CASE STUDY 8

WINTER WEATHER AND ENERGY SYSTEM BALANCING

Focus: The use of seasonal forecasts by the UK National Grid Electricity System Operator (ESO) Operator

Industrial and research partners

The SECLI-FIRM project aims to demonstrate how improving and using long-term seasonal climate forecasts can add practical and economic value to decision-making processes and outcomes, in the energy and water sectors. To maximise success, each of the nine SECLI-FIRM case studies is co-designed by industrial and research partners.

For this case study, the research partner is the UK Met Office and the industrial partner is National Grid Electricity System Operator (NGESO), one of the world's largest investor-owned utilities focused on transmission and distribution activities in electricity and gas in the UK and the US. National Grid play a vital role in connecting millions of people to the energy they use, safely, reliably and efficiently.

Boosting decision making

- The main objective of this case study is to illustrate the benefits of using seasonal forecast information to better predict the UK winter mean electricity demand and wind power.

The seasonal forecasting context

- This case study focuses on demonstrating the impact of using seasonal temperature, wind and atmospheric circulation forecast information for the United Kingdom (UK) NGESO.
- This climate forecasts will be translated into energy information, to give a forecast of winter UK energy demand and wind power.

Sectoral challenges and opportunities

- The grid network has a central role to play in the future energy mix. In a fast-changing energy landscape, NGESO is working to meet ambitious low carbon energy targets, connect new sources of energy to the people who use them, and find innovative ways to enable the decarbonisation of heat and transport.
- Ahead of each winter, the UK grid operator must estimate the demand over the coming winter, with a particular focus on peak electricity demand. This is to ensure there is sufficient electricity supply available to meet this demand.
- By identifying potential risks to the system ahead of the winter, we will explore whether it is possible to reduce the cost of managing the system over the winter period.

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Essential climate variables

- Wind speed
- Temperature
- Mean sea level pressure

Essential energy variables

- UK energy demand
- UK wind power production

Energy demand and supply balancing

NGESO operate the electricity transmission network and the gas National Transmission System (NTS) in England and Wales, with day-to-day responsibility for balancing supply and demand. As we move away from a historical reliance on large thermal power generation there is now a greater diversity of supply and flexible demand than ever before.Therefore, the electricity transmission network has a vital role to play in the future energy mix.

Winter weather and energy demand

The UK experienced a spell of severe winter weather with very low temperatures and significant snowfalls from late February to mid-March 2018. This was associated with a sudden stratospheric warming event, which was predicted from early February. Daytime temperatures remained widely below freezing with a strong easterly wind and significant accumulations of snow across much of the country. This was the most significant spell of snow and low temperatures for the UK overall since December 2010.

Industry context

Day-to-day responsibility for balancing energy resources supply and demand

Climate event

Winter 2017/18 – snow and low temperatures

Sector impact

Supply and demand balancing is vital for maintaining network reliability and limiting the cost of energy

Business Process

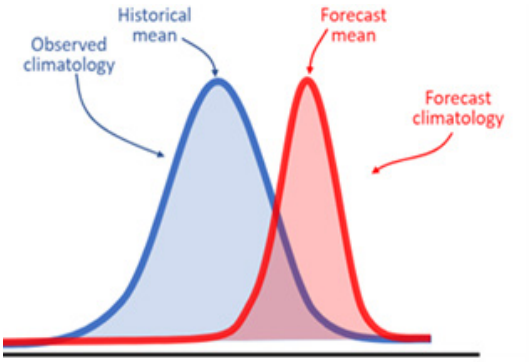
Currently an estimate of winter demand is made ahead of the winter using historical data, assuming the climatological risk of weather and associated demand. This case study will assess whether seasonal forecasts of weather can be used to improve upon this demand estimation.

Case Study Highlights

Tailoring the forecast:

Tailoring the seasonal forecast data so that it fitted in with NGESO's current processes was critical to the success of the project.This was achieved by shifting the current climatology data that drives National Grid's winter demand model based on signals within the seasonal forecast, thus, enabling National Grid to continue to use their current software, methods and processes without major adjustment.

A schematic indicating how the input climatology data could be shifted based on the signal in the seasonal forecast can be seen below. Figure 1 highlights how this method enables probabilistic information to be incorporated into the demand forecast as the forecasted weather parameters will have a probability density function (pdf) from which the mean as well as other relevant percentiles can be calculated. There are multiple sources of seasonal mean forecasts that could be applied to transform the climatology data set. For temperatures, the Met Office public seasonal forecast for temperatures, issued as part of its 3-Month Outlook (TMO) was considered. A different approach had to be taken for wind speeds as they are not currently included in the Met Office TMO. Analysis showed that the use of weather type offered no benefits beyond just using the North Atlantic Oscillation (NAO) index. Therefore, following previous studies (e.g. Clark et al., 2017), the NAO was applied to forecast wind speeds.



To allow NGESO to use a seasonal forecast with only minimal changes to their current methodology:

We propose **shifting the current observed climatology** according to the **forecast seasonal mean**.

Figure 1 – Visualisation of forecast methodology.

Business process

Estimate of electricity demand ahead of the winter using historical data to assess the risk of under-supply

Application of seasonal forecasting to optimise grid and transmission supply and demand balancing

Tailoring seasonal forecasts

The current climatology data that drives NGESO's winter demand model is shifted based on signals within the seasonal forecasts of temperature and wind speed.

Forecast skill:

Our tests have shown that there is not sufficient skill to forecast within-season variability, so we have focused on forecasting seasonal-aggregate quantities, such as the seasonal mean temperature and wind speed. Verification tests demonstrated the forecast methodology was able to transfer the seasonal mean forecast signal to the sub-daily distribution of data as used by NGESO. However, extreme events can result in changes in the shape of the distribution, which cannot be captured by our method. Our recommendation to NGESO is these events are best forecast on sub-seasonal timescales, and that the seasonal forecasts should be used in conjunction with monthly and weekly forecast products.

Value add:

Running NGESO's demand model with the tailored seasonal forecast data for winter 2020/2021 provided a comparison between NGESO's existing forecasts, based on climatology, and trial forecasts, based on seasonal climate prediction models (Figure 2). The figure shows that under the average cold spell (ACS) scenario calculated using seasonal forecast data the risk of peak demand has reduced and as such transmission demand could be met in all weeks under the high import interconnector scenario and the medium import scenario.

Qualitative research was also conducted to understand the requirements of the different decision makers and the added value of integrating the seasonal forecast data into NGESO's winter outlook:

- The value of seasonal forecasts must be considered in context of the recent changes in the energy sector and the increasing complexities of decision processes associated with balancing demand and generation.
- Many organisations working in the energy sector already incorporate seasonal forecast data into their decision process. However, these forecasts are not tailored specifically to the energy industry.
- As well as the output metric, users also value the associated probability and understanding of the drivers behind the forecast, as it enables them to draw a balanced and measured conclusion.

Forecast skill

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Value add

Re-running NGESO's demand model with the tailored seasonal forecast data for winter 2020/2021 reduced the risk of peak demand and as such transmission demand could be met in all weeks.

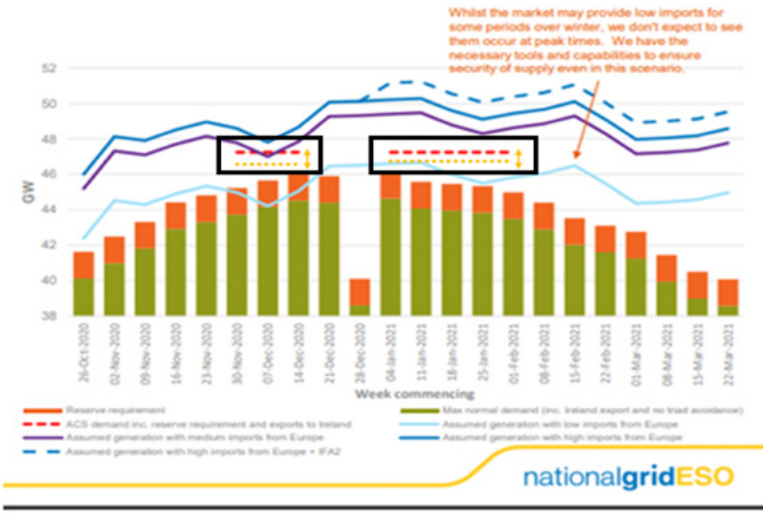

Figure 2 - Figure as published in NGESO's 2020-21 Winter Outlook but using Met Office forecast as well as the climatology. ACS calculated using climatology is represented by the red dashed line. The yellow dashed line represents the new ACS value calculated using the forecast. The other coloured lines represent assumed generation under different import scenarios.

The future

We aim to build on what we have learned through the SECLI-FIRM forecast trial, using our relationship with NGESO to further develop the forecast service. Ongoing improvements in forecast systems may provide opportunities to trial different approaches to match NGESO's requirements even more closely. The seasonal forecasting technique may also be applicable to different users in the industry.

The Added Value of Seasonal Climate Forecasting for Integrated Risk Management (SECLI-FIRM)

For more information visit:

www.secli-firm.eu or contact at: **info@secli-firm.eu**

The future
Ongoing improvements in forecast systems may provide opportunities to trial different approaches to match NGESO's requirements even more closely.

For more about this and the eight other case studies, visit www.secli-firm.eu

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