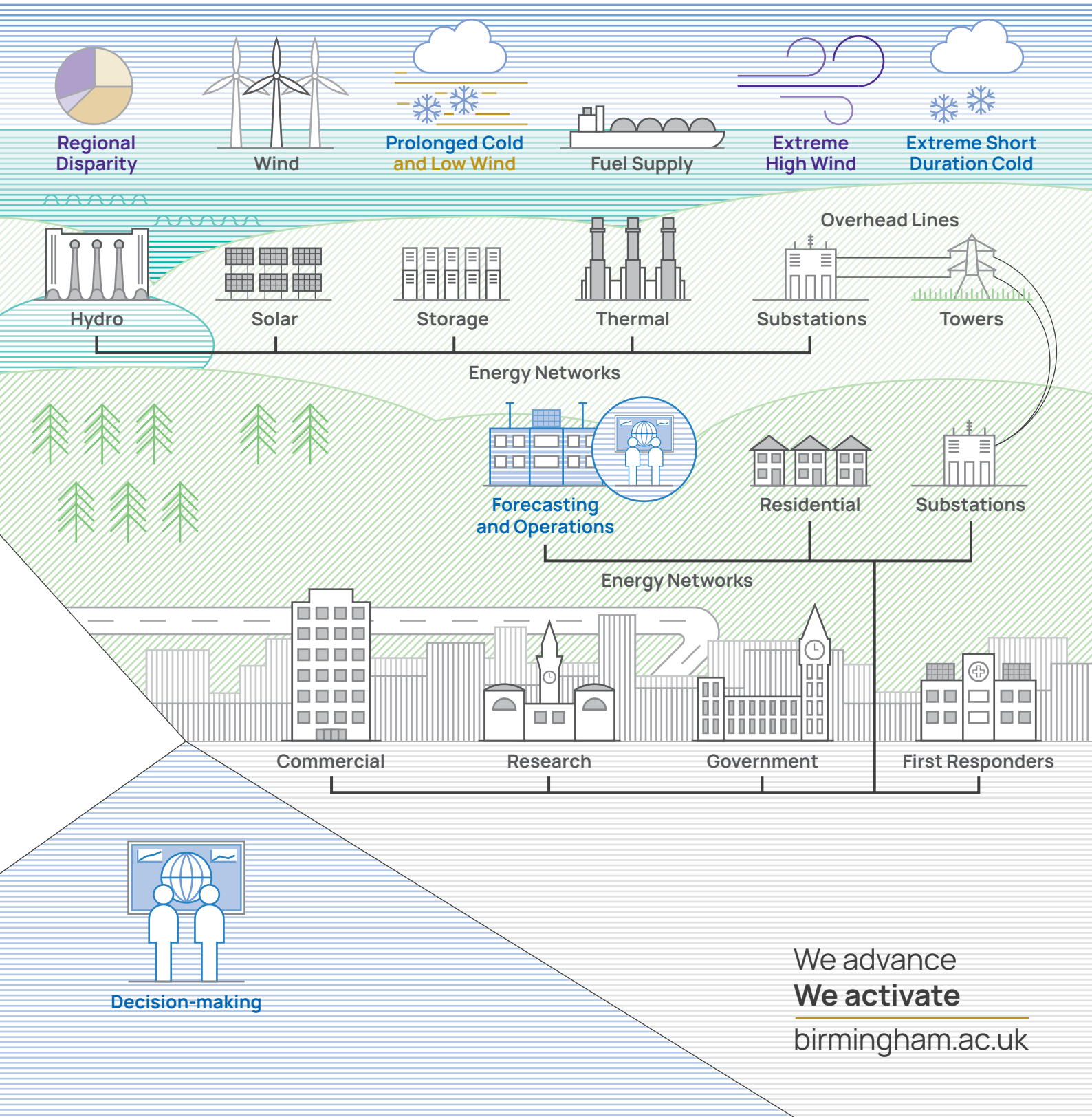
UNIVERSITY OF BIRMINGHAM

Met Office

The future of seasonal forecasting in the energy sector

Winter weather storylines for decision-making in the extremes



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Advances in seasonal forecasting have provided benefits across many sectors of the economy

This document provides insights from a collaborative project between the University of Birmingham and the Met Office to better understand energy sector decision-making using winter weather storylines, with a particular focus on seasonal forecasts. As part of this project, a workshop was held with participants from across the energy sector–including generators, policymakers, local councils, network operators, consultancies, Met Office and academics from the University of Birmingham–to understand the opportunities for seasonal forecasting to improve their short to medium view of the winter ahead for planning purposes.

Weather is an important factor in the operation of the electric grid, driving changes in load, generation, and the assets. As a result, it is growing increasingly important for energy sector stakeholders to understand and make good use of weather data. Seasonal forecasts are widely available to many sectors of society and industry and their skill has improved over the last decade. These forecasts are based on complex ensemble generation and mainly available in a probabilistic form, forecasting probabilities of deviations from a mean state rather than specific events. An overview of seasonal forecasting from the Met office is available here.

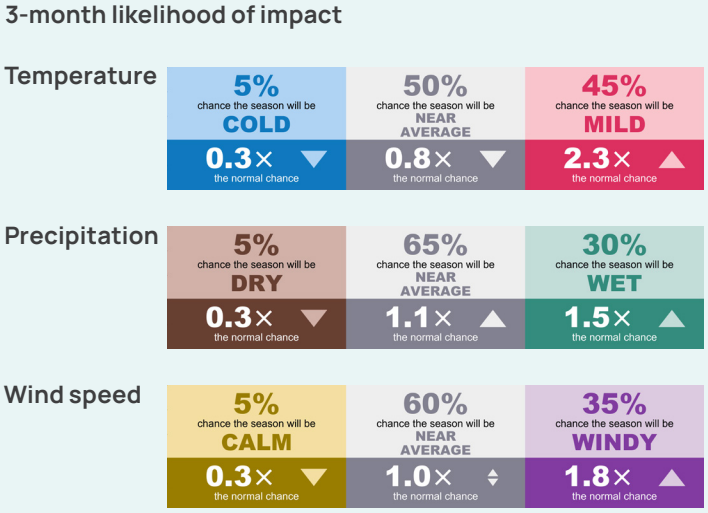
Seasonal forecasting has a wide and increasing range of applications, such as understanding of wildfire risk[1], agricultural production[2], ecological restoration[3], water management[4], and energy generation[5]. Increases in forecast skill are providing new opportunities for the use of seasonal forecasts in the energy sector. As more variable generation enters the grid it is imperative that all parties in the energy sector understand and can model the risks that will be expected within a particular year and a particular season. Winter in particular poses additional opportunities and risks due to the close correlation of energy use and weather conditions[6].

Met Office produces UK monthly and seasonal forecasts

The Met Office forecasts provide probabilistic outlooks for the upcoming one- and three-month periods. These outlooks give forecasts of UK mean temperature, precipitation and wind speed, highlighting the probability of cold, wet, or windy conditions for example. The risk of impacts, such as snow, windstorms and drought conditions are also discussed.

The forecast is provided using graphics, statistics and written descriptions. Fig. 1 provides an example seasonal forecast from November 2024. Currently, these forecasts are used by the energy sector to anticipate supply and demand challenges, by first responders to assess potential weather-related disruptions (Fig. 2), by water resource managers to support reservoir and drought planning (Fig. 3), and by government contingency planners for risk preparedness and to anticipate potential weather-related disruptions.

Fig. 1 **Example UK seasonal forecast from November 2024 for Dec-Jan-Feb, provided by the Met Office**



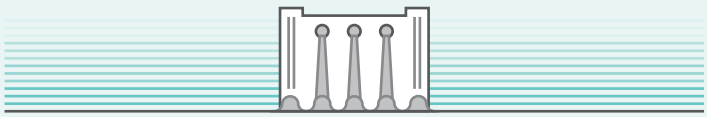
Source: Met Office

Fig. 2 **Example use case 1 – Civil contingency**
The Met Office provides seasonal forecasts to Transport Scotland and the National Highways agency to help them prepare for the coming season.

First Responders

Source: Met Office Link

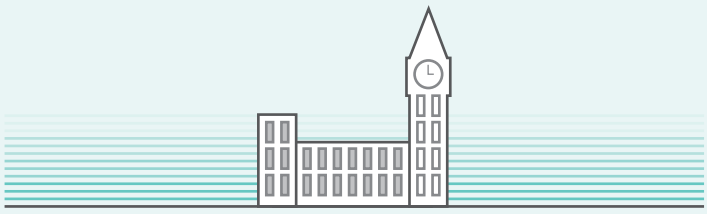
Fig. 3 **Example use case 2 – Water planning**
The Met Office provides seasonal forecasts of precipitation over the Yangtze River Basin in China to inform water and energy production management.



Hydro

Source: Scaife et. al., (2021) Link

Fig. 4 **Example use case 3 – Energy security**
The Department of Energy Security and Net Zero use seasonal forecasts of temperature and wind speed to produce outlooks of UK gas demand.



Government

Source: Met Office Link

References

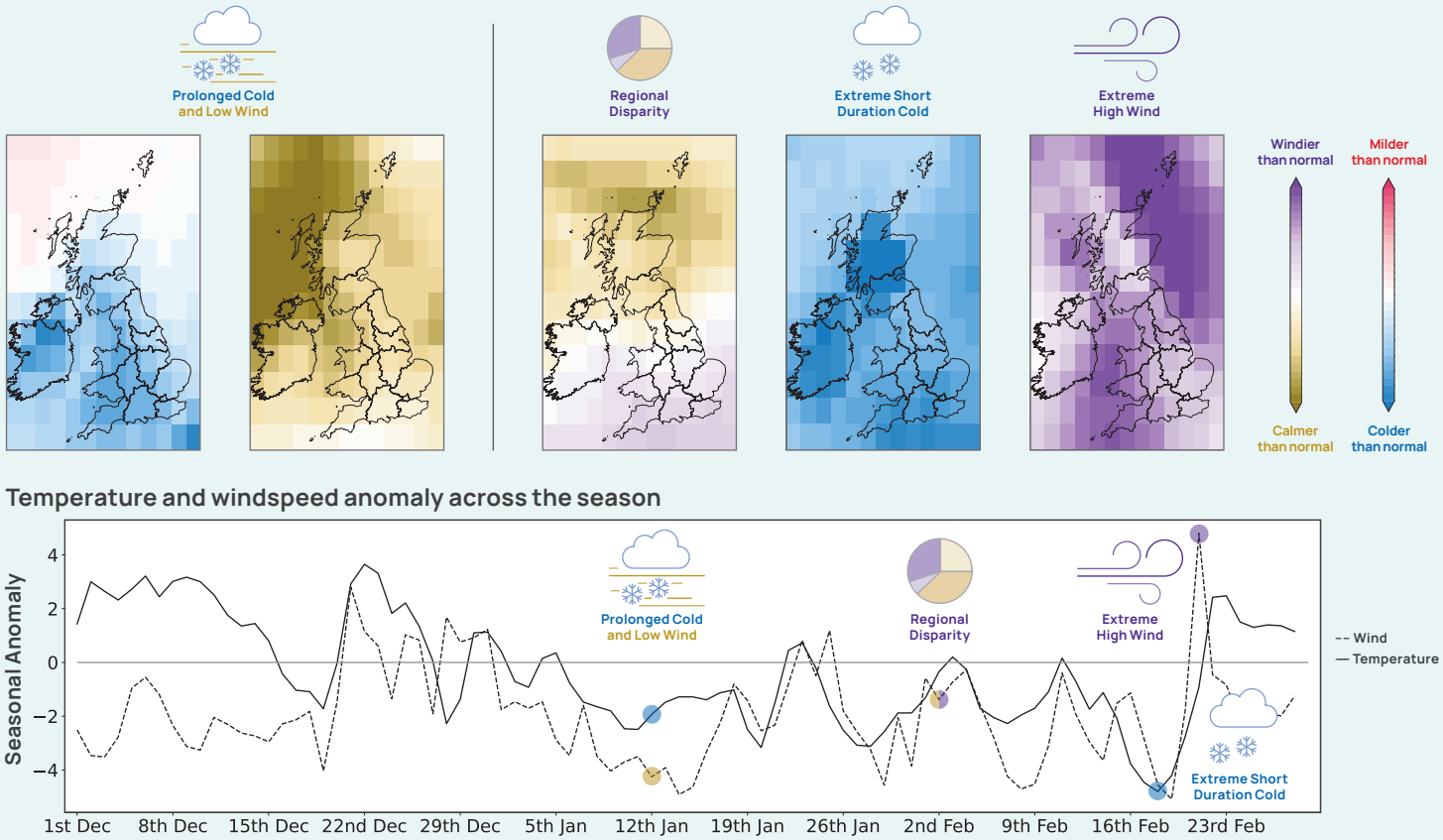
1. Borries-Strigle et. al. 2025 Link
2. Falloon et al. 2018 Link; Steinke et al. 2023 Link; Vigo et al. 2023 Link; Linés et. al. 2025 Link;
3. Hagger et. al., 2018 Link
4. Jackson-Blake et. al. 2022 Link; Bett et. al., 2023 Link; Chevuturi et al., 2023 Link
5. Goodess et. al. 2019 Link; SECLI-Firm Link
6. Thornton et. al. 2017 Link

Storylines serve as an accessible method to understand opportunities for seasonal forecasts to inform energy sector decision-making

The storylines, as their name implies, guide the participants through a narrative for a season, allowing them to focus on how they might apply the information given perfect foresight. Fig. 5 shows an example storyline from the workshop focusing on wind and temperature changes over the course of a season. In this context, key events during a season, were used to explore the types of decisions and where/if forecast information could provide value.

> "... the gap between knowledge of forecasts and what to do with them is striking."

Fig. 5 **Example storyline used in the workshop to explore wind and temperature extremes**



Source: GloSea5/6. Lockwood et al. (2023) Link

The types of decisions informed by each key event discussed in the storyline

Across all the events there was a discussion of the interactions and implications between weather, generation, and the markets, emphasising the importance of understanding the evolving weather sensitivity of energy generation and consumption.

Compound cold and low wind events were of interest to a wide range of workshop participants from across the sector as cold temperatures increase the demand for heating, while periods of low wind reduce available generation capacity. Example actions:
- Energy trading and capacity planning, including market notices.
- Security of supply margin and coordination of interconnector flows.

Regional disparities where the wind or temperature varies across the country were perceived as typical occurrence rather than extreme. The value of this aspect to inform decision-making was highly dependent on sufficient skill and spatial resolution of the forecasts. Example actions:
- Where to send crews, stage equipment or distribute emergency response.
- Where flows of gas or electricity may need to be re-directed.

Participants expressed a wide range of potential decisions related to the cold, particular centred around domestic consumption. Example actions:
- Public awareness and communications, ranging from awareness to multi-agency coordination meetings.
- Where/when to initiate local warming hubs.

High winds were of significant interest to participants due to the resulting damage to infrastructure and the need to coordinate response and restoration. Example actions:
- Scheduling/reschedule planned outages.
- Improved outage response and restoration.

As seasonal forecasting continues to advance, understanding of the skill, timing, confidence and applicability of seasonal forecasts is key to inform decisions

Engagement with storylines reveal gaps in current use of forecasts, and opportunities for future development

Researchers have shown seasonal forecasting to be valuable to the energy sector for decades[7]. Despite these benefits, adoption of seasonal forecasting in the energy sector has yet to reach its potential. As expressed by a workshop participant, the gap between knowledge of forecasts and what to do with them is striking.

Forecasts are currently utilised for severe weather communications to operational teams and customers, but short-term forecasts were more commonly used than medium term or seasonal forecasts. There are many uses for seasonal forecasts, such as operational resilience, generation, supply/demand balance and pricing. However, to achieve impact in these areas, forecast design and presentation must be tailored to specific sectors due to low overall forecast literacy. Even within a single company there were often different use cases and applications for forecast information, adding to the complexity of integrating seasonal forecasts in the decision-making process.

This workshop and wider sector-wide discussions have highlighted that current uptake and use of seasonal forecasts in decision making for operational or planning purposes is limited in the UK energy sector. Several factors inhibit the widespread usage and are listed in Fig. 6. The workshop provided a pathway for stakeholders to explore how they currently use forecasts to inform decision-making, and how those decisions might be altered with the introduction of new information from seasonal forecasts.

What did workshop participants recommend?

After completing the workshop, participants were asked for the recommendations they would make to their company and the sector more broadly. 100% of surveyed participants would recommend the use of storylines to explore seasonal forecast decision-making now or as the science improves.

For their own companies:
- Survey meteorological data used throughout the company to understand opportunities for improvement.
- Regularly explore use and suitable structures to benefit from seasonal forecasts within the company.
- Think about how future energy behaviour will shift because of changes to climate.

For the sector:
- Plausible storylines should be used to stress test systems.
- Understanding of the background (e.g. production, confidence, and skill) of seasonal forecasts is key.
- More workshops combining industry, academia, and operational service providers are necessary to understand best practices.

Fig. 6 **Barriers to adoption of seasonal forecasts remain, as evidenced by the workshop**
- **Lack of confidence in forecasts**
- **Not knowing how to interpret risk from the current seasonal forecast outputs**
- **Unable to integrate in business processes**
- **Concern over negative ramifications of wrong decisions made based on forecasts**
- **Lack of awareness of available products**

A path forward: Interconnecting the energy sector with seasonal forecasting

This workshop and wider sector-wide discussions have highlighted substantial opportunities for improved use of seasonal forecasting to provide benefits for the energy sector. Given recent developments to improve seasonal forecasts through the use of artificial intelligence[8] alongside increasing skill on the seasonal timescale, e.g. for notoriously difficult to forecast severe European windstorms[9] it is reasonable to assume further forecast skill growth this decade. However, this knowledge about existing skill for specific aspects may not be fully transparent to the energy sector. Furthermore, even with significant improved skill, the energy sector would still need to establish structures and decision-making points to benefit from this forecast information best, and to monitor ongoing forecast skill development. Thus, now is the time to prepare stakeholders across society, industry and beyond to use those forecasts in a responsible way.

The workshop highlighted the need for increased collaboration and targeted knowledge exchange for decision-making in the energy sector. For example, a Forecast Interconnector System for the Energy sector (FICS) that functions like the re-insurance broker system would successfully establish links and contracts between different parties in the energy sector. FICS would help to identify the relevant elements of skilful predictive capacity depending on the energy sector client's needs. This could include the creation of additional, post processed information e.g., about the confidence in the actual forecasts or the development of targeted products derived from seasonal forecasts for the customer in the energy sector.

Scan the QR code to shape the future of seasonal forecasting in the energy sector
- **How does your organisation currently use weather forecasts?**
- **Where and how could seasonal forecasts provide more added value?**
- **Do you have the necessary skills and structures in-house to fully benefit from forecasts?**
- **Are you interested in future workshops in this area?**

References

7. Weiss (1981) Link
8. Kent et al., 2025 Link
9. Degenhardt et. al., 2023 Link; Degenhardt et. al., 2024 Link

This document should be cited as: Donaldson, DL., Leckebusch, GC., Feltz, S., Ng, K., Geen, R., Radcliffe, J., Verma, J., Xia, X., Thornton, H., Gonzalez, P., Rogers, I., Stringer, N., and Wallace, E., 2026. *The future of seasonal forecasting in the energy sector: Winter weather decision-making in the extremes*. University of Birmingham, UK. DOI: https://10.25500/epapers.bham.00004431.

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