



CASE STUDY

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The Challenge

Long-term decisions on Britain's energy infrastructure including how much seasonal or ultra-long-duration energy storage are needed under different Net Zero pathways require a robust, quantified evidence base. A core technical challenge for the Energy Systems Catapult (ESC) was that existing modelling ran on standard laptops, imposing hard computational limits on the number and granularity of scenario runs that can be undertaken. This confined analysis to a smaller number of point estimates, rather than a wider exploration of the trade-offs between different scales of strategic storage under varying renewable generation conditions, i.e., the ability to increase the number of runs under sensitivity analysis by incrementally changing variables and rerunning the model. Moving from qualitative judgements to quantified sensitivity analysis is essential to give National Energy System Operator (NESO) and policy makers greater depth of evidence needed for infrastructure decisions of this scale and long-term consequence. Energy Systems Catapult wanted to be able to run their model faster to be able to provide evidence to help innovators understand how best to scale up their flexibility and storage solutions to meet the growing UK need.

Innovation

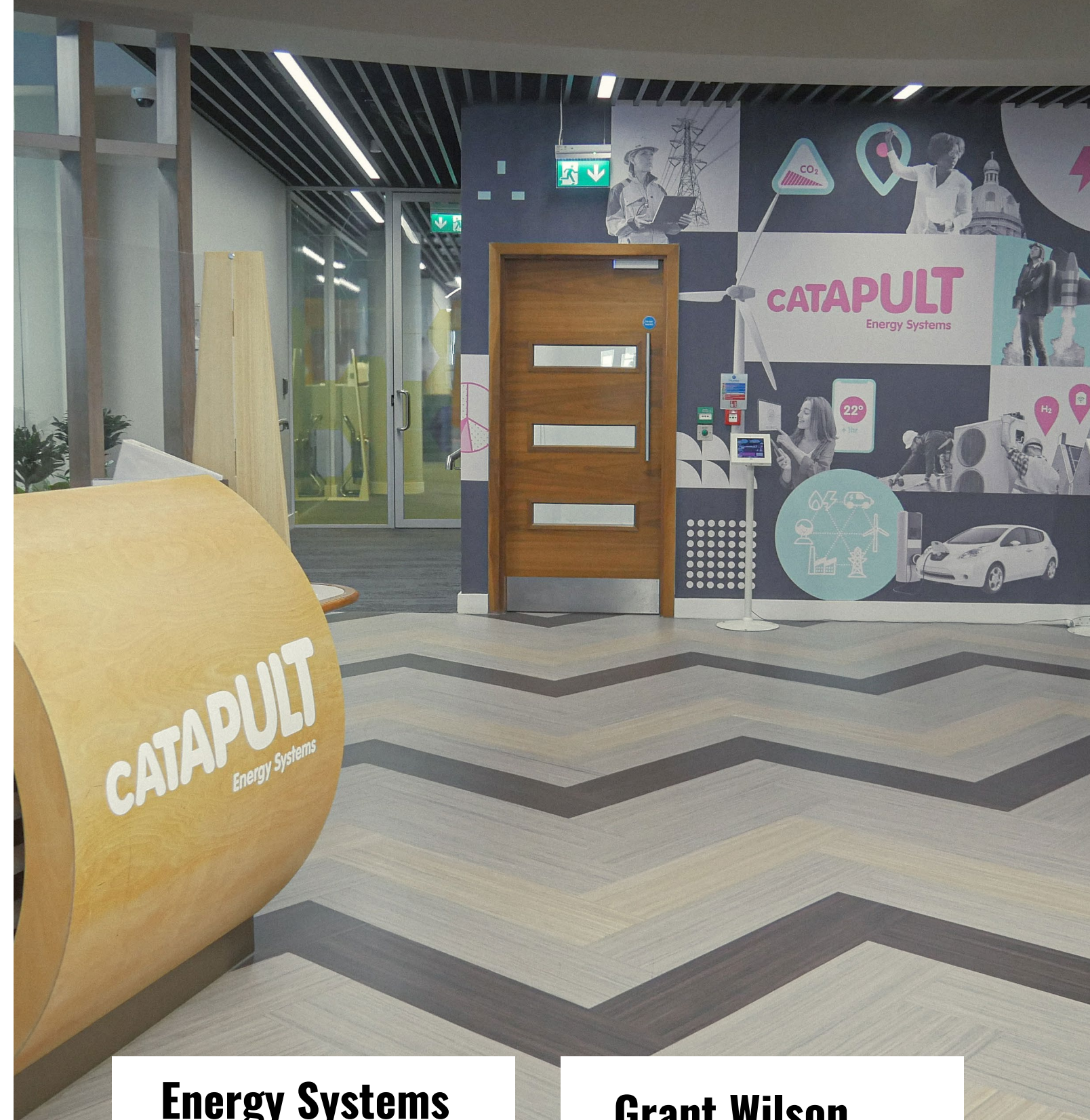
The project jointly refactored the Energy System Modelling Environment (ESME)-flex energy systems model, a Python tool that analyses outputs from ESC's flagship ESME model, to run on the University of Birmingham's Environment for Academic Research (BEAR) high-performance computing cluster. Three iterative rounds of refactoring created a more clearly structured codebase, now shared on Energy Systems Catapult's GitLab as a branch of the main ESME-flex development. Running on BEAR removes the computational ceiling previously imposed by laptop constraints, making it trivial to execute hundreds of parallel sensitivity runs varying weather years, storage capacities and other Net Zero pathway parameters. Connections were also built with the open-source energy modelling community, including the PyPSA developer community at TU Berlin, and the project developed working experience with cutting-edge open-source tools such as Marimo and DuckDB that are suited to managing and sharing large volumes of High-Performance Computing (HPC) output.

Result

The refactored ESME-flex codebase now runs on BEAR and is shared on ESC's GitLab, representing an achievable step change in the scale of scenario analysis and ensuring the work is traceable and reproducible. A response was submitted to the UK Government's Department for Energy Security and Net Zero February 2026 consultation on the Gas System in Transition: Security of Supply, directly informed by discussions developed throughout the project. Dr Wilson secured €240k as part of a €7m Horizon Europe long-duration energy storage initiative starting June 2026, with the research direction developed through the RiR project seen as a contributing factor. An honorary academic position has also been established for ESC's lead ESME-flex developer at the University of Birmingham, creating a formal mechanism for continued joint access to BEAR beyond the funded period.

Impact

The HPC-enabled ESME-flex represents a step change in the scale and granularity of energy systems scenario analysis that is practically achievable. Moving from a handful of point estimates to hundreds of sensitivity runs gives decision makers at ESC a far more robust, quantified evidence base for long-term decisions on Britain's energy infrastructure that can cover areas such as strategic storage, flexibility and security of supply under different Net Zero pathways. The community of practice event planned for September 2026, co-located with a PyPSA training event with developers from TU Berlin, will extend access to methods and findings across academia, RTOs and smaller organisations. The Horizon Europe award signals that the research questions developed through this project have wider international relevance.



Energy Systems Catapult

"We have proved the Catapult's flexibility and storage model, ESME-Flex model can be operated in a high-performance computing environment which will enable us to perform the sort of Monte Carlo based sensitivity analysis that we have been unable to do until now." - Jon Saltmarsh

Grant Wilson

"The collaboration afforded something increasingly rare in academic life - a reason to protect some of my time to engage directly with research rather than managing others to do it. This has reinvigorated my own approach to research."