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Comparative multiple regression analysis of household electricity use in Latvia: using smart meter data to examine the effect of different household characteristics

Ilze Laicane*, Dagnija Blumberga, Andra Blumberga, Marika Rosa

Riga Technical University, Institute of Energy Systems and Environment, Azenes iela 12/1, Riga, LV 1048, Latvia

Abstract

The development and implementation of effective policies for promoting energy efficiency in the household sector has been an emerging target of the EU. A recent analysis of Latvian households included in a smart metering pilot, shows this type of housing as the most statistically significant variable to impact electricity savings. This study deals with the statistical analysis of residential buildings to find simplified correlations for the assessment of factors affecting changes in electricity consumption, in particular, taking into account selected building characteristics, as well as the personal, socio-economic, socio-demographic characteristics of households. Multiple linear regression analysis is used to present and compare results between two groups – the target group with smart meters and control group without smart meters by differentiating among typical heating types as determined in a field study.

1. Introduction

The EU countries have to deal with energy efficiency targets in order to reduce greenhouse gas (GHG) emissions by 20 % until 2020. According to the Energy Efficiency Status Report 2012, residential energy consumption

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* Corresponding author. Tel.: +37126299018; fax: +37167089908
   E-mail address: ilze.laicane@rtu.lv

increased by 3.6 % between 2009 and 2010 accounting for 26.7 % of total final energy usage in 2010 in the EU [1]. Residential buildings in Latvia in 2012 consumed 28 % of total final electricity [2]. As already discussed previously [2–4] electricity demand in Latvian households has increased in recent years. At the same time, a number of energy efficiency policy instruments are introduced in Latvia and one of the main priorities is building insulation for promoting end-use efficiency in households [5].

Several building characteristics can be highlighted that cause significant impact on household energy consumption. Some studies have shown that electricity consumption is higher in single-home dwellings than in apartments [6–7], and larger houses [7–11]. In Kavousian et al. study it was found that household age does not show significant impact on electricity consumption [6], while the others found the opposite [12]. The use of a heating system has been found to be an important factor in determining electricity use in residential buildings. The parameters influencing energy demand for space heating are: the thermal quality of the building, building type, occupant behaviour and climate condition [13], as well as dwelling size, number of occupants, efficiency of heating equipment, and demand for useful energy per unit of area heated [14]. A significant variance in electricity consumption that is related to electrical floor heating as supplementary installation in households with a heat pump and combined electricity heating system has been found in [12, 15]. Ndiaye and Gabriel [16] concluded that electricity heated homes consume more electricity than natural gas heated homes. The US study results shows that the age of the household owner has a positive effect on heating energy consumption [17], whereas, Chen et al. [14] found the opposite.

The aim of this study is to examine the extent to which the abovementioned factors cause an effect on changes in consumption. Multiple regression analysis is used to present and compare results.

Nomenclature	
E	electricity consumption per household per month, kWh/ month
G	the gender of the respondent
I	households' total net monthly income in previous month after taxes, EUR
M	the number of households' members
Ti	time of staying home for all households' members, hours per day
Ag	age of the main breadwinner in the household, years
Ed	the education level of the main breadwinner in the household
Ty	type of building (detached house, apartment etc.)
Y	the mean year of household construction
Ar	household total area, m^2
Te	the temperature maintained in household during winter time, °C
Ap	the total number of electrical appliances in households
α_o	a constant (the intercept)
$\alpha_1, \alpha_2 ... \alpha_{11}$	are regression coefficients (the parameters of the regression model)
ε	the error term (disturbance term) of the regression equation

2. Methodology

2.1. Case study research. Households data and survey

The rationale of this study is based on the analysis of a large sample of buildings involved in a smart metering project in Latvia "Promoting energy efficiency of household using smart technologies" (further – pilot project) launched by JSC "Latvenergo" on 1 April 2013. In total, the project involves 1000 households – 500 households are directly included in the project installed with smart meters (i.e., target group) and another 500 households are not