

Fully-funded 4-year PhD Project at Loughborough University – Modelling the English housing stock for energy supply and demand analysis

Project Title	Modelling the English housing stock for energy supply and demand analysis
Supervisor(s)	Prof. Kevin Lomas, Dr David Allinson
Context (what is the wider social, political and technical context that leads to this work, why is it important)	As the UK strives for a zero-carbon future the need to decarbonise the heating of homes becomes an imperative. Replacement of gas boilers with heat pumps driven by low-carbon electricity is seen as a viable route forward, perhaps in association with improvements to dwelling energy efficiency. Whilst this strategy has been proposed in principle, the feasibility depends on many things, including: the feasibility of achieving different energy efficiency standards; the cost of the new heating systems and energy efficiency measures and the consequential electricity costs to households; the impact on the local electricity system of the additional electrical loads. The cost matters because many households already find it difficult to meet their energy bills; landlords are reluctant to invest in energy efficiency measures from which they do not benefit; and those in privately-owned properties have little incentive to invest. These and other barriers may, in practice, mean that achieving zero-carbon heating is much more difficult in practice than the government anticipates. This project will seek to clarify the real feasibility of zero-carbon domestic heating for a case-study area.
Project Description	Models of housing stocks can predict energy demand and the reduction in demand achieved by energy efficiency measures. Existing survey data provides information about the ownership, energy efficiency, size, etc of dwellings. Together with site surveys, these data enable realistic models to be

made of dwellings in a case study area. The model predictions need to be validated if results are to be deemed credible. This can be achieved by comparing predictions against the measured energy demand at local area level. By combining the energy demands with energy costs and CO₂ emissions the plausibility of implementing zero-carbon heating can be ascertained.

Loughborough researchers have developed stock models in previous projects and methods of generating dwelling models from other, existing, data. The project will capitalise on these efforts to build a stock model of a selected area. However, aggregated electricity loads depend strongly on the half hourly energy demands and models can be relatively poor predictors of these. Thus, the models might incorporate demand profiles gathered from real dwellings. Loughborough has an archive of such monitored data.

The validated model can then be used to make 'what-if' predictions which can explore: different energy efficiency retrofits, alternative heat pump installations, future weather conditions, etc. It will identify for which dwellings and which households the heat-pump/efficiency strategy is plausible and for which some other approach may be needed. Importantly, the cost per dwelling to achieve different levels of carbon reduction can be determined.

The creates a PhD research programme that addresses important national challenges and which incorporates a variety of research techniques.

<p>Aims and Objectives</p>	<p>The aim is to predict the energy demand, costs and CO2 emissions of UK homes as a result of the shift from gas to electric heating.</p> <p>The objectives are:</p> <ol style="list-style-type: none"> 1. To review the literature on energy demand in UK homes and prior work to predict the energy demand of dwelling stocks. 2. To select a case study area and to collect the existing geometrical, construction and energy demand data about the homes. 3. To model these homes using a combination of dynamic thermal modelling and empirical, time series, energy demand data. 4. To compare the energy demands, costs and CO2 emissions of alternative approaches to heating these homes. <p>To publish the work in leading journals and as a PhD thesis.</p>
<p>Methods: (Measurements, data sources, methods of analysis, etc)</p>	<p>The principal research method will be dynamic thermal modelling of different UK dwelling archetypes. Archetypes will build on previously developed dwelling descriptions for UK homes.</p> <p>Existing open-access databases of energy efficiency, energy demand, dwelling topography etc will be accessed.</p> <p>Site surveys may be necessary to assess the reliability of the databases and to fill gaps in the data.</p>
<p>Expected Outcomes</p>	<p>Government policy advisors and others will gain a much clearer understanding of the feasibility of decarbonising domestic heating. Local electricity suppliers will better understand the load that electric heating might place on the local supply network. The social implications of switching to a more expensive form of energy will be indicated.</p>

Multidisciplinary Aspects (what different skills and knowledge will this project develop)	The work will entail a knowledge of building physics and digital data analysis.
Skills and Interest Required of Student	A keen interest in numerical modelling and data analysis. An interest in buildings and their energy demand is also important.