

Newsletter
September 2019



Psychological, social and
financial barriers to energy
efficiency





The PENNY project

What is our aim?

The primary goal of the project PENNY is to understand consumer behaviour in the domain of energy efficiency. The project aims to provide an empirical and numerical assessment of the psychological, social, economic and financial factors that influence energy efficiency in the residential and industry sectors.

Past events

- On the 6th of June 2019 we organised the final conference of PENNY in Brussels together with the other EU Horizon 2020 projects CONSEED and COBHAM.

PENNY highlights

The PENNY project has come to an end. We hereby present you some highlights of the findings from the project team. For more information you can find the report on the [PENNY website](#).

Design of incentives

We tested the effectiveness of incentives to promote sustainable energy behaviours in three studies conducted in Italy, the Netherlands, and Germany.

In Germany, we tested whether a goal setting intervention is scalable and can thereby promote sustainable energy behaviour at large. The results show that there is a low demand for technologies that can help people to save energy. Our findings suggest that organizations and governments should focus on incentivising people to set these goals, as studies have shown that goal setting interventions can effectively promote sustainable energy behaviour.

We also tested whether people are likely to shift their energy use in time. The findings from our study in the Netherlands show that people are willing to shift their energy consumption of some energy-consuming durables over time. This is especially true for home appliances, such as dishwashers, washing machines and dryers, and electric vehicles. Furthermore, we tested which factors most strongly influence the shifting of energy consumption in time using a financial incentive. Interestingly, our findings suggest that financial incentives are not likely to influence people's energy consumption much, while the willingness to shift energy consumption increases with the perception of other people shifting their consumption, and the potential to shift energy consumption. These findings suggest that financial incentives may not be the most effective strategy to promote a shift in energy consumption, and that smart appliances, automatically turning on at times when renewable energy is available, may help people to shift their energy use in time.

Finally, we tested the effectiveness of providing information about the energy consumption of similar neighbours on own energy use in a study conducted in Italy. The results suggest that the effectiveness of social information programs differs for different types of customers. Specifically, the dimension of heterogeneity that we considered are low versus high baseline energy consumption and low versus high environmental values. We found that when baseline consumption is low, it is hard to further reduce it, no matter if the person receiving the information holds high or low environmental values. However, when pre-consumption is high, high environmental values boost the effectiveness of peer comparison.

Moreover, enhancing social information by making environmental self-identity more salient boosts the social information impact, but only among individuals who acted pro-environmentally in the past. Our findings suggest that policy makers aiming to promote sustainable energy behaviour should direct information on the energy behaviour of others towards those who strongly care about the environment, and those who currently do not engage in sustainable energy behaviour.



Status-quo bias in energy-efficient investments

Another study across Switzerland, the Netherlands and Italy investigated the extent to which individuals' natural tendency to remain in their current situation (status-quo bias) keeps them from investing in more energy efficient home appliances. The study started from the assumption that status-quo bias is a behavioural bias that may increase the energy consumption of a household through at least three channels:

- (1) by making consumers keep their energy-using durables as long as possible, until wear out forces them to replace their equipment
- (2) by making consumers choose new energy-using durables that resemble the existent ones that need replacement, and
- (3) by making consumers overuse appliances in an attempt to mentally amortize the initial investment cost.

We empirically investigated whether being status-quo biased plays a role in individuals' energy-related decision making. Using data from households in Switzerland, the Netherlands and Italy, we found that individuals that have a tendency towards remaining in the status quo tend to keep the home appliances substantially longer and to use appliances such as the dishwasher, the washing machine and tumble dryer more often. This tendency is also reflected in the total electricity consumption of the households, which we found to be about 6 percent higher for households in which the head of household is status-quo biased, compared to the households with a non-biased household head.

Our results show that the status-quo bias is an important determinant of the level of energy consumption of European households. As the status-quo bias expresses a preference to stay with the current situation, it is more difficult to address with policy measures than other behavioural biases. It might constitute a severe limit to policy-makers' opportunities to reaching the energy efficiency goals of the European Union. Nonetheless, our findings prompt policy makers to design policy instruments taking this individuals' tendency into account, such as monetary premiums (scrapping incentives) for replacing old appliance by a newer and more efficient appliance, or social-comparison feedback through apps or in-home displays that explicitly address the use of home appliances. The latter could make individuals with a tendency to over-consume energy services aware that their use of appliances exceeds the average use of appliances in comparable households.

Energy literacy and consumers' purchase of energy-efficient appliances

Although some investments in energy efficient electrical appliances, heating systems or energy efficient home renovations may ensure net monetary savings over their lifetime, households often fail to make these investments.

We conduct two experiments to test whether and to what extent limited information of individuals about the energy costs of using durables is an explanation for the underinvestment in efficient technologies. We study the impact of providing such information on real appliance purchase decisions.

In an experiment conducted in Switzerland in collaboration with two local utilities, we provide some households with individualised information on how much they can save in monetary terms by adopting new energy efficient home appliances that are comparable to the appliances that they have at home. The data on the existing home appliances were collected during individual home visits. We provide the information on the potential of monetary savings with a letter sent at the households' residence. Our results show that the informational intervention induces households to purchase new home appliances that consume substantially less electricity than those purchased by households that did not receive such information.

A second experiment has been conducted in collaboration with a large Italian online retailer. Some perspective buyers of a new fridge were provided with information on either the yearly or the lifetime energy cost of the new appliances. We find that making appliances' energy costs more salient leads to a shift in purchases from more to less efficient products. This effect is concentrated among clients who received information on appliances' lifetime energy cost. Information treatments also increase the number of product pages viewed and the time spent on them by customers, a result driven by products in lower energy classes.

The results of these two experiments inform about the importance of providing information also in terms of monetary savings from adopting energy efficient durables, rather than only their energy costs. This suggests that the way

in which the information is presented is crucial for its effectiveness in affecting consumers' purchase decisions. Moreover, the results of this study suggest that, while providing information about the energy costs of using durables may result in a higher ability of consumers to take optimal decisions from a private perspective, it might also induce consumers to make suboptimal choices from a social perspective, depending on the consumers' characteristics and the features of the institutional contexts in which these decisions are taken.





Drivers of efficiency gaps in manufacturing firms

We assess the level and drivers of energy efficiency investments using production census data for German manufacturing firms.

We show that there exists a significant potential for cost-efficient investments, that is larger for small-and-medium enterprises. Our results also highlight the importance of competitor behaviour and potential peer-group effects in explaining investment behaviour of larger firms. Moreover, we show that the payback periods of energy efficient investments range between 2 and 10 years for large firms, while they are much larger for smaller companies.

Overall, our research indicates that energy efficiency gaps may be more severe among smaller companies and that future policies could facilitate the financing of energy efficiency investments.

Efficiency improvements in the household and industry sector

Typical demand models assume that consumers are perfectly optimising agents that possess a combination of perfect information about product attributes and unbounded computational capacity that they use when taking energy-related decisions. However, experimental evidence in both the psychology and economics raise serious questions about the validity of these assumptions.

We enhanced the models by explicitly taking into account behavioural shortcomings in energy service consumption and residential energy use. First, we extended the computable general equilibrium (CGE) model such that we are able to look at the consumption of energy services of households that use electricity. Furthermore, we can analyse the impact of misperception of electricity prices on the derived demand for electricity and energy services. Second, we improved the representation of the building sector energy demand modelling.

Our results show that price misperception results in biased demands for certain goods and aggregates of goods by the consumers. The economy adjusts its output levels for these goods in order to maintain an equilibrium.

The improved model that we develop allows to take into account different behavioural shortcomings of households and see the wider impact of these biases on the derived demand for electricity, energy intensity and the associated impacts on production sectors in Europe.



Scenarios and analysis of policy interactions in the EU

We further improve the empirical grounding of the behavioural features in the existing global models used to analyse energy demand exploiting household survey data. The empirical results show that income is the most pressing factor that affects energy demand, the dwelling efficiency, and investments. Other socio-demographic characteristics also have an effect – household size and to a certain extent age. Education does not have that important of a role, neither do environmental preferences, which are also not associated with being practical at saving energy or energy-literate. Moreover, our simulation analysis shows that the complexity of choice dynamics is difficult to capture in distinct groups.

We also address the role of investment in energy efficient infrastructures. To this end, we further enhance a global buildings model to include the representation of the development over time of building vintages affecting potential of building envelope energy efficiency enhancements. We show that at the global level, heating energy demand will slightly increase, while cooling will grow more substantially. In terms of final energy, increasing levels of equipment efficiency will eventually make the overall heating demand decline, while a huge growth in cooling demand will happen in any case.

Finally, we extend the analysis of households' energy service consumption by simulating electricity price misperceptions and behavioural inefficiencies. Our results show that misperceived electricity prices change the way energy services are consumed but do not affect its overall consumption level by much. The effect depends on the direction of the misperception: while providing information about energy will increase prices energy efficiency when households perceived the electricity price to be lower than it actually is, providing actual cost information can turn out to be counterproductive in terms of energy demand reductions and CO₂ emissions when consumers overvalue electricity prices. Moreover, improving the knowledge on how to save energy using appliances more efficiently has a greater effect in the short-run.

We conclude that the impact of potential policies aimed at increasing households' energy efficiency will crucially depend on whether households actually observe prices in an unbiased fashion.



Role of energy efficiency in strengthening the Paris climate agreement

The simulation of future scenarios is important to understand which factors might help to reach the goals of the Paris climate agreement. We first provide an empirical assessment of the drivers of energy intensity, and use these to project energy intensity in the future. We show the importance of energy efficiency in achieving the Paris goals and identify the requirements in investment in R&D to fill the gaps in energy efficiency and

Finally, we analyse the impact of energy efficiency improvements of electric appliances in the residential sector. We focus on residential electricity demand and investigate the associated impact on production and CO₂ emissions in Europe. We find that energy efficiency improvements in the consumption of electric energy services reduce electricity consumption, though rebound effects lead to an increase of energy services. The results show that electricity can play a role in strengthening the Paris climate agreement.

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The PENNY project "Psychological, social and financial barriers to energy efficiency" has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723791. This newsletter reflects only the view of the PENNY Consortium and nor the European Commission, nor the Executive Agency for Small and Medium-sized Enterprises (EASME) are responsible for any use that may be made of the information it contains.