

Household thermal routines and their impact on space heating demand patterns Paper no 5-192-17

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Domestic heating in the UK

- Heating of homes is responsible for 11% of UK Greenhouse Gas emissions.
- 90% of homes have individual central heating boiler; 91% of these are fuelled by natural gas.
- To meet 2050 GHG reduction targets a substantial shift from gas to heat pumps and district heating is needed.
- It is very common in the UK to operate space heating intermittently. Power demand for heating has peaks in morning and evening.



If heating is electrified, heating peaks could have a significant impact on networks.





Temperature expectations



Pattern of diurnal temperature variation in homes reflected in demand

Average weekday winter living room temperature profiles for 275 homes grouped in 4 clusters (Huebner et al 2015 fig 1a)

Why is this important?

- How will households react to low carbon heat sources with different delivery patterns?
- Will heating demand management be acceptable to consumers?





Theoretical background to concept of thermal routines





Thermal routines: regular patterns in time of heating use and other actions taken to achieve thermal requirements





Background to study

- Data for temperature setpoints and internal temperature
- PassivSystems controllers in 337 homes, 4 January to 28 February 2016
 - Temperature setpoint,
 - Internal temperature,
 - Call for heat
 - Detected IN period, start and stop times
- Interviews with seven PassivSystems customers



Default controller settings



Example of typical operation







Thermal routines as described by residents

- Seven households volunteered for semi-structured telephone interview
- IN times didn't always match occupancy
 - OUT period in middle of day even when someone in during the day in 2 homes
 - one respondent got up before beginning of IN period
 - using controller to achieve acceptable level of comfort which conforms to expectations of how heating system should be run
- Use of supplementary heating in some homes (wood burner used regularly in evening in 2 homes)
- Preference for low temperatures when sleeping expressed by several respondents
- Heating used not only for thermal comfort: e.g. drying "emergency laundry"





Impact of morning thermal routines on demand



Time





Variation in internal temperature measured at controller over the day: mean across all days and all homes





Timing of heating start is more consistent in morning



Start time of first IN period in day N=12,499 homes x days median = 07:00 Interquartile range = 90 minutes Start time of final IN period in day N=9,606 homes x days Median = 16:00 Interquartile range = 150 minutes



Conclusions

- Thermal routines are proposed as a useful conceptual framework for considering both physical and social aspects of home heating patterns.
- In the UK, the link between regular practices and time heating is switched on leads to steep increase in demand between 06:00 and 07:00.
- Domestic heating DSM may require changing association of practices in home and heating operation times.
- General expectations of heating schedules and a common preference for low night time temperatures should be considered when heat pumps and district heating are promoted. User expectations may not match policy goals.
- Researchers using building simulation models should be aware occupancy times and heating schedules do not always match.



Limitations and ideas for further research /discussion

- Small sample size for interviews
- Homes in sample not representative of whole building stock
- Under-determination multiple possible causes for difference in morning and evening demand
- Specific to context of UK would be interesting to investigate thermal routines in other countries and with different predominant heating types.









Key finding 2 : Changes in temperature requirements in evening





Variation between homes







From Lander et al 2006



Variation between days

