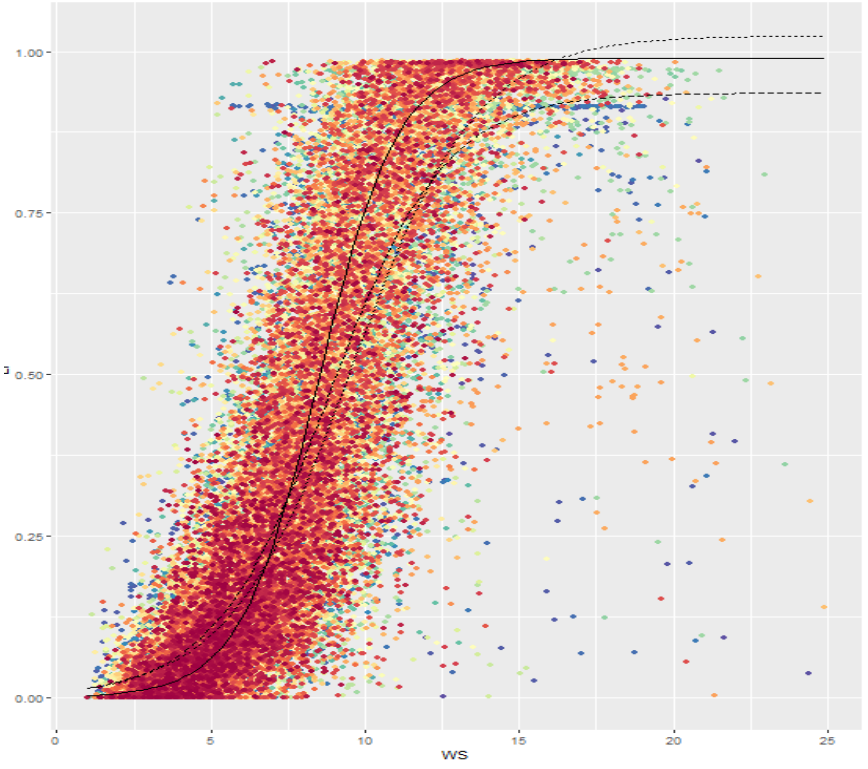


- Some parts of the UK and surrounding waters are far more important than others for wind generation!
- Hornsea (offshore) windfarm is currently the biggest with a max generation capacity of 1,218 MW
- Dogger Bank (green circle) is due to complete in 2026 and will be the largest offshore wind farm globally, with max generation capacity of 3,600 MW

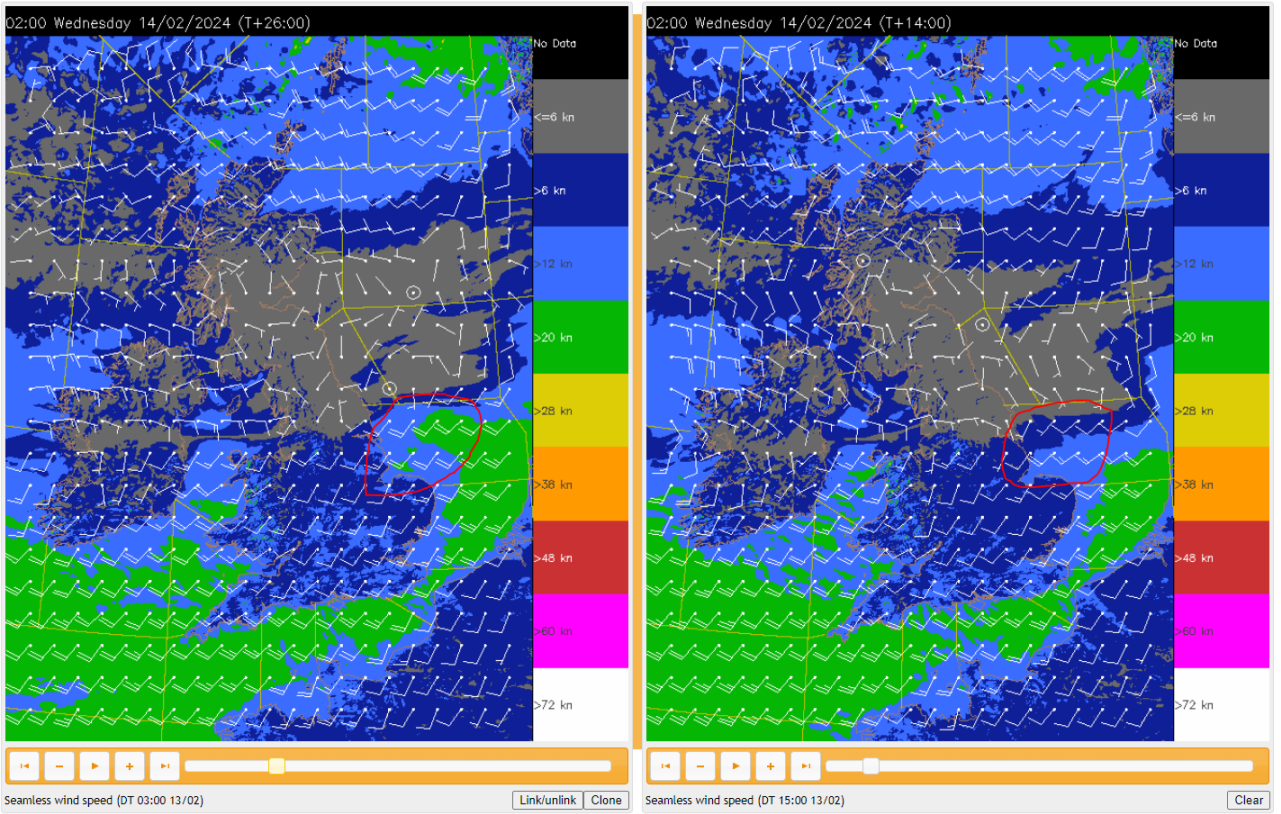
Met Office

Wind generation – power output curve





A good steer many times



- Identified a trend to weaken winds across a key windfarm area
- 100m wind speeds such that power output is very sensitive to small changes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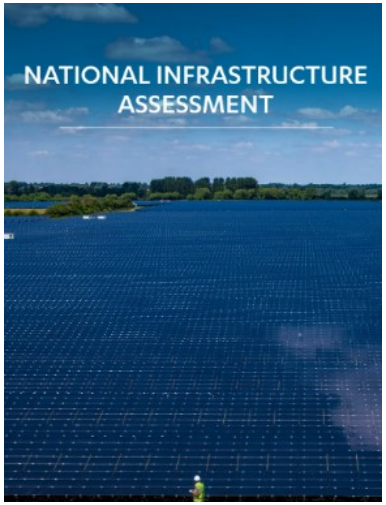
Future operation



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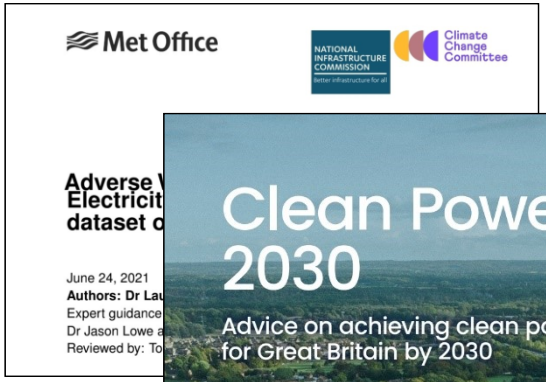
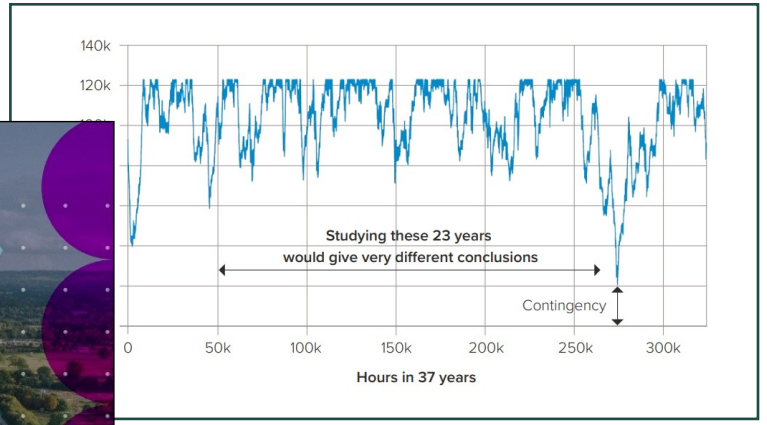
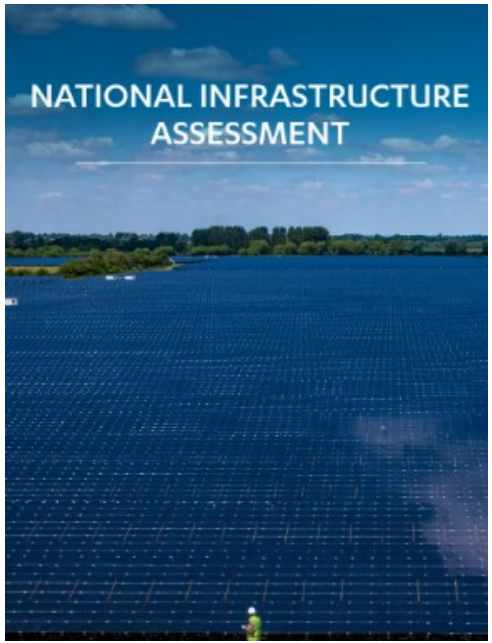


Adverse
Met Offi



e-scale electricity storage, Royal
ety (2023)

Evidence based plans



- Data
  - Return levels
  - ‘Normal’
  - Stress test
  - Scenarios
  - Local, UK, Europe, Global
  - Hours, Days, Decades
  - Compound
- Expert advice
  - Narratives/stories
  - What aspects of the weather might be material?
  - How can this be included pragmatically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Better decisions now
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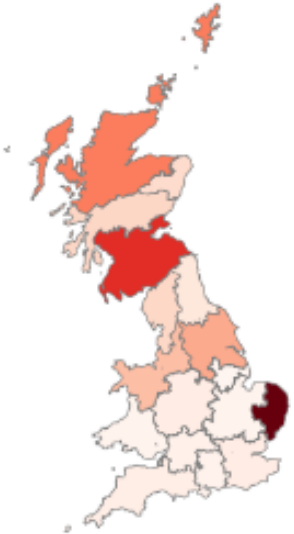
Cost-effective build
Future operation

Clean power constrained on the transmission network: 80 works recommended



Estimated £12.7billion in constraint costs and 8.1% unabated gas by 2030

Estimated ~£4billion in constraint costs and 4.97% unabated gas by 2030

Clean power 2030, NESO (2024)

Met Office

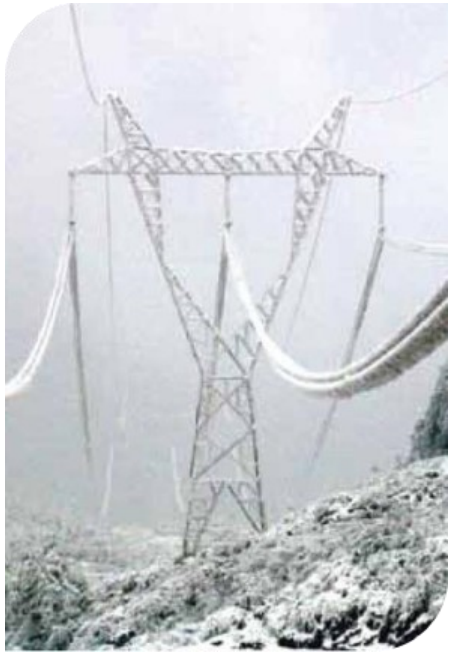
Construction News 13/06/2023

SSEN Transmission To Invest £10bn In Scottish Network

SSEN Transmission has announced a £10 billion investment in the north of Scotland's transmission network, which will play key role in enabling the connection of up to 11GW of new offshore wind capacity through ScotWind projects.

Known as the 'Pathway to 2030 programme', the company's huge investment in the north of Scotland will deliver billions in value to the UK economy whilst enabling connection of over one fifth of the UK Government's 50GW 2030 offshore wind goal. The projects include several new onshore reinforcements and subsea links and are part of a major upgrade of the electricity transmission network across Great Britain that is required to meet UK and Scottish Government climate change and energy security targets.

Feasibility study showed over engineering due to outdated ice accretion maps, updating maps had potential for significant costs savings

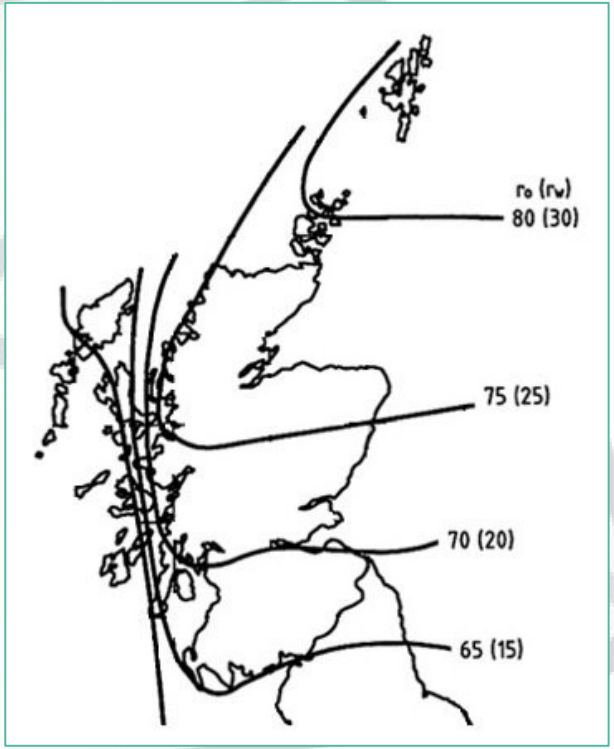


Weather is also about design

The situation of ongoing power outages in Shetland is troubling, with 2,400 customers still without power as of this morning **(15th December)**. This is largely due to significant snow and ice sticking to overhead power lines, causing them to fall. - Ofgem

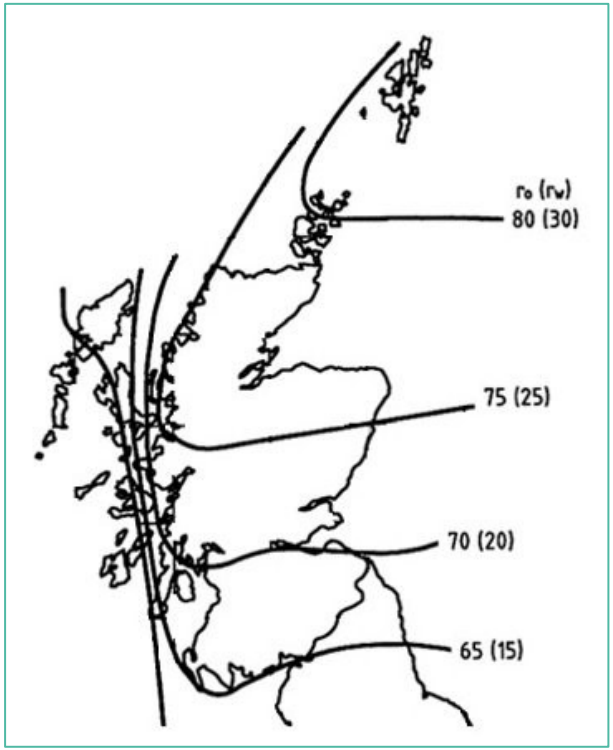
What we have

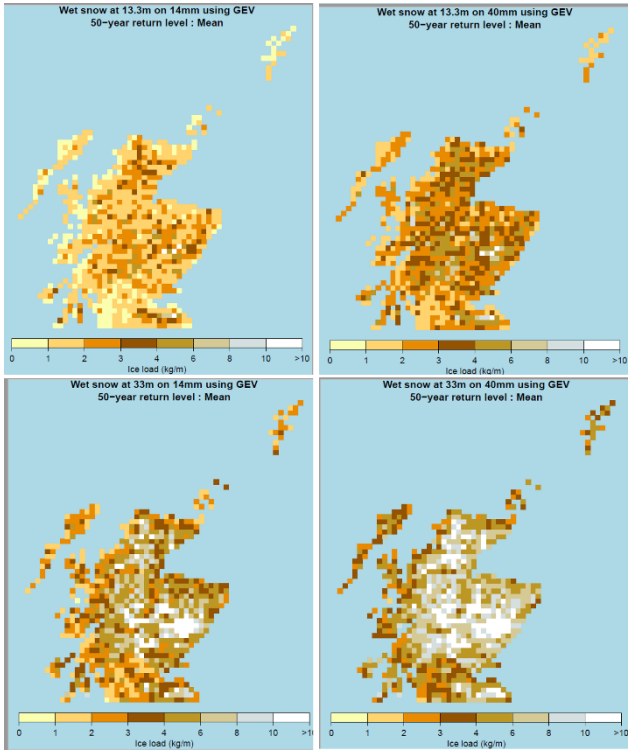
- Ice Loads drawn on map
- Maps produced ~30 years ago by Met Office
- Used derived radial ice estimates based on weather station observations
- Updated in 2006….



UK Ice map, from BS 8100-2:1986, now replaced by Figure NA.2 of BS EN 1993-3-1:2006

Wet Snow Maps





Cost effective build

Building standards

- Ice accretion
- Corrosion
- Noise
- BSI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Better decisions now
Evidence-based planning
Cost-effective build
Future operation

What strategies will we use to optimise the future system – and what benefits does that unlock?

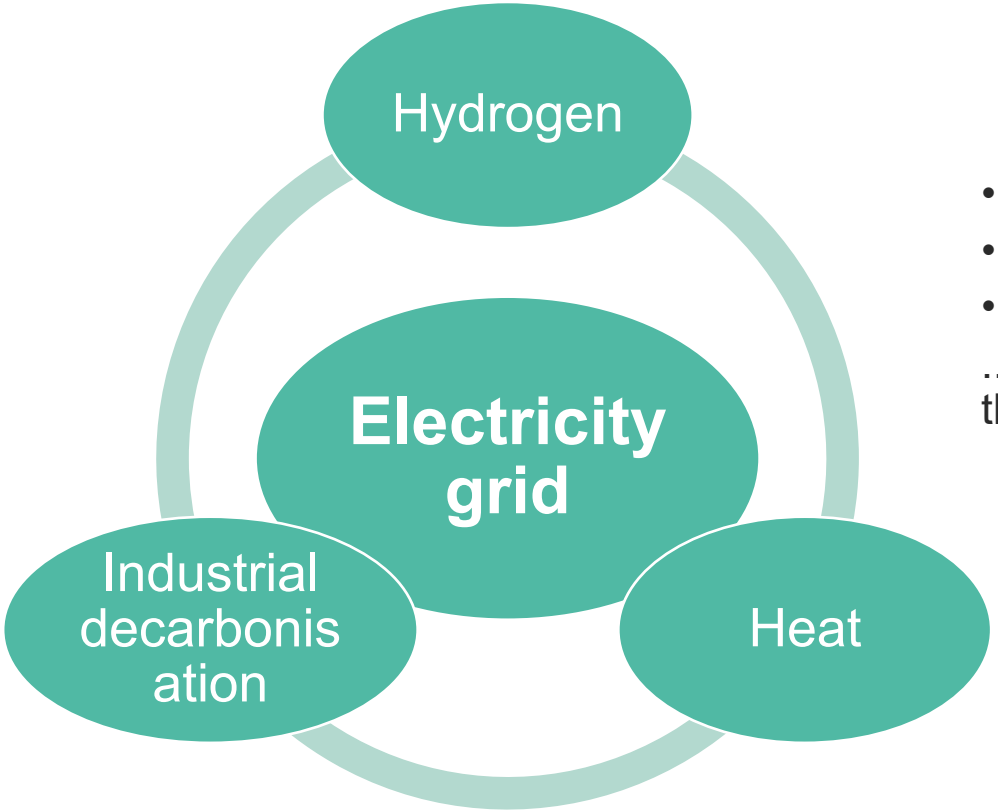
- **System optimisation:** Our modelling approximates how the system is dispatched, and allows for some inefficiencies in this, for example because market participants do not have perfect foresight. To explore the impact of more efficient dispatch decisions we tested how model results changed with a shift from one-day to seven-day foresight. This favours storage and demand flexibility, which can then avoid the need for gas-fired generation more effectively. This test sees gas use reduce from 5% to 3.5% in our pathways, while also bringing material cost savings. The possibilities here warrant further investigation which we have underway.

Clean power 2030, NESO (2024)

Met Office

ENSIGN
Energy System Digital Twin

EPSRC
Pioneering research and skills



- Severe weather
- Faults
- Black start

..simulating decision making of the future!

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