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The socio-economic, dwelling and appliance related factors affecting electricity consumption in domestic buildings

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ABSTRACT

This paper aims to investigate the socio-economic, dwelling and appliance related factors that have significant or non-significant effects on domestic electricity consumption. To achieve this aim, a comprehensive literature review of international research investigating these factors was undertaken. Although papers examining the factors affecting electricity demand are numerous, to the authors' knowledge, a comprehensive analysis taking stock of all previous findings has not previously been undertaken. The review establishes that no less than 62 factors potentially have an effect on domestic electricity use. This includes 13 socio-economic factors, 12 dwelling factors and 37 appliance factors. Of the 62 factors, four of the socio-economic factors, seven of the dwelling factors, and nine of the appliance related factors were found to unambiguously have a significant positive effect on electricity use. This paper contributes to a better understanding of those factors that certainly affect electricity consumption and those for which effects are unclear and require further research. Understanding the effects of factors can support both the implementation of effective energy policy and aid prediction of future electricity consumption in the domestic sector.

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1. Introduction

Policy-makers have realised that without significant reductions in the electricity demand, and significant increases in the energy efficiency of the domestic sector, it will be impossible to lower carbon dioxide (CO₂) emissions and mitigate the risks of global climate change [1,2]. To support informed decisions about how to reduce electricity use and CO₂ emissions from the housing sector, it is essential to know which factors influence domestic electricity consumption.

Electricity use in domestic buildings results from occupants' need for energy services, such as light, comfort and entertainment, but the energy used results from a complex series of interlinked and interacting socio-economic, dwelling and appliance related factors.

This paper presents a literature review of the existing research investigating the socio-economic, dwelling and appliance related factors that affect domestic electricity consumption. The aim is to synthesise the results of previous studies to establish whether specific factors have a significant or non-significant effect.

This paper addresses the effects of factors at the household level only (i.e. at the individual household scale), including socio-economic factors, which refer to the characteristics of the occupants residing in a home (e.g. number of occupants, presence of children, annual household income); dwelling factors, which describe the characteristics of the dwelling (e.g. dwelling type, number of bedrooms, heating system type); and appliance factors, which are the ownership level, power demand and use of electrical appliances in the home.

Non-household level factors (i.e. at the regional, national or international scale), such as policy preference and regulatory factors, whilst they may affect domestic electricity demand, are outside of the scope of the current review. This paper seeks to investigate household level factors only so that effective energy policy can be devised, not to evaluate the effectiveness of existing or past national or international policies or regulatory frameworks on electricity consumption.

Although, papers examining the factors affecting electricity demand are numerous, to the authors' knowledge, a comprehensive analysis taking stock of all previous findings combined does not currently exist. It is hoped that this review will fill the gap, and

provide evidence of the factors which are consistently stated as having either a significant or a non-significant effect on electricity use, those factors for which the literature disagrees with regard to their correlation, and those factors which have been infrequently studied.

This review begins with a description of the previous studies. It continues by outlining the socio-economic, dwelling and appliance related factors mentioned, then each factor is discussed separately, reporting on whether a significant (positive or negative) or non-significant effect on domestic electricity use was identified. In actual buildings, many of these factors will be correlated. The possible combined influences of factors are not presented, unless these combinations have been explicitly expressed in the literature. In each section a summary table is provided to combine the conclusions of all the studies investigating a specific factor. Throughout this review, significance is measured at the 90% ($p < 0.10$) level.

2. Previous studies investigating the factors affecting domestic electricity consumption

Previous studies of the factors that affect electricity consumption in residential buildings have been undertaken using either a top-down (e.g. [3]) or bottom-up approach (e.g. [4–8]). A top-down approach is used in studies which consider the national level and aim to attribute the electricity consumption of the housing stock to the characteristics of the dwellings [9]. A bottom-up approach is used in studies based at the individual dwelling level aimed at establishing relationships between household characteristics and electricity use, which are then extrapolated to the entire housing stock [5]. A number of studies also combine both the top-down and bottom-up approaches (e.g. [10,11]).

Statistical/regression and econometric methods are the most commonly implemented to investigate the influence of socio-economic, dwelling and appliance factors on domestic electricity consumption. The statistical/regression method can be considered both a top-down and bottom-up method of analysis and is particularly useful for analysing large datasets. Examples of statistical/regression studies are Sanquist et al. [6], Baker and Rylatt [7], Kavousian et al. [12], Brounen et al. [13], Bartiaux and Gram-Hanssen [14], and Tiwari [15]. A variant of the statistical/

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