The Role of Energy Literacy as a Component of Financial Literacy: Survey – based evidence from Finland

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Abstract

This study uses a novel survey data set consisting of energy and financial related questions targeted at Finnish households combined with electricity consumption data provided by a Finnish electricity provider. The objective of this paper is to provide new insights on: (i) the level of energy literacy, financial literacy, and energy awareness in Finnish households; (ii) the range of energy behaviours and attitudes towards energy consumption; and (iii) the socio-demographic and dwelling factors affecting energy literate households by employing a logit model. In addition, the relationship between financial literacy and energy literacy is analysed.

Results show that Finnish households have low levels of energy literacy and energy awareness, but possess good capabilities to manage their personal finances. Additionally, specific socio-demographic and dwelling factors are associated with the probability of being energy literate. No correlation between energy literate and financial literate households has been found. Future energy policies targeting household energy efficiency and behaviour change should not only focus on related energy savings but include measures to promote energy literacy and energy awareness that guide consumers towards more responsible decisions.

Keywords: energy literacy, financial literacy, energy awareness, Finnish households, energy efficiency, energy behaviour

Highlights

- We conduct a survey of energy and financial literacy in Finnish households
- Finnish households have low levels of energy literacy and energy awareness
- There exists no correlation between energy literacy and financial literacy

1. Introduction

Due to the problems associated with global warming and the depletion of fossil fuels, promoting energy conservation has become very timely. The key role of the residential sector to the reduction of the energy demand is not negligible: unlocking the potential of the residential sector in reducing energy consumption as a result of energy efficiency investments and energy savings through behavioral changes can lead to significant abatements in environmental pressures associated with energy production and consumption. In Finland, the residential sector accounted for 20.7% of the total energy consumption in 2014. The residential final energy consumption per capita in 2014 was the highest among the European Member States (0.92 Toe per inhabitant) and the electricity consumption increased by 46.32% over the period 1990-2014 (Eurostat, 2016). According to the Statistics of Finland, the electricity used on housing appliances amounted to 21 terawatt hours (TWh) in 2014, while the energy employed for space heating was 56 terawatt hours (TWh), representing the 72.7% of the total energy end-use in the residential sector. At the same time, the electricity price for Finnish domestic consumers is among the lowest in the European Union, thus undermining incentives to save energy. Finland is also highly dependent on imported fossil fuels – namely oil, gas and coal – and will remain so in the long term; this poses a significant challenge in terms of energy security (IEA, 2013). Hence, a reduction of energy consumption at household level could go a long way to reduce the CO2 emissions and increasing the energy security of the country. Large reductions in household energy use are unlikely to be achieved from interventions designed to finance energy efficiency investments alone. There is evidence that suggests that there is potential for larger energy savings if technical/infrastructural and behavioral interventions are applied in combination because they mutually reinforce each other, having the same goal (Santin et al., 2009; Gram-Hanssen, 2011; Morley and Hazas, 2011). In fact, policies designed to reduce energy consumption through energy efficiency measures in the residential sector are typically based upon engineering calculations, which differ significantly from outcomes observed in practice. The "energy efficiency gap" or "energy efficiency paradox" is commonly referred to the failure of consumers to make seemingly cost-effective investments in energy efficiency (see Gillingham and Palmer 2013 for an overview). Consumers are far from the purely rational decision-makers assumed by traditional economic models, and there is a wide gap between peoples' values and material interests, and their actual behaviour.

Recently, some economists have proposed that systematic behavioral biases in consumer decision-making such as incorrect "perceptions" of fuel cost savings, lack of information and attention about energy costs may explain the apparent efficiency gap (Tietenberg 2009; Allcott et al., 2014). According to Brounen et al. (2013), the main reason for these behavioral failures is the lack of knowledge about energy costs, although they represent a significant part of household income. However, even with adequate knowledge about how to save energy and a professed desire to do so, many consumers still fail to take noticeable steps towards energy efficiency and conservation (Frederiks et al., 2015). A person who is knowledgeable about energy and aware of energy-related issues will not necessarily adopt energy saving behaviors or participate in actions that promote a more sustainable energy future. It is therefore very important not only the understanding of how energy is used in everyday life or the awareness of the need of energy conservation, but moreover, the ability and willingness to use that knowledge in a functional manner and to take actions that reflects these understanding and attitudes with respect to energy behaviors.

These considerations can be reflected also against the literature on financial literacy that refers to the capability of consumers to manage their personal finances. Common findings from this literature include that the knowledge on financial issues is often somewhat deficient. Knowledge on financial issues has

been shown to correlate with financial behavior, so there is a promise that by improving knowledge one might also affect the behaviour (see Lusardi and Mitchell 2014 for an overview). However, knowledge affects only part of the financial behaviour; the attitudes and awareness of the consequences of the choices are also important determinants of the behaviour –perhaps even the most important ones (Carpena et al., 2011).

Household decisions on energy-related issues can be regarded as one component of personal finance decisions. This ranges from issues such as energy conservation (e.g. by adjusting thermostat settings) to making investments to energy efficiency solutions that impose short term costs but may pay off over time (e.g. installing heat pumps or solar panels), to understanding price formation and making choices based on price comparisons (e.g. comparing different suppliers and making decisions, for instance switching suppliers, on that basis), and to seeking expert advice (Palmer and Walls, 2015). Energy consumption typically forms a non-trivial part of the total household consumption.

The personal finance side of energy literacy, can be thought of consisting of various components that are relevant for energy related decisions: among others, awareness of different actions that consume energy and the price formation of household energy; how to evaluate the long-term decisions related to investments that improve energy efficiency; the willingness to take energy conserving measures; and the information needs of consumers and their willingness to gather information. Like in the case of financial literacy, it can be assumed that knowledge affects behaviour, but behaviour is also shaped by awareness and attitudes.

For the above-mentioned reasons, in this paper we collected survey data on energy and financial related issues in the residential sector of Finland in order to examine:

- The level of energy literacy, financial literacy, and energy awareness in Finnish households.
- The range of energy behaviours exhibited and attitudes towards energy consumption.
- The factors affecting energy literate households and whether financial literacy and energy literacy are correlated.

The results of this article shed new light on the knowledge gaps in energy literacy and whether energy conservations practices can be influenced by improving energy knowledge and behavior change programs. In addition, our findings can be also used to plan educational interventions on energy issues and evaluating the efficiency of such interventions. Educational programs are in fact motivated by the willingness to reduce and address market and behavioral failures such as asymmetric information, bounded rationality, prospect theory, heuristic decision making (Gillingham et al., 2009), and to help guide consumers toward better decisions.

The paper proceeds as follows. Section 2 gives an overview of the background of the study. Section 3 presents the description of data. Section 4 describes the methodology employed. Section 5 discusses the main results in comparison with previous research. Section 6 provides concluding remarks and policy implications.

2. Literature Review

Despite the proven cost-effective opportunity to reduce energy consumption, a large portion of the potential for energy efficiency in the existing residential building sector remains untapped, creating the so called "energy efficiency gap" (Gillingham and Palmer 2013). Empirical studies consistently indicate that increases in energy efficiency do not regularly lead to one-to-one reductions in energy consumption (Galvin, 2014). This is because people are irrational and do not always do "the right thing". Non-rational behavior is central to human decision-making, and so any approach based on the traditional economic assumption that people are rational and self-regarding is incomplete (Gowdy, 2008). In the last years, to better reflect the behavior of consumers in energy models, behavioural economists and psychologists have tried to understand the range of behavioral drivers and constraints affecting household energy decisions (Kahneman and Tversky 1979; Abrahamse et al., 2005; Gillingham et al., 2009; Della Vigna 2009; Allcott and Mullainathan 2010). In particular, there are many behavioral failures and psychological phenomena influencing consumers' patterns of energy usage such as the status quo bias, loss and risk aversion, sunk-cost or endowment effects, temporal and spatial discounting, availability bias, normative social influence, intrinsic and extrinsic rewards, and trust (Pollitt et al., 2011; Gillingham et al., 2013; Frederiks et al., 2015).

In addition, research on household energy use has found that several types of socio-demographic factors and attitudes influence energy usage behavior. The understanding of these factors is crucial to implement effective interventions (e.g., Black et al., 1985; Stern, 1992; Steg, 2008; DeWaters and Powers, 2011; Martinsson et al., 2011; Kang et al., 2012). According to Abrahamse et al. (2005), the energy conservation interventions are more effective to the extent that they target and change important determinants of energy use. For example, an information campaign may not have been effective because the target groups were already familiar with the information provided and no increase in knowledge occurred. Therefore, a problem diagnosis is necessary in examining which behaviours and which behavioural determinants (motivation, attitudes) should be targeted by the intervention.

Costa and Kahn (2013) have traced the difficulties to realize the energy saving potentials on several sources: first, consumers may lack the necessary information to act in their best interest; second, even if they would in principle know what is in their best interest, energy conservation may not be high on their list of priorities and consumers make suboptimal choice because of the lack of salience; third, consumers are probably rather heterogeneous with respect of their attitudes towards energy conservation and their attitudes are likely to influence the behavior.

It is not very common for households to be informed about their energy bills and use. Generally, if consumers are more aware of the way they use energy and of its cost, they should be more interested in reducing their energy consumption (Scott, 1997). Brounen et al. (2013), by using data from the 2011 Dutch National Bank Household Survey (DHS), measure the extent to which households are aware of their energy consumption and whether they have taken measures to reduce their energy costs. Their 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.

Recently, Blasch et al. (2017) estimated the role of energy and investment literacy of Swiss households on electricity consumption. By using a generalized true random effect model (GTREM) with a panel dataset of 1,994 Swiss households, they find that for households exhibiting energy-saving behaviours, electricity consumption is lower; in addition, households with a high level of energy and investment literacy are associated with lower electricity consumption, although investment literacy plays a more vital role.

Among Swiss households they found low levels of energy literacy (27%) while high levels of investment literacy (71%).

Ameli and Brandt (2015), through an empirical analysis of the OECD Survey on Household Environmental Behaviour and Attitudes, investigate which factors, such as socio-economic, attitudes, and knowledge about energy use, might drive household decision-making for the adoption of clean energy technologies. The results suggest that even though the respondents were asked to get hold of their energy bills before answering the survey, only about 55% were able to provide information about their energy spending. Attari et al. (2010), provide evidence on households' misperceptions of energy consumption and savings. They suggest that there is relatively little knowledge regarding the effectiveness of different measures to conserve energy. Participants of a national US survey, considered curtailment behaviours such as turning off lights, more effective to save energy than energy efficiency investments such as buying energy efficient appliances or installing more efficient light bulbs. The authors suggest that respondents' difficulty in judging energy use and savings might partly result from an anchoring bias. In addition, Di Maria et al. (2010), using survey data collected in 2001 for a representative sample of 1500 Irish households, found that over 50% of their respondents are not aware of the potential energy savings (or even their existence) of compact fluorescent light bulbs compared to the traditional bulbs.

Dianshu et al. (2010) tested the households' awareness of the electricity consumption and some fundamental aspects of electricity use and knowledge in Liasoning Province (China). In particular, a series of questions regarding electricity bill, knowledge about energy efficiency, and knowledge about appliances were asked. Despite electricity being pre-paid, and requiring more direct involvement than the automated billing, the results suggest a low general awareness of the households about the electricity bill. In fact, more than 40% of the respondents did not remember their monthly electricity bill size.

The way customers pay their electricity bills may have implications for how they consume energy. This was demonstrated by a study of Brutscher (2011) that looked at the role of pre-payment (in the context of pre-payment metering) for household electricity consumption. He found that Northern Ireland households paying their electricity upfront tend to consume more electricity than households paying ex post.

The fact that consumers do not observe the amount of electricity consumed by a washing machine or the energy required by a house to maintain the standard temperature, makes energy efficiency (as well as energy consumption) an intangible and secondary characteristics of goods (Ramos et al., 2015). In fact, households can hardly know how their daily habits are translated in energy consumption. Kazukauskas and Broberg (2016), by using a household survey data of approximately 90,000 randomly recruited Swedes, found that many people use energy under imperfect knowledge about costs and that have on average relatively high cost perceptions. Most interesting, households with poor knowledge about energy demand and costs are less willing to receive customized information about their own and other's energy use.

Over the last few decades, information on the household use of energy has become an important instrument to achieve energy savings. Studies using before and after measurements have found an increase in knowledge levels after mass media campaigns (e.g. Staats et al., 1996), and workshops about energy conservation (Geller, 1981), but this did not necessarily result in behavioral changes or reductions in energy use. There is often a sizeable discrepancy between peoples' self-reported knowledge, values, attitudes and intentions, and their observable behaviour - examples include the well-known "knowledge-action gap" and "value-action gap" (Frederiks et al., 2015). For example, a Fondazione Eni Enrico Mattei survey (FEEM, 2007) indicated that while 70% of Italians surveyed were willing to increase energy savings only 2% were actually reducing their use (Pongiglione, 2011).

Some authors have argued that increased information transparency in energy consumption can be instrumental as a "nudge" to encourage energy conservation among private consumers (Allcott and Mullainthan, 2010; Allcott, 2011). Giving consumers feedback on their consumption, providing information on the potential of energy savings opportunities, and comparing their use to their neighbourhood, have caused households to reduce energy consumption (mainly electricity) by 5-12% (Fischer, 2008), but also undesirable boomerang effects[1] (Ayres et al., 2012; Sælen and Westskog, 2013). More recently, Delmas and Lessem (2014) have estimated substantial energy cost savings in the magnitude of 20% that could be achieved by behavioral changes alone. However, while private information alone was ineffective, public information combined with private information motivated a significant reduction in electricity consumption achieved through lower use of heating and cooling.

Many of the behavioral biases and drivers affecting the energy awareness and energy literacy are similar to those that determine the financial literacy of the households, and the two issues are therefore assessed jointly. Low levels of financial literacy and lack of information regarding basic financial issues has been documented in several studies (Lusardi and Mitchell 2011; 2014).

Given the many ways financial literacy affects financial behavior (Lusardi and Mitchell, 2014), it is important to understand the extent of people's understanding of basic financial concepts. Lusardi and Mitchell (2009) provide a generally accepted standard set of questions to evaluate financial literacy by assessing basic knowledge of four fundamental concepts in financial decision-making: knowledge of interest rates, interest compounding, inflation, and risk diversification. Atkinson and Messy (2012) have constructed an indicator of financial literacy as a combination of knowledge, attitudes and behaviours necessary to make sound financial decisions and achieve individual financial wellbeing. The analysis of the relationship between knowledge and behaviour suggests a positive association in every country under investigation: when knowledge increases so does behavior. There is also a positive association between attitudes and behaviour: people with positive attitudes towards the long term are more likely to behave in ways that are consistent with achieving long-term goals. Recently, Miller et al. (2014), reviewed 188 articles that present impact results of interventions designed to increase consumers' financial literacy or skills, attitudes, and behaviors (financial capability). They found that targeted financial literacy programs that are focused on specific behaviours and populations can lead to smarter financial decisions.

Differently from many other countries, Finland seems to show a good level of financial literacy. In a recent study commissioned by the World Bank (Klapper et al., 2015), more than 150,000 nationally representative and randomly selected people in more than 140 economies were interviewed during 2014. Worldwide, only 1-in-3 adults are financially literate. However, Finland is one of the countries with the highest levels of financial literacy (63% of the adults). Similarly, Kalmi and Olli-Pekka Ruuskanen (2015) measured the level of financial literacy among Finns in comparison to other countries. The results indicate that the level of financial literacy in Finland is comparatively high, although it is rather unequally distributed among population (gender and low-income issues).

[1] The "descriptive norm" element of the Home Energy Report treatment, in which a household's energy use is compared to that of its neighbours, would cause households that previously used more than the norm to decrease usage, but would cause households that used less than the norm to use more (Allcott, 2011).

3. Data

The survey questionnaire was designed between 2016 and 2017 and it is based on an extensive literature review of survey methodology (Bowling, 2005; Fricker et al., 2005; Kreuter et al., 2008; Beck et al., 2009; Chang and Krosnick, 2009; Dillman et al., 2009; Taylor et al., 2009; Potoglou et. al., 2012) and households' energy and financial related surveys (Martinsson et al., 2011; Brounen et al., 2013; Lusardi and Mitchel, 2014; Ameli and Brandt, 2015; Kazukauskas and Broberg, 2016). It was then reviewed by several national and international experts and pre-tested on a sample of academicians in March 2017. Between April and May 2017 we collected data by using the survey tool Webropol 2.0.

Household customers of Vaasan Sähkö (Finnish electricity provider) and Vaasan Sähköverkko (Finnish electricity distribution company) were asked to participate in a study aimed at exploring (i) the level of energy and financial literacy, (ii) the level of energy awareness about electricity prices, running costs of appliances, and electricity monthly bills, (iii) the range of energy and financial behaviors exhibited, (iv) the attitudes towards energy consumption and financial plans.

The survey consists of 57 energy and financial related questions, including information regarding the socio-economic and demographic characteristics of the respondents. In addition, the survey comprised questions about environmental attitudes, dwelling characteristics, and respondents' willingness to get more information about energy consumption, how to save energy, and the operating costs of the electric appliances.

Among 244 adults who initially showed interest in participating to the survey, 184 completed the questionnaire - response rate of approximately 75%. The questionnaire was delivered in Finnish, Swedish, and English, as most of the respondents live in Vaasa that is a bilingual city on the west coast of Finland. Approximately 75% of the respondents were Finnish speaking, while 25% were Swedish speaking. Only one person completed the questionnaire in English language. Among those who submitted a full questionnaire, 20 respondents have been randomly selected to be awarded 100€ gift card.

The survey data is then combined with monthly electricity consumption data from April 2015 to March 2017 provided by Vaasan Sähkö (Finnish electricity provider) and Vaasan Sähköverkko (Finnish electricity distribution company).

On the basis of the survey questionnaire and literature review, we formulate two hypothesis. The first hypothesis relates to the levels of energy literacy, energy awareness, and financial literacy among Finnish households. While several studies indicate that the level of financial literacy in Finland is high especially in comparison to other countries (Kalmi and Olli-Pekka Ruuskanen, 2015; Klapper et al., 2015), the level of energy literacy and energy awareness of Finnish households has not been previously analysed. However, some studies targeted at households of different countries suggest a general low level of energy awareness (Dianshu et al. 2010; Di Maria et al., 2010; Brounen et al., 2013; Ameli and Brandt, 2015; Blasch et al, 2017). Thus, our first hypothesis is:

H1: Finnish households have a low level of energy literacy and energy awareness, while they a have high level of financial literacy.

With the second hypothesis we empirically test the correlation between energy and financial literacy, by assuming a positive relationship between high levels of energy literacy and high levels of financial literacy. This is because the drivers and barriers of energy literacy are similar to those of financial literacy (see Introduction). Thus, our second hypothesis is:

H2: High levels of energy literacy are associated with high levels of financial literacy.

Table 1 reports descriptive statistics for the main variables used in the data analysis.

Table1. Descriptive statistics

Variables	N	Mean	Std Dev	Min	Max
Energy Literate (0 – no. 1 – yes)	184	42.39%	0.495	0	1
Financial Literate (0 – no. 1 – yes)	184	58.15%	0.494	0	1
Age	184	48.5	16.145	19	85
Agesq	184	2619	1581,689	361	7225
Npeople	184	2.3	1.1	1	5
Female (0 – no. 1 – yes)	184	46.74%	0.5	0	1
BA degree or higher (0 – no. 1 – yes)	184	47.83%	0.501	0	1
High income household (0 – no. 1 – yes)	126	10.32%	0.305	0	1
No young (no persons under 18 years old are in the household) (0 – no. 1 – yes)	184	66.3%	0.473	0	1
No old (no persons over 62 years old are in the household) (0 – no. 1 – yes)	184	71.2%	0.454	0	1
Electricity bill payment: Myself (0 – no. 1 – yes)	184	70.11%	0.459	0	1
Single house / Detached (0 – no. 1 – yes)	184	50.54%	0.501	0	1
Year dwelling: >2000 (0 – no. 1 – yes)	182	30.22%	0.46	0	1
Owner dwelling (0 – no. 1 – yes)	184	79.78%	0.402	0	1

4. Methodology

We measured energy literacy by a binary variable that takes the value of one if the respondent correctly answered to two questions assessing the ability to choose between two different heating systems with the same lifespan but different retail price and monthly heating bills (Table 2). Differently from the study of Brounen et al., (2013) we used two questions instead of one as a proxy to determine energy literacy.

Table 2. Energy literacy

ENERGY LITERACY	
Trade-off between two models of heating systems - lifespan of 15 years	Trade-off between two models of heating systems - lifespan of 5 years
Q1. Think about a hypothetical situation where you own your home, your heating system breaks down and is beyond repair. As a replacement, you can choose between two heating systems. Model A sells for €3750 and the heating is expected to cost €100 per month. Model B is more expensive, with a retail price of €5000, but the heating will cost €80 per month. You can assume that both models have an economic lifespan of 15 years. Which heating system would you choose? ➢ Heating system A ➢ Heating system B ➢ Both models are equally adequate ➢ Cannot say	Q2. What would happen if both models would have an economic lifespan of 5 years (instead of 15 years as assumed before)? Which heating system would you prefer? ➢ Heating system A ➢ Heating system B ➢ Both models are equally adequate ➢ Cannot say

The level of financial literacy is also measured by a binary variable that takes the value of one whether respondents correctly answered to three questions concerning the interest rate, compound interest (Blasch et al., 2017), and stock options (Lusardi and Mitchel 2014) – Table 3.

Table 3. Financial literacy

FINANCIAL LITERACY		
Interest rate	Compound interest	Stock options
Q1. Suppose you put €1000 into a savings account with a guaranteed interest rate of 1% per year. The inflation is 2% annually. You do not make any further payments into this account and you don't withdraw any money. In one year's time will you be able to buy: ➢ The same amount as today ➢ Less than you could buy today ➢ More than you could buy today ➢ Cannot say	Q2. Suppose you put €100 into a savings account with a guaranteed interest rate of 2% per year. You do not make any further payments into this account and you don't withdraw any money. Assume that there is no tax on interest paid. How much would be in the account at the end of five years? ➢ More than €102 ➢ Exactly €102 ➢ Less than €102 ➢ Cannot say	Q3. When you buy a wide range of stocks, it usually means a higher risk of decrease in value, than in investing in one stock only. ➢ True ➢ False ➢ Cannot say

With regard to energy awareness we selected three proxies to measure whether respondents provided a reasonable estimate of the following: prices of electricity (energy and distribution cents per kwh); running costs of appliances and heating system; and average monthly summer and winter electricity bills – Table 4.

In order to select the correct answers for the 'awareness of electricity prices', the actual energy costs and distribution charges (provided by Vaasan Sähkö and Vaasan Sähköverkko) are compared to reported estimation.

The variable 'awareness of different operating costs' results from the correct answers to at least two of the three questions concerning the running costs of an ordinary dishwasher for two hours, an ordinary oven for two hours, and the percentage change of the heating bill by increasing the temperature of two degrees. On average, assuming 16 cents/kWh as energy and distribution costs, an ordinary dishwasher of 1,800 watt that runs for two hours would cost 57 cents. The answers between 30 and 70 cents are considered correct. On the other hand, an ordinary oven of 2,300 watt that runs for two hours would cost 73 cents. The answers between 50 and 90 cents are considered correct. Regarding the heating system, increasing the heating temperature by 2 degrees results in an average increment of 6% of the heating bill. The answers between 2% and 10% are considered correct.

The variable 'awareness of monthly electricity consumption' draws from the correct answers to both the latest winter and summer monthly electricity bills. Reported estimation are compared with actual electricity consumption data. Correct answer is considered not only the selection of the exact range of amount paid (e.g., 60-89 euros), but also the one above or below the selected range (e.g., 30-59 euros or 90-119 euros).

Table 4. Energy awareness

ENERGY AWARENESS

➢ **Awareness of electricity prices**

Electrical energy cost	Electrical distribution charge
Q1. How many Cents per Kilowatthour do you pay for the electrical energy cost on average? *Please provide the exact amount or an estimate.* ➢ Cents per Kilowatthour [……..] ➢ Cannot say	Q2. How many Cents per Kilowatthour do you pay for the electrical distribution charge on average including all taxes and levies? *Please provide the exact amount or an estimate.* ➢ Cents per Kilowatthour [……..] ➢ Cannot say

➢ **Awareness of different operating costs**

Dishwasher	Oven	Heating bill
Q1. How much does it cost (Cents) to run an ordinary dishwasher for two hours? *Please provide an estimate.* ➢ Cents [……..] ➢ Cannot say	Q2. How much does it cost (Cents) to use an ordinary oven for two hours (at 200°C)? *Please provide an estimate.* ➢ Cents [……..] ➢ Cannot say	Q3. What is the percentage (%) your heating bill goes up on average if you increase the temperature of your house by two degrees in a month? *Please provide an estimate.* ➢ My heating bill goes up by (per cent) [……..] ➢ Cannot say

➢ **Awareness of monthly electricity consumption**

Winter electricity bill	Summer electricity bill
Q1. How much did you pay for your monthly electricity bill (basic charge, energy charge, distribution charge and taxes) during the last winter (December 2016-February 2017)? *Please give the monthly average amount.* ➢ 30-59 euros ➢ 60-89 euros ➢ 90-119 euros ➢ … ➢ 500 euros or more ➢ Cannot say	Q2. How much did you pay for your monthly electricity bill (basic charge, energy charge, distribution charge and taxes) during the last summer (June 2016-August 2016)? *Please give the monthly average amount.* ➢ 30-59 euros ➢ 60-89 euros ➢ 90-119 euros ➢ … ➢ 500 euros or more ➢ Cannot say

In the second part of the analysis, we examine the energy-saving behaviours and energy efficiency investments made by Finnish households. The energy-saving behaviours are measured on a frequency scale from "never" to "always" and they refer to the majority of the daily activities. Concerning the energy efficiency investments, we collect information on different types of solutions implemented and whether these efficiency investments are planned to be made or not.

We then turn the analysis to the factors influencing the likelihood of Finnish households to be energy literate within a standard discrete choice logit model framework.

The logit model assumes that while we only observe the values of 0 and 1 for the variable y_i (En_i), there is a latent, unobserved continuous variable y_i^* that establishes a linear relation between the variables of interest and determines the value of y_i. Thus, in order to explore the determinants of energy literacy, we estimate the following equation:

$$\Pr(En)_i = \alpha_i + \beta_i S_i + \delta_i D_i + \varepsilon_i \quad (1)$$

where $(En)_i$ is a binary dummy representing whether respondent i is "energy literate" as result of the positive outcome of the two questions assessing the ability to choose between two different heating systems. S_i and D_i represent vectors of explanatory variables with household i socio-demographic and

dwelling factors, respectively. β_i and δ_i are the parameter vectors to be estimated, and ε_i represents the error term that is assumed to follow the standard logistic distribution with mean 0 and variance $\frac{\pi^2}{3}$, $\lambda(\varepsilon) = \frac{e^{\varepsilon}}{(1+e^{\varepsilon})^2}$.

With regard to the socio-demographic and dwelling explanatory variables that influence the probability of being energy literate as confirmed by Brounen et al. (2013), the following variables are included: the household respondent's age, gender, educational level, level of household income, dwelling by type and period of construction, housing tenure, whether young or elderly persons are present in the household, the responsible of the electricity bill, and the financial literacy proxy (Table 1).

Given the non-linear nature of the logit models, in order to provide a direct interpretation of the coefficients the average marginal effects (AMEs) are estimated. For dummy variables, the average marginal effect shows how the predicted probability of observing that a Finnish household can be considered energy literate (y=1) changes as the dummy variables change from 0 to 1. In addition, the Hosmer and Lemeshow goodness-of-fit tests (all P values > 0.05), the McFadden Pseudo R^2, and the percentage of correctly predicted for logit models are represented (Table 5).

Because of the reliance on self-reported data, it is important to interpret the results discussed in the following section with caution. Several factors such as social desirability, response scales, word phrasing and other types of response bias may influence the participants of a survey from providing an accurate or truthful response (e.g., Podsakoff et al., 2002; Ewert and Galloway, 2009).

5. Discussion and Empirical Results

5.1 Energy literacy, financial literacy, and energy awareness

Results confirm the hypothesis H1[2]. Energy use seems to be not on the mind of the consumers and only 42% of the respondents are "energy literate". Energy literate respondents correctly answered to both questions about the optimal choice of the heating system, thus having been able to translate their knowledge about energy-related issues into energy behaviours.

Looking at the specific results in more detail, 69% of the respondents answered correctly to the first question about the trade-off between two models of heating systems with a lifespan of 15 years. This result is slightly higher than the findings of Brounen et al., (2013) in which approximately 60% of Dutch households are found to be energy literate as result of the answer to this question.

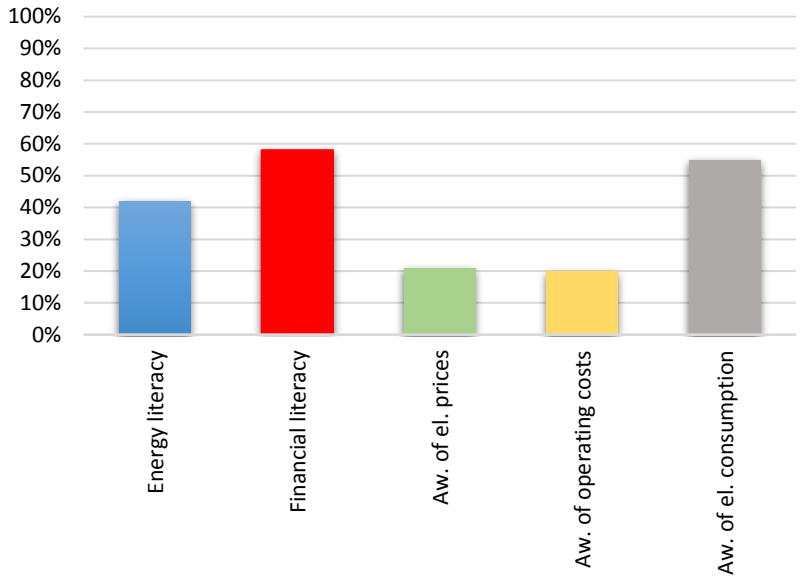
With regard to the second question about the trade-off between two models of heating systems but with a lifespan of 5 years (instead of 15 years), 63% of the respondents answered correctly.

On the other hand, 58% of the respondents correctly answered to the three financial literacy questions, proving to be able to use knowledge and skills to make effective and informed money management decisions. In addition, 47% of the financial literate respondents belong also to the category of energy literate households, while 64% of the energy literate respondents correctly answered to the three questions about financial literacy.

[2] Finnish households have a low level of energy literacy and energy awareness, while they a have high level of financial literacy.

Respondents overestimated their ability to read and understand the electricity bill. While 70% of the respondents stated to have a high capability to understand the electricity bill, less than one-quarter provided the right answers about the electrical energy and distribution costs. In addition, only 20% of the respondents are aware of the operating costs of the electrical appliances and heating system, and 55% of the respondents provided a reasonable estimation of their latest winter and summer electricity bills. These results are in line with several studies indicating low levels of energy awareness among households (e.g., Dianshu et al. 2010; Ameli and Brandt, 2015).
Figure 1 illustrates the levels of energy literacy, financial literacy, and energy awareness among the respondents of the survey.

Figure 1. Levels of energy literacy, financial literacy, and energy awareness



Source: Authors' elaboration based on Finnish household survey data (2017)

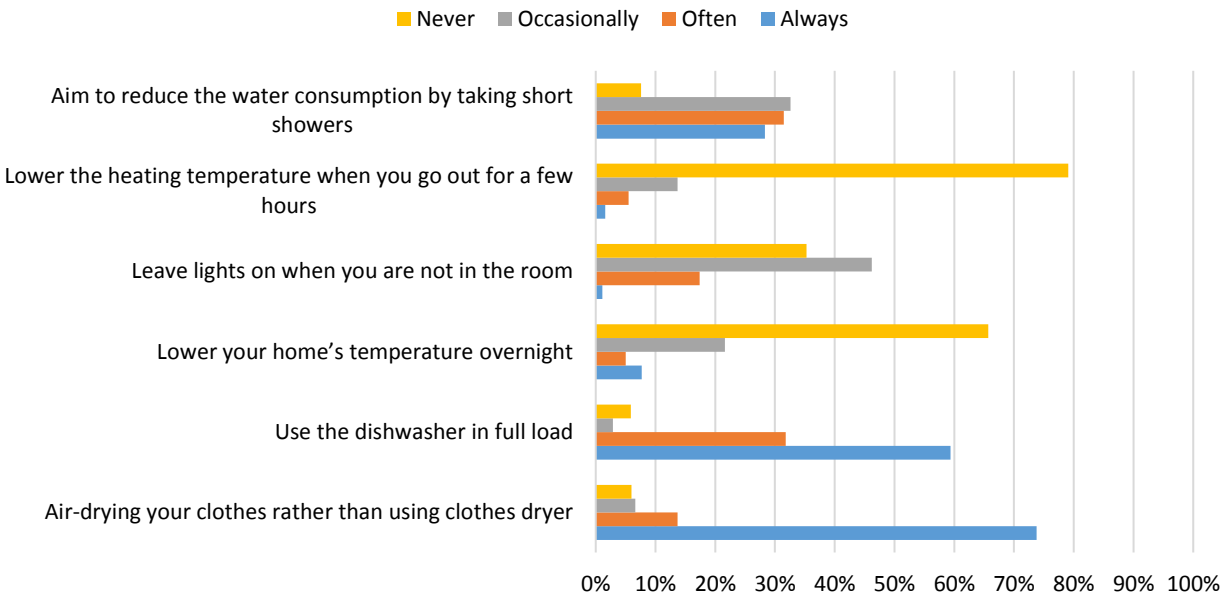
The lack of 'energy awareness' is supported by the willingness of the respondents to receive more information about their energy consumption. In particular, more than two-thirds of the respondents would like to have more information on: how to save energy at home; their energy consumption compared with the energy consumption of similar households; their current energy consumption compared with past energy consumption; and the operating cost of all the electric appliances.

5.2 Energy saving-behaviours and energy efficiency investments

We then asked respondents to state the frequency ("never", "occasionally", "often", and "always") of the following daily energy-saving behaviours: reducing the water consumption by taking short showers; lowering the heating temperature when out for few hours; leaving lights on when not in the room; lowering the home's temperature overnight; using the dishwasher in full load; and air-drying clothes rather than using clothes dryer. Using the dishwasher in full load and air-drying clothes rather than using

clothes dryer seem to be common energy habits. 60% of the respondents declared to pay attention to the water consumption by taking short showers, while approximately 80% of the respondents never or only occasionally leave lights on when not in the room. Very few respondents stated to lower the heating temperature overnight or when not at home (Figure 2). Beyond the adverse cold-climate conditions of Finland and the need of households to keep the heating constantly on during winter time, the relative disinterest of the respondents toward reducing heating consumption may be due to the fact that 40% of them live in a district-heated house. This means that the occupants have relatively little control over the heating temperature and may not have incentives to save energy because the heating costs are often embedded in the housing management or rental payments (Kyrö et al., 2011).

Figure 2. Reported daily energy-saving behaviours

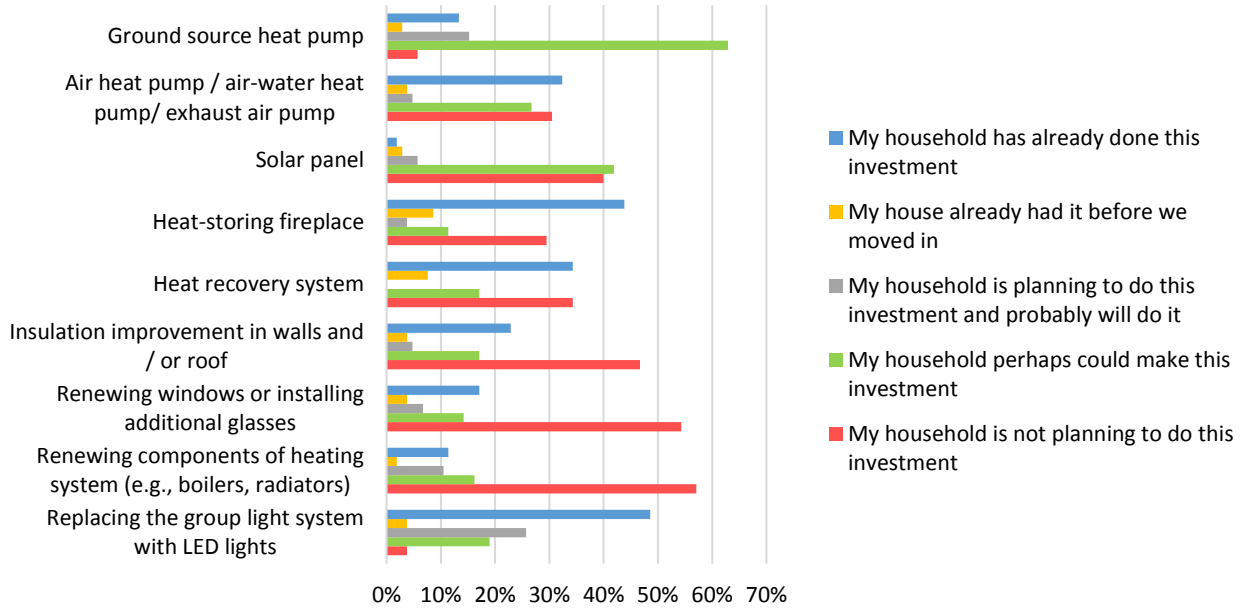


Source: Authors' elaboration based on Finnish household survey data (2017)

Respondents were also requested to indicate whether they had invested in a number of different energy efficiency investments; if they were planning to do so; or if their house already had such efficiency solutions before they moved in.

Among the households who are fully responsible of all the different types of energy efficiency interventions in their house, 16% invested (or their house already had it before they moved in) in a ground source heat pump, 36% have an air heat pump or air-water heat pump or exhaust air pump, 5% a solar panel, 52% a heat-storing fireplace, and 42% a heat recovery system. 27% of the respondents made an insulation improvement in walls and/or roofs, 21% renewed windows or installed additional glasses, and 13% renewed components of heating system (boilers, radiators, etc.). Additionally, one out of two of the respondents (fully responsible of the energy efficiency interventions) replaced the group lighting system with led lights (Figure 3). It is interesting to note that respondents belonging to the category of energy literacy or financial literacy (or both) carried out 82% of at least one of these energy efficiency investments.

Figure 3. Energy efficiency investments



Source: Authors' elaboration based on Finnish household survey data (2017)

5.3 Determinants of energy literacy

Results of the logit estimations of energy literacy respondents disconfirm the hypothesis H2[3]: despite energy-related issues can be regarded as an important component of personal finance decisions, no statistically significant positive correlation between high levels of energy literacy and financial literacy has been found (Table 5).

[3] High levels of energy literacy are associated with high levels of financial literacy.

Table 5. Average Marginal Effects (AMEs) for Logit Estimations of Energy Literate Respondents

Variables	Energy Literate (AMEs-Logit)
Financial literate	0.05
	(0.09)
Age	-0.1
	(0.02)
Agesq	-0.00
	(0.00)
Npeople	0.17*
	(0.08)
Female	0.18*
	(0.09)
BA degree or higher	-0.18
	(0.09)
No young	0.53**
	(0.17)
No old	-0.29*
	(0.14)
High income household	0.33*
	(0.14)
Electricity bill payment: Myself	0.22*
	(0.09)
Single house / Detached	0.02
	(0.1)
Year dwelling: >2000	0.41***
	(0.08)
Owner dwelling	-0.11
	(0.15)
Number of observations	126
McFadden Pseudo R^2	0.1805
Hosmer–Lemeshow test	0.6932
% of correct prediction	74.6%

*** indicates significant at 1% level, ** significant at 5% level, * significant at 10% level.
Standard errors in parentheses.

Gender seems to influence the probability of being energy literate. In line with studies in which women seem to be more attentive to the energy issues (Carlsson-Kanyama and Linden, 2007; Raty and Carlsson-Kanyama, 2010) but in contrast to the findings of Brounen et al. (2013), women are found 18% more likely to be energy literate than men.

While we did not find any indication about the age factor on the probability to being energy literate, the type of the household composition seems to play an important role in influencing higher levels of energy literacy. Respondents living in a household with a higher number of persons are 17% more likely to be energy literate, and the ones living in a household in which young persons (under 18 years old) are not present seem 53% more likely to be energy literate. Similarly, respondents belonging to a household in which elderly persons are not present seem 29% less likely to be energy literate. The intuition is that there appear to be a positive relationship between some households' characteristics that led to higher electricity consumption and the probability of being energy literate. In fact, both the number of occupants and the number of older/retired persons (that spend more time at home), significantly increase the demand for electricity (e.g. Lindén et al., 2006; Jones and Lomas, 2015). Hence, these households may have more incentives to be informed about efficiency solutions that reduce energy consumption and increase thermal comfort.

Being responsible of the electricity bill payment clearly affects the probability of being energy literate. Here, the line of reasoning is that a direct involvement in the payment of the bills might increase the level of information for responsible decisions and actions.
The variable that controls for the educational level "BA degree or higher", is not a predictor of energy literacy. This result is in contrast with the findings of Brounen et al. (2013), in which the educational level of Dutch households is found to be positively correlated with energy literacy.
Households with a high level of income and living in a modern house are 33% and 41% more likely to be energy literate, respectively. This may be due to the fact that compared to households with lower income living in older houses, wealthier households have the financial capacity to afford energy efficiency investments (Urban and Scansy, 2012) and are able to make more informed decisions in this regard.

6. Conclusions and Implications for Energy Policy

This study builds on a novel survey consisting of 57 energy and financial related questions targeted at 184 Finnish households. The survey data is then combined with monthly electricity consumption data from April 2015 to March 2017 provided by Vaasan Sähkö (Finnish electricity provider) and Vaasan Sähköverkko (Finnish electricity distribution company).
We first examine the level of energy literacy, financial literacy, and energy awareness among Finnish households. We then analyse reported daily energy-saving behaviours and energy efficiency investments made or planned for the next years. Furthermore, we use logistic regression to empirically investigate the socio-demographic and dwelling-related characteristics driving energy literacy and its relationship with financial literacy.
Results show that Finnish household have a low level of energy literacy and energy awareness, while they possess a high level of financial literacy. 42% of the respondents correctly answered to the questions designed to test their level of energy literacy, 21% are aware of the electricity energy and distribution prices, 20% are aware of different operating costs of the electrical appliances and heating system, and 55% gave a reasonable estimation of their latest winter and summer electricity bills. With regard to financial literacy, 58% correctly answered to the three questions concerning interest rate, compound interest, and stock options.
While lowering the heating system when out for few hours or during the night are not common energy habits, more attention is paid to the use of lights, shower water, dishwasher, and also clothes dryer. The heat-storing fireplace is the most common energy efficiency investment made, followed by the replacement of the group lighting system with led lights.
Logistic regression allows us to trace a profile with specific characteristics of Finnish households in respect to energy literacy. Main findings can be summarized as follows. Despite energy-related issues can be regarded a component of personal finance decisions, no statistically significant positive correlation between high levels of energy literacy and financial literacy has been found. Women seem more likely to be energy literate than men. Additionally, energy literacy is driven by the number of occupants, the presence of elderly persons in the household, higher income levels, the variable capturing modern houses, and the direct involvement in the payment of the bill.
The direct effects of increasing levels of energy literacy and energy awareness to reduction of electricity consumption in Finland are still indeterminate and merit additional thoughts. However, a recent Swiss study (Blasch et al., 2017) provides some promising evidence for this possibility.

By providing more reliable and transparent information, behavioural issues leading to higher electricity consumption could be lessened. This is also supported by the high percentage of participants of the survey willing to receive more information on: how to save energy at home; their energy consumption compared with the energy consumption of similar households; their current energy consumption compared with past energy consumption; and the operating cost of all the electric appliances.
In this setting, an important part of the future energy policy agenda on behavioral and efficiency interventions is to give people a tangible sense of their energy consumption and helping them to make optimal investment choices. Even tough information is not sufficient to generate an increase in energy awareness and energy literacy, it is a necessary precondition for action.

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