



# Energy literacy, awareness, and conservation behavior of residential households<sup>☆</sup>



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## ABSTRACT

The residential sector accounts for one-fifth of global energy consumption, resulting from the requirements to heat, cool, and light residential dwellings. It is therefore not surprising that energy efficiency in the residential market has gained importance in recent years. In this paper, we examine awareness, literacy and behavior of households with respect to their residential energy expenditures. Using a detailed survey of 1721 Dutch households, we measure the extent to which consumers are aware of their energy consumption and whether they have taken measures to reduce their energy costs. Our results show that “energy literacy” and awareness among respondents is low: just 56% of the respondents are aware of their monthly charges for energy consumption, and 40% do not appropriately evaluate investment decisions in energy efficient equipment. We document that demographics and consumer attitudes towards energy conservation, but not energy literacy and awareness, have direct effects on behavior regarding heating and cooling of the home. The impact of a moderating factor, measured by thermostat settings, ultimately results in strong variation in the energy consumption of private consumers.

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## 1. Introduction

Energy conservation is a significant element of international policies addressing pollution, global warming, and fossil fuel depletion. The housing market is an important element in these endeavors, since about one-fifth of the global energy demand stems from the residential sector. Finding novel ways to reduce residential energy consumption has not only triggered the attention of policymakers, but of academics and the real estate industry itself as well.<sup>1</sup> But, to what extent this increasing focus on energy efficiency is also acknowledged, shared and supported by the households that consume the energy in their homes, is still unclear.

Although household utility bills in most countries are on the rise – mostly due to increasing oil and gas prices, but also following increases in income and taxation – there is limited evidence that energy efficiency is in fact finding its way into the market equilibrium pricing. The

prospects of reduced energy bills should be a firm and reliable base for energy efficiency investments in a dwelling, but private market initiatives often struggle to succeed without governmental support (Jaffe and Stavins, 1994). This struggle is especially prominent in the residential market. In contrast, recent research suggests that institutional property investors and tenants capitalize energy savings in commercial real estate quite precisely (Eichholtz et al., 2013).

To assess properly the implications of increased energy efficiency in the residential market, evidence of the willingness to pay for energy-saving measures and the discount rate applied by private consumers is crucial (Horowitz and Haeri, 1990). Moreover, an important condition for the effective capitalization of energy efficiency into housing prices is that buyers (and sellers) are aware of residential energy consumption, and the influence of home characteristics therein. Variation in future utility bills will only be reflected in the transaction prices of homes if energy efficiency is properly understood and decision-making is rational. There is an emerging literature on the use of energy labels to resolve information asymmetry on the energy efficiency of dwellings (Brounen and Kok, 2011) and the relevance of information provision in changing consumer behavior has been addressed in field experiments providing feedback on energy consumption to consumers (Alcott and Mullainathan, 2010).

In this paper, we analyze an important link between energy policy design and household energy consumption, through examining the extent to which households are aware of their energy consumption; understand the energy efficiency of their homes; and appropriately adapt their behavior. In line with recent work on financial literacy

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<sup>1</sup> The literature on residential energy demand and price elasticity has a long history. See for example Houthakker (1951) and Halvorsen (1975) for early analyses, and Reiss and White (2005) for more recent work.

by van Rooij et al. (2011), we generate and exploit a survey among 1721 Dutch households, inquiring into consumer knowledge of energy consumption, by posing simple questions such as: *How much do you pay for your monthly gas (electricity) bill? At which temperature do you set your thermostat during the evening? What type of thermal insulation have you added to your current home?* These carefully constructed survey questions allow us to measure the awareness of the household towards energy use, and to assess “energy literacy” – whether households are able to make a trade-off between long-term savings from energy efficiency investments and the upfront investments that are required to achieve improvements in energy efficiency. We also measure the willingness to conserve energy by addressing consumer attitudes and ideology towards energy conservation. Importantly, we relate our constructs of awareness, energy literacy, demography, attitude and ideology to decisions that household make on a daily basis about comfort and temperature, and then to actual measures of household energy consumption.

Our results show that, although the average energy bill in the Netherlands amounts to 222 euro per month (some eight percent of the net household income, on average), just 56% (47%) of the respondents are aware of their monthly charges for gas (electricity) consumption. This lack of “energy awareness” is the strongest among younger households enjoying higher incomes. We also confirm that the awareness of energy consumption is higher among households that keep organized financial records and that generally pay more attention to conserving resources (measured by their driving style). Interestingly, the level of education is unrelated to awareness of energy consumption, but we do find that it is the most important household characteristic explaining energy literacy – making the optimal choice when considering an investment in more energy-efficient equipment. Environmental ideology, measured by voting preferences, is unrelated to either awareness or literacy.

We then focus on energy conservation behavior, measured by the evening temperature in the home and, importantly, the propensity to lower the thermostat at night. We document that attitude and demographics, but not awareness, literacy or ideology, explain the choice of thermostat setting and the likelihood of lowering the temperature at night. Elderly people, and those with higher incomes, select a higher comfort temperature. The former are also less likely to reduce home temperatures at night. Those respondents that are willing to “make sacrifices in the short run in order to secure future income” settle for a lower home temperature in the evening, presumably to save on energy expenditures.

The outcome of literacy, ideology, attitude and behavior regarding residential energy conservation can ultimately be measured in household energy consumption. Within the sample of respondents that are aware of the household energy expenditures, we explain the variation in energy consumption by a set of dwelling characteristics, household demographics and their behavior related to ambient comfort, using the Heckman (1979) model to account for sample selection bias. In line with Brounen et al. (2012), we document the substantial effect of dwelling vintage on energy consumption – homes constructed pre-1980 consume, on average, about fifty percent more energy. Importantly, modeling the effect of demographics on energy expenditures through the evening temperature as a moderating factor, we find that consumer behavior, as measured by the choice for comfort level, has a significant effect on household energy consumption. Energy literacy does not have a direct impact on household energy consumption.

Our results have some implications for policy makers. Many of the current energy conservation policies are aimed at providing incentives for investments in the energy efficiency of private homes. However, our findings show that only about fifty percent of households in our sample are aware of their actual energy consumption. Energy use does not seem to be on the mind of the typical consumer. Moreover, many households forego savings on energy payments through ignoring temperature control. We refer to this group of consumers as “sleepers.” Also, the rationality in decision-making that is expected from private consumers

might be overly optimistic – basic financial calculus seems to provide a challenge for consumers. Comparable to what has been documented for financial literacy (see, for example, Lusardi and Mitchell, 2008), “energy literacy” is much lower than policy makers tend to assume.

This paper also relates to the literature on environmentalism and consumer choice that increasingly focuses on residential energy consumption. Ideology and attitude increase awareness of energy consumption and the propensity of buying green energy, but do not necessarily affect behavior. “Greens” may drive a Prius (Kahn, 2007; Sexton and Sexton, 2011), but we do not find evidence that they actively reduce comfort temperatures or lower the night temperature to save on resources.

The remainder of this paper is organized as follows: the next section describes the data and provides descriptive statistics and details regarding the setup of the survey analysis. Section 3 provides the empirical results explaining energy awareness and literacy, while Section 4 focuses on energy behavior and consumption. Section 5 is a brief conclusion.

## 2. Data

We use data from the 2011 Dutch National Bank Household Survey (DHS). DHS is a long-standing, annual household survey that includes extensive information about demographic and economic household characteristics, focusing on wealth and savings data. The data set is representative of the Dutch population, and it contains over 2000 households.<sup>2</sup>

The DHS is built up in several sections. Section A inquires into the financial background of the respondent (i.e., income, savings, spending behavior, etc.). Section B focuses on whether households rely on external advice for their financial matters. Section C deals with the pension plan of the household, while section D asks questions with respect to housing and mortgage details.

In addition to using data from the core of the DHS, we also use data from additional, self-designed survey modules on financial literacy and residential energy consumption, added to the survey in April 2011. This section of the survey is designed to assess the ability of households to make proper financial decisions and to trade off long-term benefits with short-term investments.

In total, the survey consists of 50 questions, and requires 18 min to complete, on average. Survey participants are interviewed via the Internet.<sup>3</sup> A total of 1721 out of 2028 households completed the financial literacy and residential energy module – a response rate of 84.9% (in line with the response rate for the main survey). The respondent for these residential energy questions typically represents the member of the household that is in charge of household finances.

DHS offers a wide variety of background characteristics on the households in our sample, enabling an analysis of factors determining energy awareness across our sample. The dataset also benefits from existing survey data on the panel, enriching our survey results with additional background items that were addressed in other DHS surveys executed in 2011. For an overview of the survey questions, we refer to an online appendix.<sup>4</sup>

<sup>2</sup> See Nyhus (1996) for a detailed description of this survey and an assessment of the data quality. CentERdata is a survey research institute at Tilburg University that specializes in Internet surveys and manages the panel. For more information about the survey agency, see <http://www.uvt.nl/centerdata/en>.

<sup>3</sup> Although the Internet connection rate in the Netherlands is among the highest in Europe (some 80% of Dutch households are connected to the Internet at their home), households need not have an Internet connection to participate in the survey. Recruitment and selection of households are first done by phone through a randomly selected sample of households. Households without an Internet connection are provided with a connection or with a set-top box for their television (for those who do not have access to a personal computer). This method of data collection has several advantages. For example, data collected using Internet surveys suffer less from reporting biases than data collected via telephone interviews (see Chang and Krosnick, 2003).

<sup>4</sup> See <http://fsinsight.org/docs/download/brounen-kok-quigley-appendix-survey-overview.pdf>.

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