CASE STUDY

BRINES (Building Risk-Informed redundancy for Net-zero Energy Systems)

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Introduction

As we increase our reliance on renewable energy in Great Britain, energy systems are becoming significantly more affected by extreme weather. Challenging conditions range from storms damaging parts of the network, to exceptionally cold temperatures causing network components to freeze and high demands, to unusually warm days affecting assets' efficiency. In addition, climate change is causing already complex meteorological challenges to become even more difficult for energy providers to navigate, as the frequency and intensity of many types of extreme weather is increasing.

The BRINES project studied the challenging question of whether our present and future energy systems are prepared, and how to manage them during these weather-driven periods of stress on the networks.

Who's involved?

The BRINES project is led by Dr Hannah Bloomfield, an Academic Track Fellow in Climate Resilient Energy Systems at Newcastle University, in a collaborative project with Professor Sean Wilkinson and Dr Colin Manning of Newcastle University and Dr Ji-Eun Byun of University of Glasgow. This is a multi-disciplinary project comprising meteorologists, energy and transport systems modellers.

When did the project start and finish?

The project ran from June 2024 to March 2025.

Key challenges that BRINES aims to solve

Challenges to the UK power sector come from both traditional weather extremes of flooding, high winds, snow and so on, as well as what's termed 'new weather extremes' – those caused by our increasing reliance on renewable energy.

The BRINES project focuses on how to ensure resilience in the energy system now, as we head towards Net Zero in 2030, and as far ahead as 2080.

BRINES seeks to identify when the most stressful conditions in the UK power sector will occur, and whether there is enough back up power or 'slack' in the system to cover basic power requirements during these difficult periods.

DAFNI Data & Analytics Facility for National Infrastructure

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Increasing dependence on renewable energy has significant impacts on power generation. For example, during Storm Eoywn in January 2025, the UK experienced very high winds coupled with cold temperatures which caused some wind farms to stop generating to protect the equipment from wind damage. However, a few days before the storm broke, very low winds meant that generators produced very little power.

What was the key aim of the project?

Policymakers, energy system operators and the public are very interested in where the UK's power comes from, what people are doing to help keep the power on during extreme weather situations, and how to help keep energy bills down.

Traditional and new weather system extremes combined with increasing reliance on renewables for generating power cause a challenging system from an operational perspective. The project sought to provide a way to identify how prepared our present and future systems are for times of 'high meteorologically-driven stress', and how they will manage during these weather-driven stress periods.

BRINES helps decision-makers to identify the critical amount of redundancy that is needed in present day and future energy systems – the slack or the back-up generation that's available – and what would happen if a large power generation asset such as Sizewell A, B or C went off-line.

What did DAFNI allow you to do that you couldn't otherwise have achieved?

DAFNI was especially critical to BRINES on the data side – the team had been seeking a place to house datasets which would cover both energy demand, wind and solar, and damage datasets. The DAFNI platform proved to be the solution to house the data and allow stakeholders to get online and play with the data, to explore if it was appropriate for their own modelling.

Whilst data repositories exist, they are typically hard for people who aren't specialists to navigate, whereas DAFNI is very accessible and provides a workspace for using the datasets on the platform as well as just viewing them.

The announcement of DAFNI-funding for BRINES was swiftly followed by a significant consultancy request to Hannah and team from the Climate Change Committee (CCC). The CCC requested the team's input to a supplementary report to the Seventh Carbon Budget which predicts emissions from 2038-2042, a key part of the UK's goal to reach net zero carbon emissions by 2050. Hannah explored one of the key types of weather events from the BRINES project (times of high demand and low wind and solar generation) in greater detail to develop the report "Reasonable worst case stress test scenarios for the UK energy sector".

The CCC were happy for the data Hannah used to produce the analysis for the CCC to be hosted on DAFNI, as an independent platform where researchers upload to set standards, where research is properly documented, and which is truly open.

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What outputs from the project have you put onto the DAFNI platform?

Datasets added to the DAFNI platform include GB and European synthetic energy demand, wind power and solar data – which is used to model security of energy supply. These are complemented by datasets of damage indicators like extreme weather variables - including temperatures, rainfall and wind speed over GB.

- Hourly electricity demand, wind power and solar PV data from all European countries – to model security of supply 1940-2023 time series.
- UK Hourly electricity demand and wind power generation from 1980-2080.
- Infrastructure datasets – daily indicators of extreme weather (wind gusts, max temperature and precipitation) for time slices through from 1980-2080 time series.
- The historical datasets present science's best estimate of weather in the past back to 1940 using a product called ERA5. And the future climate projections are made using the Met Office's UK Climate Projections allows us to look from 1980 forwards to 2080.

The project also created a dataset for Ji-Eun Byun of weather time series at different points on GB transmission network – including temperatures, windspeeds and shortwave solar radiation.

The redundancy model itself created by Ji-Eun Byun is also now available on DAFNI – it ingests the datasets as an input and analyses questions such as 'If one region of energy gets damaged, what would be the response of the rest of the network?'

The code will be open so people can access it in a GitHub repository.

How do you anticipate other researchers, policymakers and stakeholders using this work?

The team has received further requests following the CCC work, from stakeholders interested in accessing uniformity across datasets and decisions made. The inputs used for BRINES will all be on the DAFNI platform, and organisations such as National Grid are interested as BRINES presents a much greater level of detail on extreme weather risks to the energy sector than is available in current white papers.

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Interest is also coming from other energy systems modellers, people working with policy in government, and the team is already working with the Energy Networks Association around challenges of climate related hazards. Ofgem are interested in the work too and Hannah and Sean sit on the Ofgem Climate Resilience Expert panel along with Raghav Pant from University of Oxford and other DAFNI users.

The team also works a lot with the Met Office and with energy companies. They also sit on the Energy User Group for UKCP18 where there's a lot of excitement around the datasets that Hannah is creating.

What would you identify as the main impact of this work?

BRINES has built a catalogue of historically challenging times that researchers can use to stress test a current system. It also allows them to think about the impacts of climate change on the system using a big ensemble of climate data (3 different time slices of 240-year chunks of data) and assigning return periods to events 1 in 20 year events, so a more granular level than is typically available. Being able to quantify the uncertainty is a big plus as well, through collaboration with the USARIS project.

[Pull out quote] The DAFNI platform provides a place to collaborate, it's a great way to do an interdisciplinary project, where meteorologists can work with transport and energy modellers and other disciplines.
This interdisciplinary research is hard to get funded, and DAFNI made that possible.

Weather data is usually quite inaccessible to researchers as it involves such huge datasets. The BRINES project involved collapsing data - for the wind power data alone, they collapsed 25TB of gridded data into 10MB time series, involving a lot of processing by the team but creating datasets which are much more accessible and useable by non-meteorologists.

How could this work benefit society as a whole?

We live in a society where we expect 24/7 access to energy. The science in the BRINES project is confirming that this is still possible to do even with the changing climate and increasing dependence on renewable energy.

By modelling out to 2050, the work gives the UK Government plenty of time to put solutions in place so that as a nation we can be confident of having access to energy in the way we currently rely on it.

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Next steps

Further collaboration with DAFNI-funded USARIS (Uncertainty quantification and Sensitivity Analysis for Resilient Infrastructure Systems) project is in the pipeline, around analysis of a wind power dataset. They are already working with USARIS, led by Dr Francesca Pianosi of the University of Bristol, to identify how large the impacts of climate change will be on wind power generation.

Hannah and Colin Manning are writing up a paper around the weather datasets used in BRINES as the first protype way to create both energy security of supply and operational extreme weather stress tests in a present and future climate.

Hannah would also like to work with developing countries which experience much more significant weather extremes and could benefit from the transferable model and methods devised by the BRINES team.