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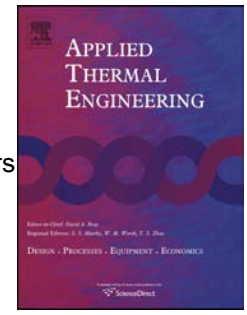

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S.J.G. Cooper, G.P. Hammond, M.C. McManus, John G. Rogers

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Impact on energy requirements and emissions of heat pumps and micro-cogenerators participating in demand side management

S. J. G. Cooper[a]*, G. P. Hammond[a, b], M. C. McManus[a, b], John G. Rogers[a]

[a] Department of Mechanical Engineering, University of Bath, BA2 7AY, UK

[b] Institute for Sustainability, Energy and the Environment, University of Bath,

BA2 7AY, UK

*corresponding author: sjgcooper@bath.edu / +44 1225 385366

Abstract

The potential impacts of participating in demand side management (DSM) on the performance of air source heat pumps (ASHP) and micro-combined heat and power (mCHP) units are considered by this study. As significant consumers and generators of electricity at the distribution level, large numbers of heat pumps and micro-cogenerators would provide considerable scope for participation in DSM systems. However, it is possible that operating regimes which are optimised for grid considerations will not achieve the maximum performance that is possible from the units.

Modelling has been conducted to investigate the significance of this effect, considering the case where local distribution constraints are the main driver for demand side interventions. A model of domestic electrical demand has been adapted to consider a neighbourhood of 128 dwellings in order to identify when interventions are necessary. This has been combined with dynamic models of two combustion engine micro-cogenerators, a solid oxide fuel cell micro-cogenerator and two ASHPs. A simple thermal model of each building is combined with a range of user preferences in order to determine the preferred operating profiles of the heating units.

The DSM scheme analysed here is likely to have minimal impact on the emissions and energy requirements associated with each heating unit. Its effect is similar to that which occurs without DSM if the control system gain is relaxed such that equivalent thermal comfort is achieved. DSM can reduce the peak electrical demand of the neighbourhood. However, in the scenarios investigated, it is unlikely that the peaks can be reduced sufficiently such that they do not exceed the capacity of the local distribution transformer if ASHPs are used in all dwellings. By using a combination of mCHP units with ASHPs, it is possible to supply heating to all dwellings without exceeding this capacity. In this case, the use of DSM can increase the ratio of ASHPs used. In the context of a low carbon grid electricity supply, this will reduce the average carbon emissions associated with the neighbourhood.

Keywords: Demand side management; micro-cogenerator; heat pump; micro-combined heat and power; efficiency

Abbreviations

ASHP Air Source Heat Pump

COP Coefficient of Performance

DSM Demand Side Management

ICE Internal Combustion Engine