Using Climate-Sensitive Critical Infrastructure Power Reserves to Improve Grid Resilience

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Objective and Background

Reserve power systems are widely used to provide power to critical infrastructure systems in the event of power outages. The reserve power system may be subject to regulation, typically focussing on operational time, but the energy required for ensuring the supply of reserve power may be highly variable and sensitive to weather conditions. By understanding levels of "surplus" capacity (see figure), reserve infrastructure can offer potential benefits and services back to the wider electricity system when not in use, supporting a transition to low-carbon technologies such as wind and solar power.

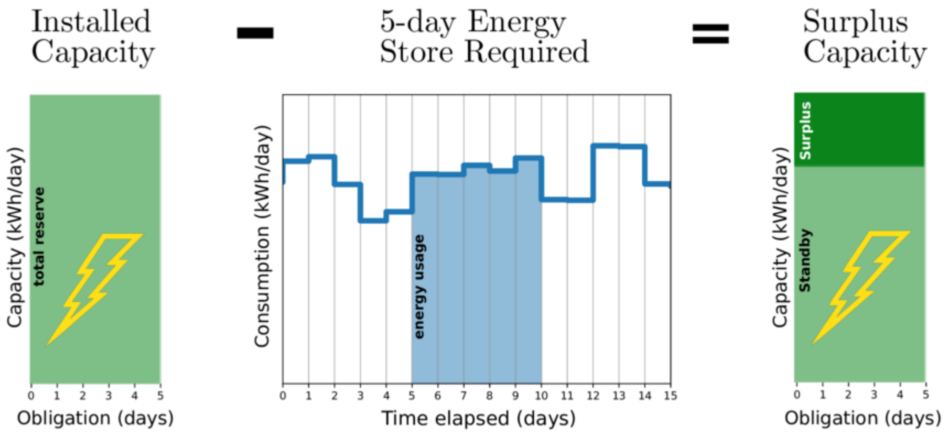

Figure: Schematic demonstrating the concept of surplus capacity. A critical infrastructure system has a fixed capacity of installed reserve. Outside of high demand periods, the N-day consumption is less than the installed capacity, leaving a portion of "surplus" available for other purposes. If this surplus can be accurately anticipated, it may be utilised for other purposes without impacting the agreed N-day reserve delivery.

Method

Drawing on the Great Britain (GB) telecommunications systems as an example, we present a methodology and case studies demonstrating that historic meteorological reanalyses can be used to evaluate the capacity of reserve required to maintain the regulated target of 5-days operations. Models derived from historic data are additionally applied to climate projections of GB surface temperature, to anticipate changes in planning requirements and surplus capacity levels.

Principal Findings

Across three case-study regions with diverse weather-sensitivities, it is shown that infrastructure with cooling-driven electricity demand leads to a peak in the energy consumption during the summer, thus determining both the overall capacity of the reserve required. Surplus that can be allocated using climatological data is expected at 60 to 130 days average energy use allocated across a given year in the case study, and increases up to 160 to 250 days with perfect forecast information.

Conclusions

We have developed a novel risk-aware framework for assessing weather- and climate-risk to support planning decisions, and expected levels of surplus capacity. In cooling-driven systems, surplus capacity is estimated to have high utility value and is readily available during cold (high load) seasons on the grid, i.e. periods when additional energy capacity may be sought by the grid transmission system operator. Climate projections indicate an increased capacity requirement in a warmer future world.