Frequency response services designed for energy storage

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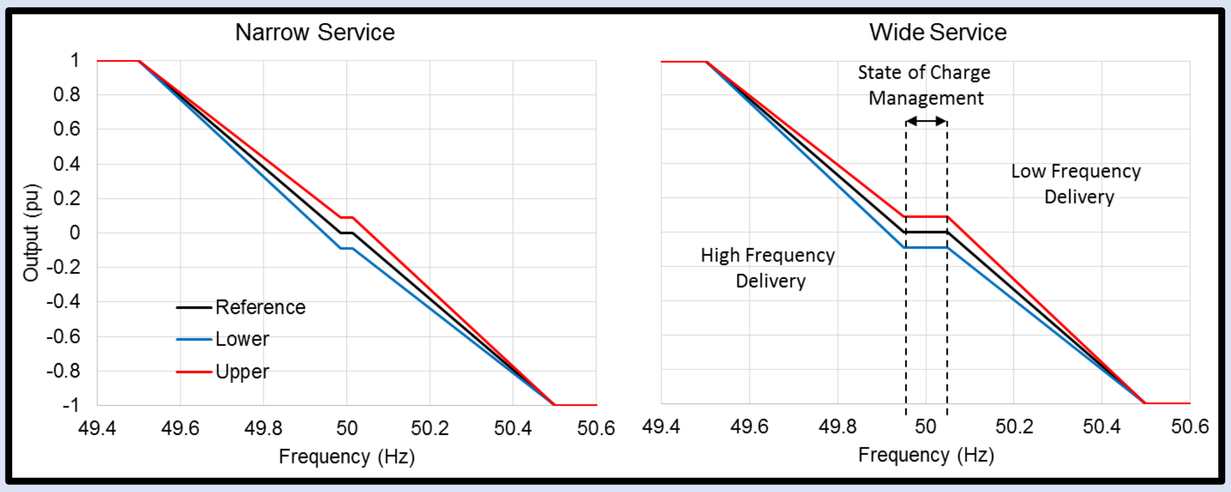
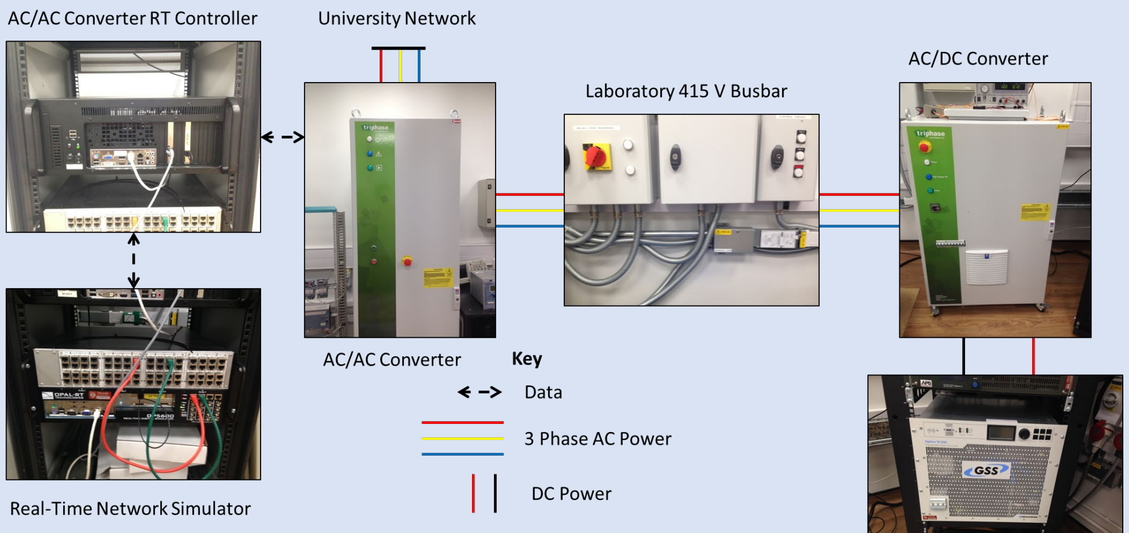
Introduction

Experimental facilities can help build **confidence** and **understanding** in future energy systems. **Energy storage emulation** can enable experiments with technologies that are **not readily available**; can enable **repeatable testing**; and can provide **sensitivity analyses** around less well understood technological phenomena. **Power hardware in the loop** allows testing of energy storage **applications** in a **laboratory environment**. This work developed a novel experimental setup to demonstrated how **frequency response** can be provided effectively by energy storage systems. The results show that energy storage has a **fast response** which improves the resilience of an electricity system to the loss of large generation units.

Methodology

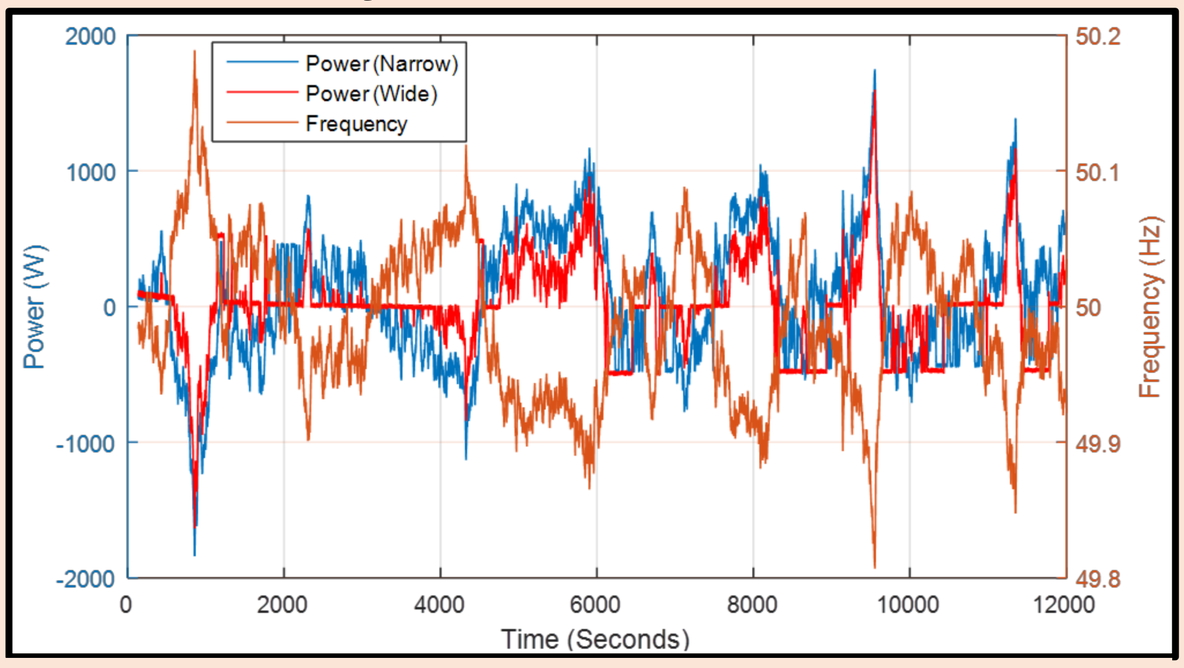


Frequency response curves allowing state of charge adjustment



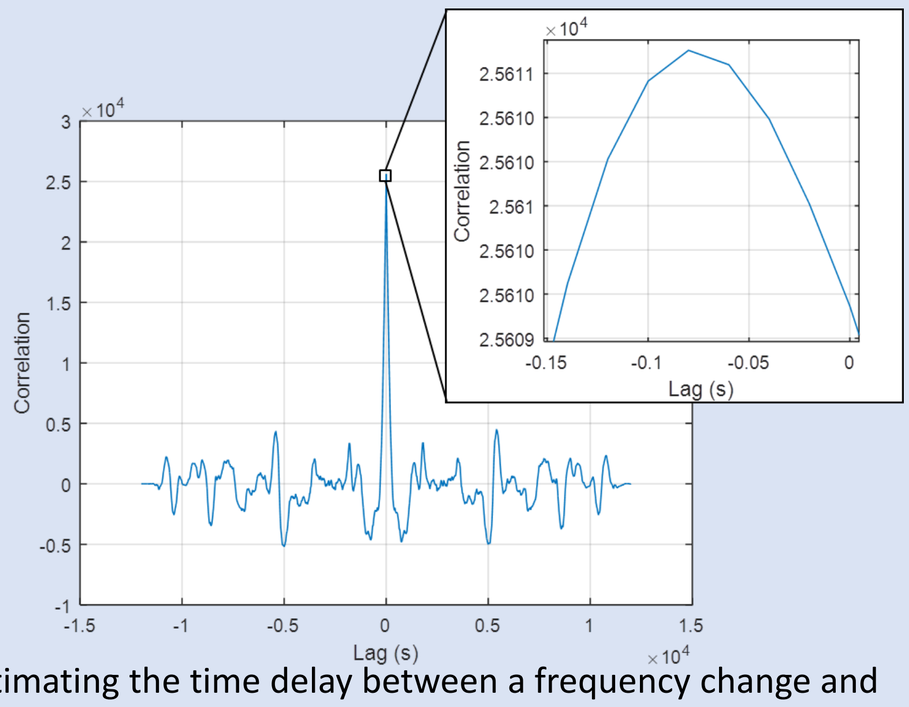
The hardware-in-the-loop laboratory integration used for the experimental work

System Behaviour

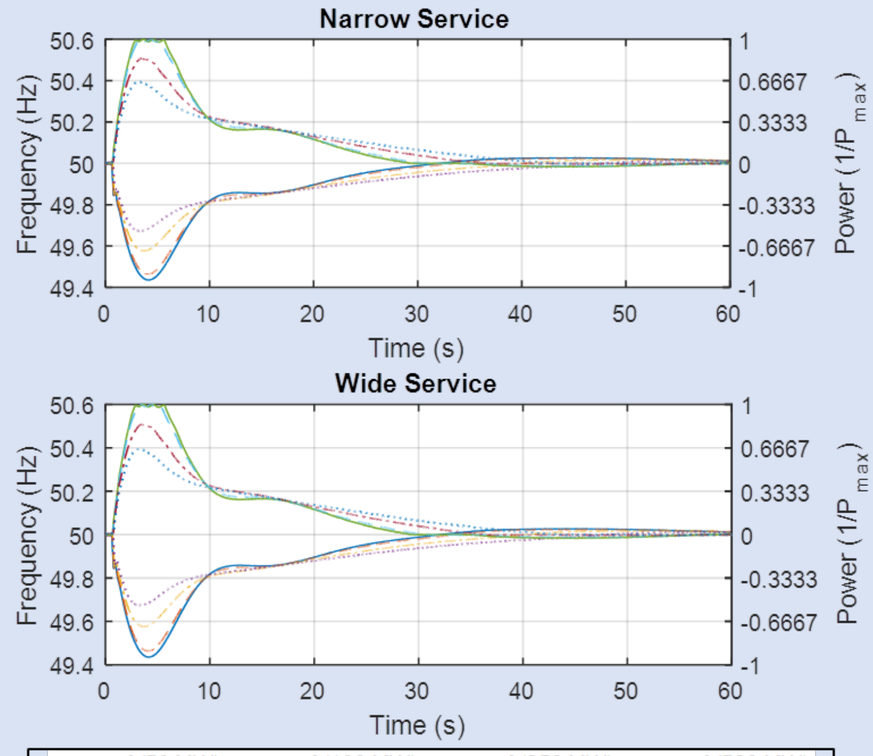


An emulated energy storage system providing wide and narrow services responses to historical frequency data

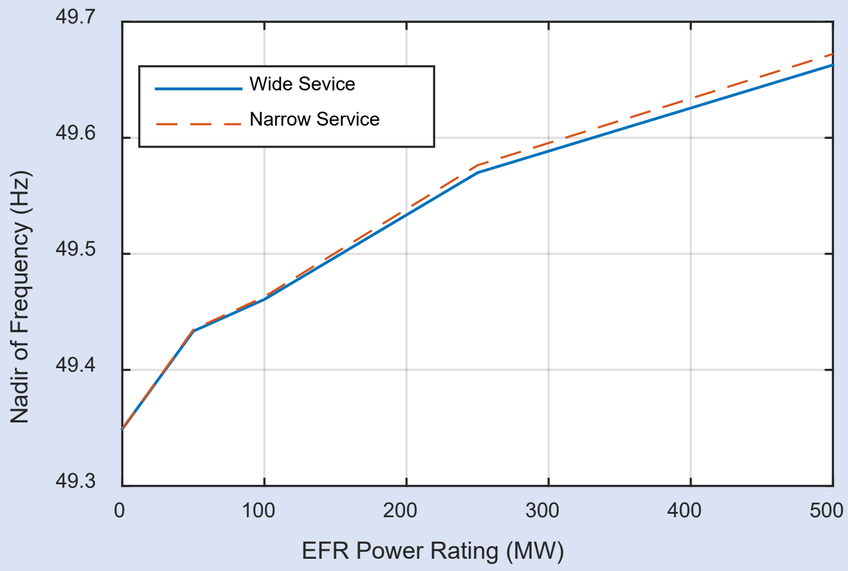
Results



Estimating the time delay between a frequency change and ESS response – energy storage can respond within 80 ms



Results of a dynamic simulation on a real-time simulated network with frequency response provided through and emulated energy storage system



Impact of ESS power capacity on Nadir of Frequency

Conclusion

A novel experimental design, harnessing **power-hardware-in-the-loop technology**, was used to investigate provision of fast frequency response by energy storage systems. The results show that **energy storage can respond within 80 ms** of a frequency deviation, and that its presence can substantially reduce the nadir of frequency. Future work will adapt the experiment investigate the role of hydrogen systems in supporting grid frequency.

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CESI National Centre for Energy Systems Integration

EPSRC