Network Impact of Active Buildings

ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

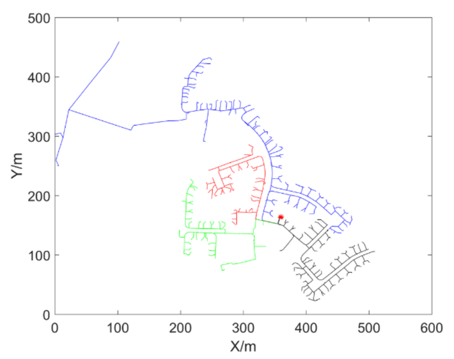
Introduction

Energy consumption in residential buildings has a growing importance since they consume more than 40% of the worldwide energy usage. The increasing demand and related uncertainties impose operational and planning stresses on energy systems. While designing strategies for the residential sector, the nature of the service needs of network operators should be considered and the benefits of active buildings at local scale should be assessed.

Network Impacts of ASHPs

The UK government have committed to a heat pump deployment rate of 600,00 per year by 2028, but the implications of this strategy on infrastructure operation has raised concerns. We determined the effects of varying ASHP penetrations on network violations, and the efficacy of the management strategies preheating, thermostat setback, and space heating storage, on controlling these violations.

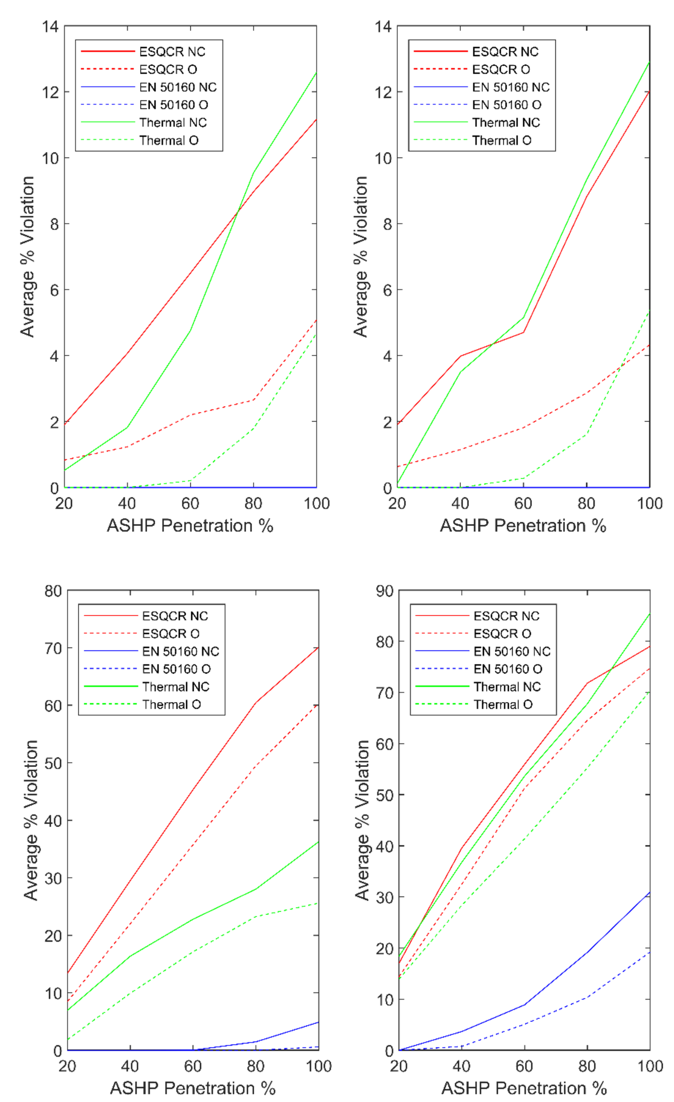
Demand profiles were generated using the EWASP tool, and were applied to 2 openDSS LV power network models. By testing every combination of management strategies, we were able to compare the optimum mix of management strategies to the base case (no management) scenario.



The graph to the left shows the cable topology of 'LV network 1'

Decentralized management resulted in moderate reductions in voltage and thermal violations, though passive fabric improvements proved far more effective:

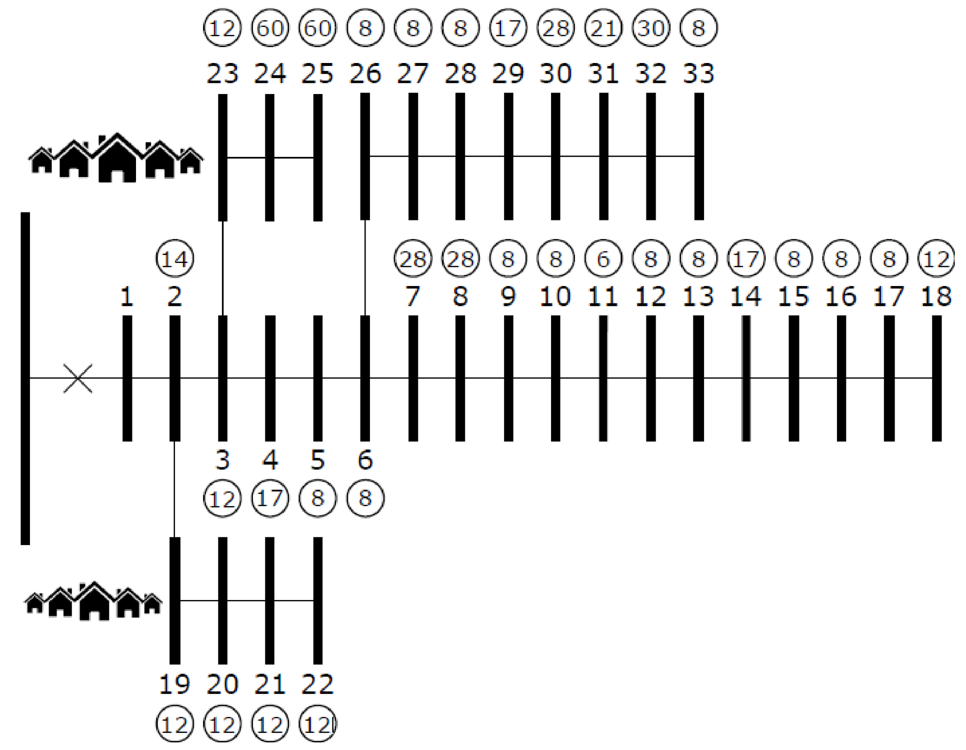
The graphs below show (top left)the percentage of households on 'Network 1' experiencing voltage violations in Houses are of 1970's fabric standards. (top right) The same data for the 'Very cold' case. (bottom) The same for mid-2000's fabric standards.



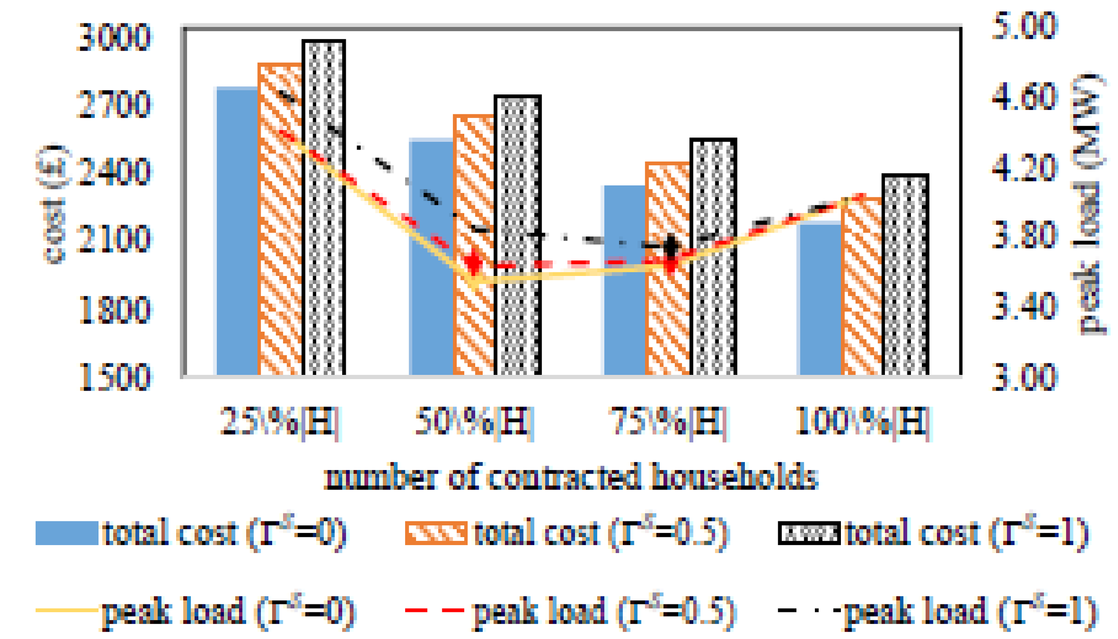
Assessing Flexibility of Active Buildings

Active buildings through demand response programs helps address concerns about increasing demand and related uncertainties in distribution networks. We incorporated uncertainty in residential load models arising from customer behaviour and studied its impacts on the decisions of aggregators while considering distribution network constraints.

We developed a robust convex model and applied to the following distribution network. We showed that consideration of customer behaviour uncertainty in optimization of profit and/or peak load affects the amount, location and time-window for contracted flexibility, and therefore both aggregator profits and network power flows.



The graph below show the effect of robustness on the optimal results for varying number of contracted flexibility. The minimum peak loads for each robustness level are highlighted by diamonds (defines the level of uncertainty that can be tolerated).



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