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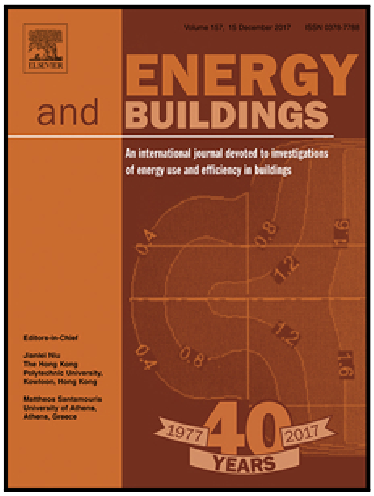

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Disaggregating High-resolution Gas Metering Data Using Pattern Recognition

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Abstract
Growing concern about the scale and extent of the gap between predicted and actual energy performance of new and retrofitted UK homes has led to a surge in the development of new tools and technologies trying to address the problem. A vital aspect of this work is to improve ease and accuracy of measuring in-use performance to better understand the extent of the gap and diagnose its causes. Existing approaches range from low cost but basic assessments allowing very limited diagnosis, to intensively instrumented experiments that provide detail but are expensive and highly disruptive, typically requiring the installation of specialist monitoring equipment and often vacating the house for several days. A key challenge in reducing the cost and difficulty of complex methods in occupied houses is to disaggregate space heating energy from that used for other uses without installing specialist monitoring equipment. This paper presents a low cost, non-invasive approach for doing so for a typical occupied UK home where space heating, hot water and cooking are provided by gas. The method, using dynamic pattern matching of total gas consumption measurements, typical of those provided by a smart meter, was tested by applying it to two occupied houses in the UK. The findings revealed that this method was successful in detecting heating patterns in the data and filtering out coinciding use.

Keywords: gas disaggregation, smart meters, gas heating, Building Physics, dynamic models

1 Introduction

The building sector holds great potential for saving energy and reducing CO_2 emissions, due to its large share of global energy use and the relative cost-effectiveness of energy saving measures [1]. In order to tap into this potential, policy makers across the world are imposing increasingly stringent requirements on building energy performance and introducing schemes to incentivise energy saving measures. However, the actual savings realised as a result of implementing those policies have repeatedly been shown to fall short of theoretical predictions [2]. As the scale and extent of this performance gap [3] has become clear, policy makers and the construction industry have become increasingly concerned that the shortfall could fundamentally impact the ability of the building sector to deliver its anticipated share of the national carbon reduction plan.

Addressing the performance gap requires methods to assess and understand the energy performance of existing buildings at scale, using methods that allow diagnosing the reasons for the shortfall, whether relating to physical or human factors. Such methods do exist, but as the existing building stock is largely in-use, the challenge is for these methods to be applicable to occupied buildings with minimal cost and disruption to occupants, but this issue has remained largely unsolved.

The main building performance measurement methods available are either based on intrusive heating experiments, such as the co-heating test and its various similar alternatives (e.g. QUB [4],ISABELE [5]); or on steady-state analysis of data recorded during normal operation and averaged over days or more, such as Energy Signature methods and a host of linear regression-based ones [6, 7, 8, 9], which try to quantify the relationship between heating energy and external-internal temperature difference and use it to characterise the energy efficiency of the building.

The first approach can be robust and provide accurate and detailed outputs, but is highly intrusive and expensive; it requires the building to be empty and unused for an extended period, along with extensive