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Stacking Models for Grid-Scale Batteries: Impact of Capacity and System Inertia

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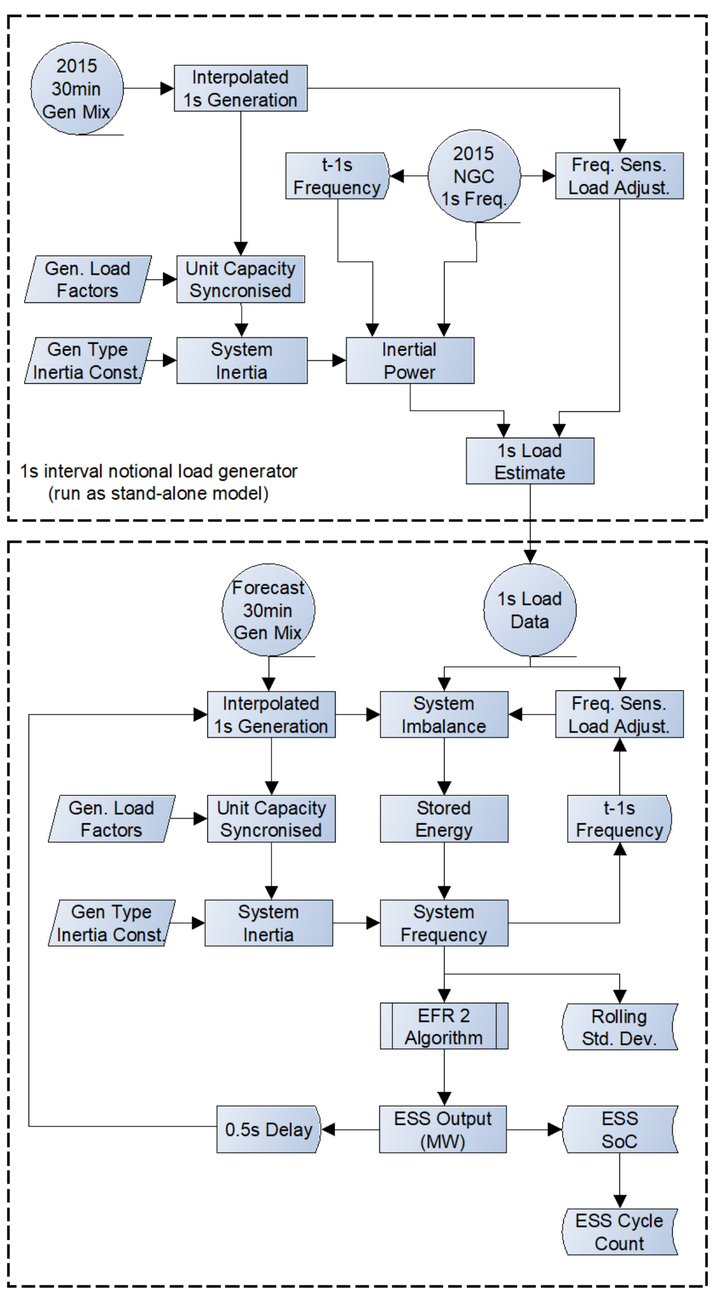
Introduction

Inverter connected battery systems are able to respond rapidly to transient events on the network and have the potential to provide ‘synthetic’ inertia to replace that lost from traditional large rotating generator sets as well as shifting intermittent renewables to times of greatest demand. The impact of these services on battery cycling rates will determine the rate of cell degradation and thus the cost of providing such services.

Aims

To analyse the impact of future changes in generation mix (thus system inertia), and the installed capacity of batteries, on the cycling and cost effectiveness of grid-scale battery systems.

Methodology

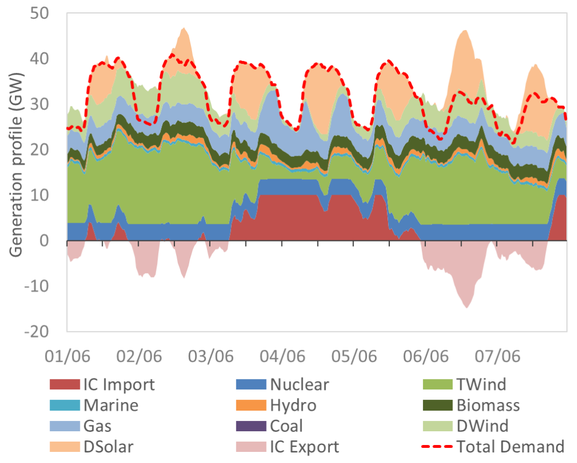


National Grid (NGC) 30min. generation mix data[1], adjusted for embedded wind and solar, is used to infer inertia[1].

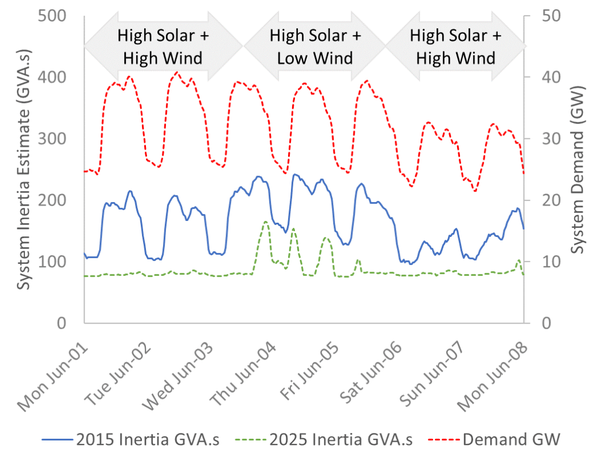
Each 1s change in system frequency (NGC data[2]) is used to modify the interpolated generator profile, adjusted for frequency sens-itive load[3], to develop a notional 1s load estimate using the swing equation[4].

This load profile is then run through a reverse model with battery output determined by the NGC Enhanced Frequency Response[3] algorithm.

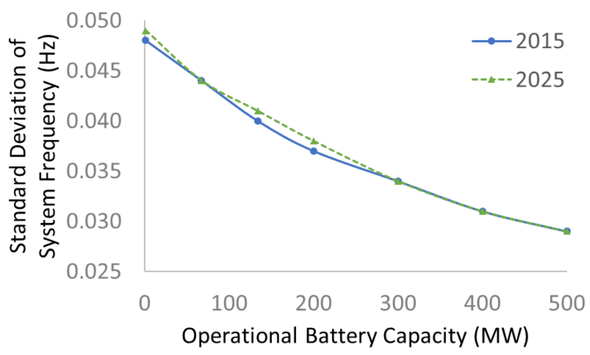
Results

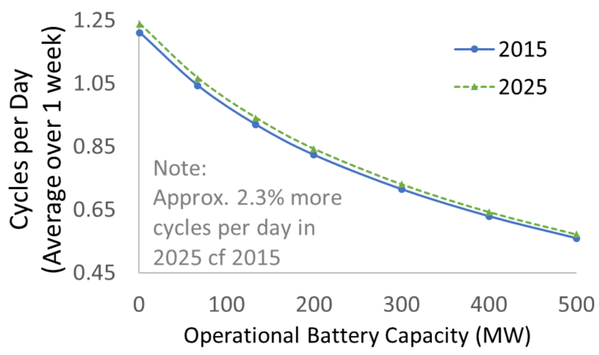


Modified NGC summer 2025 Consumer Power scenario[3].



System inertia for 2015 and 2025 generation mixes. (Min. 4000MW CCGT plant)





Reduced system inertia appears to have only a small impact on frequency volatility (2025 vs 2015) assuming similar plant response to changes in demand. Increasing battery capacity reduces volatility and cycling per MW of operational capacity (based on design C-Rate of 2).

Conclusions & Further Work

- A methodology for generating 1s load data based on future generation mixes and suitable for testing battery operation has been demonstrated.
- Battery cycling, hence degradation and operational cost, decreases as operational capacity increases; doubling current proposed EFR capacity reduces cycling by circa 25%.
- Additional work is planned to model alternative service stacking options and identify the economic viability and impact on battery degradation of these options.

References
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