SEEDS
Sustainability Environmental Economics and Dynamics Studies

Working Paper Series

Green energy transition in Europe: Importance and behaviour of private households

by

Jens Horbach

02/2024

SEEDS is an interuniversity research centre. It develops research and higher education projects in the fields of ecological and environmental economics, with a special focus on the role of policy and innovation. Main fields of action are environmental policy, economics of innovation, energy economics and policy, economic evaluation by stated preference techniques, waste management and policy, climate change and development.

The SEEDS Working Paper Series are indexed in RePEc and Google Scholar.
Papers can be downloaded free of charge from the following websites:
http://www.sustainability-seeds.org/.

Enquiries:info@sustainability-seeds.org

SEEDS Working Paper 02/2024
July 2024
By Jens Horbach

Green energy transition in Europe: Importance and behaviour of private households

Jens Horbach

Abstract

The success of a green energy transition is highly dependent on the household sector as one of the most important energy users. Private heating, electricity consumption or private transport are important key levers to reduce households´ energy use and its impacts on climate change. The paper analyses the determinants of energy related attitudes and activities of households based on econometric estimations of European and German survey data. The results show that personal factors such as female gender and a high income are positively correlated to green energy behaviour. Highly qualified persons are more likely to realize green energy related measures. People having difficulties to pay their bills are significantly more likely to use energy friendly public transport, but they have a lower willingness to pay for energy saving measures compared to richer groups.

JEL-Classification: C25, D12, D91, Q41, Q54

Key words: Green energy behaviour, climate change, European data, multivariate probit model

Disclaimer

The present paper partially uses the Research Note of "Horbach, J. (2022): Determinants of the greening of households in Europe, Research Note on behalf of the European Commission, Brussels, DOI: 10.2767/31379". Compared with the Research Note, the present shortened paper uses completely new data sources, and the focus is more on energy related behaviour instead of the analysis of general green household behaviour.

Correspondence: Prof. Dr. Jens Horbach, Technical University of Applied Sciences Augsburg, School of Business, Friedberger Straße 4, D-86161 Augsburg, Email: jens.horbach@tha.de

1. Introduction

The success of climate change measures depends heavily on changes of household behaviour, which is one of the most important sources of carbon dioxide emissions. In the EU in 2021, the household share of final energy consumption amounted to 28% (Eurostat 2024). Household heating, electricity consumption and private transport are important levers in reducing households' impacts on the environment and energy use. The environmental behaviour of households is strongly related to factors such as personal characteristics of household members (e. g. gender, education level), their social and political environment, or their income and employment situation. A crucial point is the assessment of the role of income for energy related behaviour: A high income allows more investment in energy saving measures but also leads to more consumption (e. g. bigger cars, more electronic devices etc.). On the other side, poor people might use more public transport modes and consume less energy. Therefore, it is interesting to make the difference between cost-intensive and costless energy related measures.

This paper examines the green energy related behaviour of households at the European level. It comprises a summary of the respective literature, together with econometric analyses of European-wide and German household data. The analysis uses survey indicators for the description of households´ energy related behaviour. These indicators represent respondents' subjective perceptions of their willingness to pay for green energy, as well as revealed preferences, such as measures to increase energy efficiency or the use of green travel modes. Among others, the determinants of green household behaviour comprise the housing situation, the type of region (town or countryside) and the social milieu. Household characteristics such as age, number of household members, and working and living conditions are also considered.

The literature on individuals' and households' green behaviour is extensive. However, there is a lack of analyses at the European level, and joint analyses of different indicators of energy related behaviour of households – this paper aims to close these gaps. Its main focus lies on an econometric analysis of the determinants of energy related behaviour using different indicators. The analysis is based on two recent European data sources and German data. One data source is the Eurobarometer 97.4 from 2022 allowing the analysis of three different indicators for the energy related behaviour of households. Another data source is the Eurobarometer 92.4 of 2020, which captures European citizens' attitudes towards the environment. It allows a detailed and comparative analysis of six different energy related activities in 28 countries. The green SOEP (Socio-Economic Panel) dates from 2022 and contains the answers of 11,375 German households. It contains questions on the willingness to pay an additional tax for climate protection or

higher taxes on gasoline and diesel and on a speed limit on highways as an interesting example of a costless energy saving indicator.

The econometric analysis of the determinants of green household behaviour sheds light on factors such as the role of income, education, working conditions and regional social environment. A broad range of control variables is also considered. A deeper understanding of these factors and determinants is necessary for the design and fine-tuning of household-oriented environmental and energy related measures. For example, the planning and shaping of subsidies for renewable energy in households might require knowledge of household characteristics, such as income or education level.

The paper is structured as follows: Section 2 draws an empirical picture of the importance of households for the energy transition in the EU. Section 3 describes the driving factors of energy related behaviour of households from a theoretical perspective. Section 4 contains a summary of main empirical results from the respective literature. Section 5 presents econometric analyses of the determinants of energy related behaviour of households. Finally, Section 6 summarizes the main results of the econometric estimations and discusses some implications for European policy measures.

2. Importance of households for the energy transition in the EU

The overall share of households (residential sector) on final energy consumption amounted to 28% in 2021 (Eurostat 2024) (Table 1). The relevance of households for the overall energy use is even higher as they also take part in transport activities where a proper separation of households and other sectors such as the industry is not possible.

Table 1: Sector shares of final energy consumption in the EU

Sectors	**Share on final energy consumption, 2021 in %**
Households (residential sector)	27.9
Transport	29.2
Industry	25.6
Services	13.8
Other sectors	3.6

Source: Eurostat (2024).

Space heating shows the highest share of the residential sector on final energy consumption (Table 2) underlining the high importance of the introduction of more climate friendly heating systems such as heat pumps.

Table 2: Final energy consumption in the residential sector in the EU

Use category	Share on final energy consumption 2021, in %
Space heating	64.4
Water heating	14.5
Lighting and appliances	13.6
Cooking	6.0
Space cooling	0.5
Other	1.1

Source: Eurostat (2024).

Table 3: Per capita consumption of the household sector by countries

Countries	Energy use including electricity	Space heating	Cooking	Water heating	Electricity in kwh per capita (2022)
	Gigajoule per capita (2021)				
Belgium	31.08	23.13	0.50	3.38	1404.3
Bulgaria	15.43	8.20	1.30	2.68	1835.9
Czechia	31.49	21.87	2.06	4.79	1492.0
Denmark	32.39	19.47	0.57	7.09	1630.2
Germany	29.55	19.49	1.89	4.93	1613.1
Estonia	30.32	21.55	1.49	3.52	1476.8
Ireland	25.14	15.15	0.56	4.97	1627.2
Greece	16.70	8.89	1.51	2.34	1581.8
Spain	13.02	5.16	1.01	2.54	1549.8
France	26.04	17.90	1.26	2.67	2289.2
Croatia	26.32	18.10	1.66	2.56	1669.6
Italy	22.72	15.20	1.46	2.59	1095.0
Cyprus	16.13	5.63	1.31	3.79	1930.8
Latvia	26.57	17.13	1.87	5.10	876.4
Lithuania	24.27	16.48	1.46	2.85	1170.2
Luxembourg	31.22	25.08	1.06	2.56	1489.2
Hungary	27.75	20.19	1.34	3.30	1274.4
Malta	9.57	2.15	1.08	2.17	1937.2
Netherlands	24.25	15.97	0.47	3.90	1280.0
Austria	35.87	24.94	0.93	5.30	2193.2
Poland	25.02	16.37	2.08	4.27	811.1
Portugal	12.23	3.76	3.82	2.06	1344.3
Romania	19.15	11.94	1.89	2.71	708.4
Slovenia	23.03	14.78	1.06	3.43	1769.1
Slovakia	22.79	17.00	1.01	2.67	1081.1
Finland	45.11	30.12	0.56	6.59	4104.4
Sweden	31.56	17.01	0.51	4.36	3887.7
Norway	36.24	24.29	0.55	4.61	6741.8
Europe	24.72	15.93	1.45	3.56	1650.2

Source: Eurostat (2024).

Not surprisingly, the differences in energy use between the European countries are considerable because of different mean temperatures, opportunities to produce electricity by renewables and

economic development (Table 3). A higher average temperature in the countries leads to a lower energy use of households (Spain, Portugal) but also the economic development seems to play a crucial role (e.g. Bulgaria and Romania). In fact, "cold" and rich countries show the highest energy use per capita (e. g. Finland, Norway, Austria, Luxembourg).

Table 4: Growth rates of households´energy consumption by different fields

Countries	Energy use including electricity	Space heating	Cooking	Water heating	Electricity in kwh
	Growth rates from 2017 to 2021				
Belgium	5.29	7.05	2.18	-3.09	3.94
Bulgaria	3.62	1.83	4.33	4.53	7.32
Czechia	9.30	9.95	14.33	2.43	13.47
Denmark	-0.61	-4.45	-4.69	2.56	10.18
Germany	3.54	1.51	8.48	8.49	0.44
Estonia	2.38	0.84	-0.41	1.27	14.90
Ireland	7.31	6.74	8.67	6.40	10.91
Greece	-3.74	-9.06	77.53	0.27	-9.73
Spain	2.44	1.22	1.71	5.44	2.46
France	2.65	2.97	-3.29	-0.22	5.37
Croatia	2.15	2.34	-2.24	-0.67	5.25
Italy	-2.65	-3.67	-1.00	-5.93	2.38
Cyprus	-	-	-	0.00	9.19
Latvia	0.65	-1.09	-0.94	4.02	8.42
Lithuania	11.98	8.22	3.17	42.51	20.18
Luxembourg	-10.35	-9.72	10.71	7.56	-2.98
Hungary	2.03	0.32	9.34	1.44	10.90
Malta	30.38	39.58	0.13	17.60	30.21
Netherlands	5.86	8.96	-4.41	1.38	3.02
Austria	10.28	8.68	12.65	15.70	18.48
Poland	10.37	9.18	14.76	16.24	4.83
Portugal	7.85	7.08	7.65	3.22	13.41
Romania	13.45	11.56	17.58	19.81	13.08
Slovenia	0.32	-1.55	19.56	-3.80	14.29
Slovakia	40.96	54.03	11.69	15.61	21.40
Finland	3.45	2.27	34.84	1.82	7.77
Sweden	2.91	0.37	15.56	3.63	2.37
Norway	1.85	2.87	-0.56	0.48	3.60
Europe	3.96	3.16	6.81	5.09	4.48

Source: Eurostat (2024).

Most of the European countries show high growth rates of energy use of their household sectors from 2017 to 2021 (Table 4). This is especially true for economically "catching up" countries such as Czechia, Slovakia or Lithuania. The correlation between economic development and energy use underlines the high necessity of the use of saving potentials of households´ energy consumption. A faster implementation of heat pumps might be a solution but because of high fixed investment costs the elasticities of a change to such an environmentally friendly way of heating are still low. Travel and transport activities also show energy saving potentials which might be achieved by speed limits, smaller cars, increase of the use of bicycles or public

transport. The substitution of energy saving electric and electronic products might also be an option but alle these measures depend on the preferences and the economic possibilities of household connected with the political framework in a country. Therefore, it is highly important to assess the drivers and barriers of such a sustainable household behaviour leading to less energy use.

3. Determinants and barriers of sustainable household behaviour

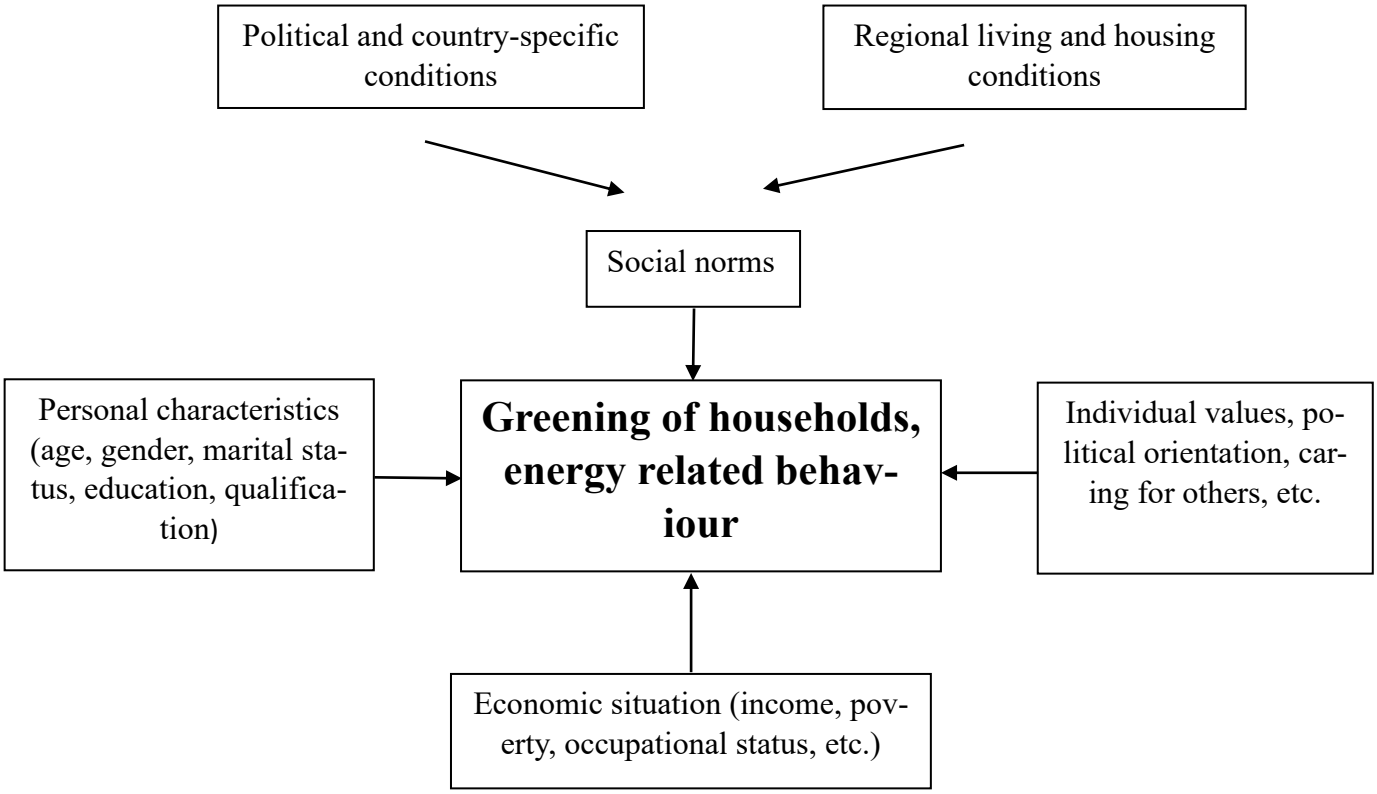
Green or pro-environmental behaviour describes a "… behaviour that consciously seeks to minimise the negative impact of one's actions on the natural and built world (e. g. minimise resource and energy consumption connected with a reduction of climate-damaging factors, use of non-toxic substances, reduce waste production)" (Kollmuss and Agyeman, 2002:240). Mere green attitudes and environmental awareness among individuals do not necessarily result in real activities to reduce households' environmental impacts. Kollmuss and Agyeman (2002) explain the reasons underpinning this discrepancy between attitude and behaviour: Attitudes can change quickly but there are barriers to changing habits. Social norms such as family or cultural traditions shape individual behaviour, but these norms are often persistent and slow to change. External barriers and sunk costs may also act as a barrier. E.g., it is expensive to replace an existing heating system with one that consumes less energy or uses renewable energy. On the other side, these barriers might also be low as there are also energy saving measures that are costless or even save money such as the reduction of speed on highways or the use of smaller cars consuming less energy.

Up to now, there is no overall theory explaining green behaviour but the extensive literature on green (consumption) behaviour contains many approaches that can be used to draw a comprehensive picture. Figure 1 summarises the main determinants of green attitudes and energy related behaviour that will be empirically tested in Section 5.

The theory of planned behaviour (Ajzen, 1991; Bamberg and Möser, 2007) assumes rational behaviour of individuals, i. e. that people always evaluate the consequences of their behaviour. This theory is closely related to the theory of social norms and customs (Akerlof, 1980; Videras et al., 2012; Keizer and Schultz, 2018; Vögele et al., 2021). Rational individuals comply with social norms because they fear punishment or social exclusion, feel guilty about disobedience, or, conversely, expect rewards for following social norms. Overall, individuals anticipate and assess positive and negative consequences of different behavioural options and decide their

actions accordingly (Bamberg and Möser, 2007). Social norms and customs depend on regionally relevant political framework conditions, but also on the living and housing environment (see Figure 1).

Figure 1: Determinants of green household behaviour



Source: Horbach (2022), adapted version.

The concept of value–attitude–behaviour does not rely on rational behaviour, but, rather, stresses the importance of functional, social, or emotional values to consumer behaviour (Zhang and Dong, 2020). In addition to a rational calculation of the social consequences of green behaviour, individual values such as political orientation, environmental consciousness, or willingness to care for others, might trigger environmentally advantageous household behaviour.

Many empirical studies on environmentally relevant behaviour suggest that other factors such as personal characteristics and economic situation should also be considered (e. g. Ziegler, 2020; Vögele et al., 2021; Lange et al., 2017; Kahn, 2007).

Several studies show that women have a higher environmental consciousness than men and are more likely to buy green products (e. g. Liobikiene et al., 2016). Economic situation and occupational status are also crucial determinants of environmental behaviour - poor and/or unemployed people may be less likely to pay a premium for green energy. This raises the question of

whether a low income similarly impacts ‘costless’ green activities, such as the separation of waste, the use of bicycles instead of cars or the support of a speed limit on motorways. Low-income households might be even more climate friendly as they cannot afford a car, or they consume less compared with rich households.

Professional activity might be positively or negatively correlated to green behaviour because individuals working in environmentally relevant professions might be more open to green energy. The reverse may also be true - working in polluting or energy-intensive industries might lead to lower environmental awareness, as job opportunities could be negatively affected by green measures (e. g. workers in the lignite industry are perhaps less well-disposed towards climate protection measures such as the extension of renewable energy). Education and qualification level of individuals may also be an important factor, with higher qualified people perhaps more likely to be informed on the complex effects of climate change or other environmental problems, triggering green behaviour.

Based on this theoretical background, the empirical analysis in Section 5 will test the following hypotheses:

H1: Personal characteristics, such as gender or education influence green energy related behaviour.

H2: Determinants of energy related behaviour differ between costless and cost-intensive green activities, with economic situation relevant primarily for cost-intensive activities.

H3: The living conditions are highly relevant for the energy related behaviour of households.

4. Literature overview on energy related household behaviour

There is extensive literature on energy related household behaviour. In a Swedish study of 4,000 households from 2004 to 2007, the results of ordered logistic regression models show that socioeconomic characteristics such as age, housing type and income were positively correlated with savings on heating and hot water usage (Martinsson et al., 2011). The authors emphasise the important role of general environmental attitudes in energy-saving behaviour, but they do not discuss the possible endogeneity of this variable. Ramos et al. (2015) confirm that finding, using data of a national representative survey of Spanish households in 2008. The results of a discrete-choice model show that pro-environmental households are more likely to take energy efficiency measures. Households with older members seem less likely to invest in energy

efficiency and show fewer eco-friendly habits. Similar results are obtained by Trotta (2018) for Great Britain. Household (e. g. age, income), dwelling characteristics and environmental attitudes are highly relevant for energy-saving behaviours and investments. For a sample of Italian households in the late 90s, Fiorillo and Sapio (2019) find that monetary drivers such as income and perceived energy costs are more crucial for energy-saving behaviour. Contrary to the previous findings, their results even show a negative correlation of environmental attitudes. For a sample of Irish households, Aravena et al. (2016) also find that energy efficiency measures are mainly driven by monetary factors, such as gains in energy savings and private cost reductions. This argument is confirmed by Cayla et al. (2011) showing that income clearly constrains equipment purchases of French households.

Schleich (2019) analyses the role of income in the adoption of energy efficient technologies for 15,000 households in eight European Union (EU) countries (France, Germany, Italy, Poland, Romania, Spain, Sweden, and the United Kingdom (UK)). The author differentiates between high-cost, medium-cost, and low-cost energy efficient technologies. Poor homeowners show a lower probability of adopting high-cost energy efficient technologies. This is particularly true for Poland and Romania, which have relatively low average incomes but a high share of owner-occupiers. The effect of income on energy efficiency is also analysed by Pommeranz and Steininger (2021), using the German rental apartment dataset from 2007 to 2019. The results of hedonic regression models show that rents for energy-inefficient apartments are negatively correlated with high purchasing power and high green awareness. The rent-decreasing effect of purchasing seems to be higher than that of green awareness, but the latter effect became more important from 2017 to 2019.

Welsch (2021) uses data from the European Social Surveys. He shows that individual moral foundations such as care, fairness, or liberty are correlated to climate-friendly behavior.

Based on consumer expenditure data of 26 EU countries for 2010, linked with greenhouse gas (GHG) intensities, Ivanova and Wood (2020) demonstrate the unequal distribution of household carbon footprints. “The top 10% of the population with the highest carbon footprints per capita account for 27% of the EU carbon footprint, a higher contribution to that of the bottom 50% of the population” (Ivanova and Wood, 2020:1). Lévay et al. (2021) use consumption data for Belgian households, combined with an environmentally extended input-output model including GHG emissions. They find that income and household size seem to be the most important determinants of consumption-related emissions. Interestingly, the emission intensity of the

consumption of poorer households is disproportionally high because they spend a higher share on emission-intensive products.

Frondel and Kussel (2019) analyse consumers' electricity tariff choices, using Germany's Residential Energy Consumption Survey. The results of their instrumental variable endogenous switching regression model show that information about electricity prices is a significant determinant of household behaviour. Households that are well informed about electricity prices are sensitive to price changes, whereas uninformed households do not change their behaviour. Their econometric model allows to correct for the possible endogeneity of household behaviour. A higher transparency of (green) electricity tariffs seems to have considerable impact on green household behaviour. Sommer (2018) uses the same database to show that richer and better educated individuals are more likely to adopt green electricity. His analysis relies on an endogenous dummy treatment effects model to control for self-selection into green tariffs. Ziegler (2020) confirms the importance of transparency of electricity contracts for households' green behaviour. His analysis of a computer-based survey of more than 3,700 citizens in Germany shows that patience and trust are positively correlated with the choice of green electricity contracts. The results of these analyses are confirmed by Ameli and Brandt (2014) analysing the barriers of households´ investment in energy efficiency and renewable energy. Costs for fossil energy might be too low because negative external effects are not fully internalized. Furthermore, capital constraints for low-income households reduce the implementation of energy efficiency measures. Principal agent problems might arise because, normally, the tenant benefits from energy saving measures so that the owner of a building has less incentives to invest. Information problems in connection with time inconsistent consumer behaviour might lead to the problem that household overestimate the present costs of energy related measures compared to future energy savings.

Kim and Lee (2023) stress the role and importance of social innovation activities for the energy transition. These activities can be defined "… as the entire interaction process between the pragmatic actions of agents and the participation of citizens" (Kim and Lee 2023:1). For South Korea, the authors find out that social innovation significantly leads to changes in the behaviors of citizens.

Green policy orientation and household income play an important role in the use of green electricity. Groh and Ziegler (2020) analyse the determinants of a reduction in electricity consumption in 3,700 German households. Whereas norms and environmental awareness only seem to

play a minor role, the estimation results demonstrate the high importance of dwelling and socio-demographic characteristics.

Mezger et al. (2020) examine the switching behaviour of private consumers towards green electricity, using a sample of 787 German electricity consumers. The results of their structural equation model confirm those of Ziegler (2020), that trust promotes the choice of green electricity. Reputation and perceived environmental impact were also relevant variables in this context. Based on a discrete choice experiment, Petrovich et al. (2021) analyses residential solar investment activities in Switzerland. Here, policy uncertainty seems to be a higher barrier to investing in solar electricity compared to inherent market risks. Colasante et al. (2021) stress the importance of economic incentives for the installation of photovoltaic systems, based on a sample of Italian households.

Sardianou and Genoudi (2013) explore the factors behind the willingness of consumers to adopt renewable energies. The authors find out that a high education and income is positively correlated to the residential adoption of renewable energy sources whereas the gender and marital status does not play a significant role. Chen et al. (2024) explore the role of women for an energy transition in China. Their findings suggest "…that households where women have greater bargaining power are more likely to adopt cleaner energy options such as gas or electricity" (Chen et al. 2024:1).

Antunes et al. (2023) show considerable differences across 26 European countries in the affordability of energy. The authors find out that the energy and climate crisis disproportionately affects poor and vulnerable households in Europe. Jakucionyte-Skodiene and Liobikiene (2023) stress the role of climate change policy for changes in energy consumption and CO_2 emissions for Lithuanian households.

Kola and Leki (2024) analyse the effects of the energy price shock in 2022 on the energy behaviour of the residential sector for a representative sample of 1200 Polish households. Not surprisingly, changes in the energy behaviour predominantly included solutions such as lowering the temperature that did not lead to additional expenses. For Belgian households, Peersman and Wauters (2024) explore the effects of energy price shocks on energy and non-energy related consumption. Low-income households and those planning major home renovations show a disproportionally high price elasticity of energy demand. The MPC (Marginal Propensity to Consume) describing the effect of an energy bill caused change in disposable income on consumption depends on variables such as income, saving buffer, financial uncertainty or gender.

From a policy perspective, Andor et al. (2020) show that social comparison-based home energy reports are an effective measure to reduce the energy consumption of households, confirming previous US findings (Allcott and Rogers, 2014, see also Andor et al. 2018). For Germany, however, the effect sizes are considerably lower than those of the US.

5. Empirical analysis of energy related behaviour of households

5.1 Data bases and descriptive statistics

The database of Eurobarometer 92.4 (December 2020) allows the analysis of energy related and climate change behaviour of households by various fields. It also contains revealed preference indicators, such as the use of renewable energy for heating, insulation of houses and flats, waste, recycling, and tourism. It covers 28 European countries, with 27,498 observations in the sample. The survey was carried out by Kantar Public Brussels, at the request of the European Commission in 2019 (European Commission, 2019).

The Eurobarometer 97.4 has been carried out from May to June 2022 and covers 26,390 households in 27 European countries. Besides questions on energy efficiency measures, the survey also contains information on different travel modes and the willingness to pay for energy to promote the green transition (European Commission 2022).

The green SOEP (Socio Economic Panel) dates from 2022 and contains the answers of 11,375 German households. Besides questions on the willingness to pay an additional tax for climate protection or higher taxes on gasoline and diesel there is also a question on the main sources of information (newspapers, internet) of the households. Furthermore, a question on a "speed limit on highways" as an interesting example of a costless indicator is available (Frondel et al. 2023).

5.2 Econometric analyses

Estimation strategy

Most of the dependent variables capturing the energy related behaviour of households are binary, thus probit models can be used for estimation. For example, concerning environmentally friendly ways heating, a household has to decide whether to use a green alternative (e. g. a heat pump) (Y=1) or a non-green one (e. g. a heating system based on fossil fuels) (Y=0). Following the theoretical considerations, different factors such as gender, income, and education level, summarised by a vector **x**, may influence this decision. Therefore, an estimation of the

probability *Prob (Y = 1| **x**) = F (**x**, β)* is needed. The β parameters reflect the impact of changes in x on this probability (Greene, 2008:772). Average marginal effects for all covariates are calculated, allowing comparisons of the different climate change activities. The analysis of different energy related activities may require an estimation of a multivariate probit model instead of simple probit models, as the different outcomes might be correlated (see Section 5.2.2). The multivariate probit model simultaneously estimates the determinants of different activities, including a common set of covariates.

5.2.1 Eurobarometer 97.4 (2022)

The Eurobarometer 97.4 from 2022 allows the analysis of three different indicators for the energy related behaviour of households (Table 5). The energy efficiency indicator shows the related measures of households to reduce energy consumption in their home such as the installation of a new heating system. The predominantly used travel mode is also a revealed preference indicator whereas the willingness to pay shows the perceived potential behaviour to financially support energy related measures.

Table 5: Indicators of energy-related household behaviour

Energy-related indicators	In %
Made home more energy efficient in last five years (*energy efficiency*)	40.03
Most often used travel mode: Train, public transport, privately owned bike or scooter, shared bike, scooter or moped, walking (*travel mode*)	49.09
Willing to pay more for energy: 10%, 20%, 30% or above 30% more (*WTP*)	34.39

Source: European Commission 2022.

The results of probit models (Table 6) show that younger people (*age*) and especially *students* show a higher WTP for energy to speed up the green transition, whereas older people are more likely to realize energy related measures. These results are not in contradiction because older persons are more likely to own houses or flats to realize these measures. *Women* show a lower willingness to pay for energy and they are less likely to implement energy saving measures, but they are more likely to use environmentally friendly travel modes. There is also a clear relationship between education level and energy related behaviour. Highly qualified persons (*highqual*) show a higher WTP and they are more likely to realize energy related measures. *Houseowners* and *employed* people are more likely to introduce energy efficiency measures, but their support of environmentally friendly travel modes is lower. This result is plausible because, on average, these groups are disproportionally rich, and their houses are predominantly located in regions showing a lower availability of public transport. On the other side, not surprisingly, a

better availability of public transport (*availpubtransport*) is very important for the choice of these environmentally friendly modes of transport. Living at the *countryside* is thus negatively correlated to the use of environmentally friendly transport probably also due to a worse availability of public transport.

Table 6: Determinants of energy-related behaviour of European households

Correlates	Energy Efficiency	Travel Mode	WTP
Age	0.001**	0.000	-0.001**
	(0.000)	(0.000)	(0.000)
Householdsize	0.021**	-0.036**	-0.001
	(0.003)	(0.003)	(0.003)
Woman	-0.022**	0.113**	-0.020**
	(0.006)	(0.006)	(0.006)
Highqual	0.031**	0.006	0.120**
	(0.007)	(0.007)	(0.007)
Houseowner	0.129**	-0.093**	0.018**
	(0.007)	(0.007)	(0.007)
Employed	0.031**	-0.189**	0.079**
	(0.010)	(0.011)	(0.011)
Student	-0.067**	0.227**	0.087**
	(0.015)	(0.015)	(0.017)
Retired	0.021	0.002	0.053**
	(0.013)	(0.012)	(0.013)
Poverty	-0.069**	0.040**	-0.108**
	(0.006)	(0.006)	(0.006)
Availpubtransport	-	0.146**	-
		(0.006)	
Countryside	0.009	-0.089**	-0.066**
	(0.006)	(0.006)	(0.006)
Internet	0.083**	-0.118**	0.033**
	(0.008)	(0.008)	(0.008)
Energsubsidies	0.411**	-0.021*	0.136**
	(0.009)	(0.009)	(0.009)
Climateaware	0.068**	0.041**	0.130**
	(0.006)	(0.006)	(0.006)
Observations	26,387	26,387	26,387
Wald Chi^2	3915^{**} (40)	6870^{**} (42)	3356^{**} (40)
Pseudo R^2	0.13	0.30	0.11

Probit models. Average marginal effects are reported. Robust standard errors in parentheses, ** p<0.01, * p<0.05, + p<0.1.

Source: European Commission 2022, own estimations.

Furthermore, the willingness to pay for energy is lower at the *countryside*. People having difficulties to pay their bills (*poverty*) are significantly more likely to use public transport, but they have a lower WTP compared to richer groups. The awareness of individuals for climate change problems (*climateaware*) is positively correlated to all three indicators WTP, energy efficiency measures and environmentally friendly transport. Not surprisingly, energy related subsidies

support energy efficiency measures and they also increase the willingness to pay for energy (*WTP*).

5.2.2 Estimation results based on Eurobarometer 92.4 (2020): European citizens' attitudes towards the environment

Eurobarometer 92.4 (European Commission, 2019) allows an analysis of different energy and climate change related activities for 28 European countries (see Table 7).

Table 7: Different energy and climate change related activities

Activities during the past six months	In %
1. Chosen a more environmentally-friendly way of travelling (walk, bicycle, public transport, electric car),	27.8
2. Cut down your energy consumption (e. g. by turning down air conditioning or heating, not leaving appliances on stand-by, buying energy-efficient appliances),	36.1
3. Bought local products,	43.6
4. Used your car less by avoiding unnecessary trips, working from home (teleworking), etc.,	18.8
5. Bought second-hand products (e. g. clothes or electronics) instead of new ones,	20.7
6. Repaired a product instead of replacing it.	30.9

Source: European Commission, 2019, own calculations.

In a first step, one indicator for energy and climate change related activities is used. This indicator gets the value one if at least one of the six activities in Table 7 are realized. In Table 8, probit models for this indicator are estimated for different country groups.

The econometric results for the model capturing all countries (see Table 8) show that women are more likely to engage in energy related green activities, confirming the findings of the literature review.

Interestingly, this result does not hold for Croatia, Cyprus, Greece and Malta and the Eastern European countries. The highest marginal effect can be observed for the Northern and the Baltic countries (4.3% and 3.6%). Living in a *partnership* also promotes green activities. The result for *partnership* is especially relevant for Croatia, Cyprus, Greece and Malta, but is not significant for the Northern, Eastern European and the Baltic countries.

Except the Baltic and the Balkan countries, a high qualification (*highqual*) is positively correlated with climate change activities.

Table 8: Results for climate change related activities

Correlates	All countries	EU core	Eastern European countries	Baltic countries	HR, CY, GR, MT	DK, FI, SE
Age	0.000	0.000	0.001	0.000	-0.000	-0.002**
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)
Female	0.022**	0.032**	-0.009	0.036*	0.010	0.043**
	(0.005)	(0.008)	(0.011)	(0.016)	(0.013)	(0.011)
Partner	0.027**	0.034**	-0.003	0.011	0.076**	0.013
	(0.006)	(0.009)	(0.014)	(0.018)	(0.016)	(0.016)
Householdsize	0.013*	0.015	0.041**	0.006	-0.010	0.004
	(0.006)	(0.009)	(0.013)	(0.018)	(0.014)	(0.017)
Highqual	0.049**	0.065**	0.059**	0.027	0.005	0.046**
	(0.006)	(0.009)	(0.014)	(0.016)	(0.016)	(0.013)
Diffbills	-0.018**	0.009	-0.002	-0.073**	-0.074**	-0.016
	(0.006)	(0.009)	(0.012)	(0.018)	(0.013)	(0.023)
Upphighclass	-0.069*	-0.005	0.016	-0.197	-0.416**	-0.036
	(0.032)	(0.042)	(0.072)	(0.125)	(0.115)	(0.059)
Workclass	-0.028**	-0.021*	-0.047**	-0.020	-0.052**	-0.001
	(0.006)	(0.009)	(0.014)	(0.017)	(0.015)	(0.015)
Housemanwife	0.009	0.012	-0.033	0.061	0.021	-
	(0.012)	(0.017)	(0.031)	(0.040)	(0.028)	-
Employed	0.016*	0.020+	0.003	0.024	0.021	0.027+
	(0.007)	(0.010)	(0.015)	(0.022)	(0.016)	(0.015)
Unemployed	-0.005	0.002	-0.048	-0.037	0.026	0.058**
	(0.011)	(0.017)	(0.030)	(0.034)	(0.025)	(0.021)
Retired	-0.009	-0.009	-0.029	-0.048+	0.042*	0.031
	(0.008)	(0.013)	(0.020)	(0.026)	(0.021)	(0.020)
Bigtown	0.020**	0.014	0.014	0.049**	0.024	0.004
	(0.006)	(0.009)	(0.014)	(0.017)	(0.016)	(0.013)
Countryside	0.001	0.013	-0.013	0.023	-0.014	-0.011
	(0.006)	(0.009)	(0.013)	(0.016)	(0.015)	(0.013)
Envaffected	0.076**	0.079**	0.075**	0.032*	0.112**	0.061**
	(0.005)	(0.007)	(0.011)	(0.015)	(0.013)	(0.011)
Envcostbear	0.039**	0.056**	0.035*	0.030	0.020	0.014
	(0.006)	(0.009)	(0.014)	(0.021)	(0.014)	(0.011)
Highsatisfaction	0.005	-0.001	0.004	-0.002	0.016	0.021+
	(0.006)	(0.009)	(0.016)	(0.021)	(0.015)	(0.012)
Left	0.050**	0.048**	0.064**	0.036+	0.045**	0.033*
	(0.006)	(0.009)	(0.014)	(0.020)	(0.016)	(0.014)
Middle	0.041**	0.057**	0.035**	0.073**	0.015	0.003
	(0.005)	(0.009)	(0.012)	(0.015)	(0.014)	(0.013)
Politunsatisfied	0.018**	0.013	0.024*	0.011	0.028*	0.018+
	(0.005)	(0.008)	(0.011)	(0.015)	(0.013)	(0.011)
Observations	27,397	11,173	6,151	2,991	4,039	3,030
Wald Chi^2	1757^{**} (48)	904^{**} (31)	226^{**} (25)	147^{**} (22)	233^{**} (24)	171^{**} (21)
Pseudo R^2	0.07	0.09	0.03	0.05	0.06	0.09

Probit models. Average marginal effects are reported. Robust standard errors in parentheses,
** p<0.01, * p<0.05, + p<0.1.

Source: European Commission, 2019, own estimations.

The economic situation of the household matters for their climate change activities. Households with lower income indicated by belonging to *workclass,* or by difficulties paying bills (*diffbills*)

in the last 12 months are less likely for climate change affectedness and behaviour. Interestingly, these results are not valid for the Northern countries, the low-income variables *diffbills* and *workclass* are not significant. This result is likely due to the highly developed social security systems in these countries.

Living conditions characterised by a high level of pollution play a role for all countries. Those feeling a direct daily negative life effect of environmental problems (*envaffected*) show more green activities. This result holds for all considered country groups. Interestingly, for the model of all countries, living in big towns (*bigtown*) increases the probability of energy related activities, while living in the *countryside* has no significant effect.

The results for the political orientation show that politically *left* and *middle* oriented people are more likely to engage in green climate activities, as are those who are dissatisfied with politics in their country. This might be because the majority of the parties with government responsibilities do not sufficiently represent the preferences of green respondents. This result is especially relevant for the Eastern European and the Balkan countries but is not the case in the Baltic and Northern countries, where green consumers seem to support their governments.

Differences between different energy related activities

The analysis of different energy-related activities uses a multivariate probit model (Roodman, 2011) instead of simple probit models (see Table 9), as the different green activities are captured by items of one question in the questionnaire so that they could be correlated. As the error terms of the single models are significantly correlated, this choice of model is appropriate.

Gender (*female*) is relevant only for environmentally friendly ways of travelling (walk, bicycle, public transport or electric car) and for buying local products. By contrast, recycling activities such as repairing rather than replacing a product or energy saving activities show no gender difference. Not surprisingly, younger people are more likely to use bicycle or public transport whereas older people are less able to move about on foot or bicycle so that the marginal effect of *age* becomes significantly negative. Contrary to this result, the *age* of the respondent is positively correlated with energy saving activities and buying local products.

People struggling to pay their bills (*diffbills*) show a lower probability of buying local products or energy saving measures, but the marginal effects of this variable for environmentally friendly mobility and recycling are insignificant or even positive (recycling).

Table 9: Results for different energy and climate change related activities

Correlates	Env. travel	Energy savings	Local products	Home working	Secondhand repair
Age	-0.002**	0.001*	0.001**	0.000	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female	0.022**	0.009	0.053**	-0.014**	-0.005
	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)
Partner	-0.022**	0.025**	0.035**	0.023**	0.036**
	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)
Householdsize	0.000	0.016*	0.003	0.018**	0.017*
	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)
Highqual	0.048**	0.054**	0.068**	0.052**	0.052**
	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)
Diffbills	-0.009	-0.024**	-0.043**	-0.004	0.025**
	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)
Upphighclass	-0.028	0.015	-0.019	0.001	-0.026
	(0.029)	(0.034)	(0.034)	(0.026)	(0.034)
Workclass	-0.021**	-0.022**	-0.007	-0.042**	-0.001
	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)
Housemanwife	-0.027*	0.040**	-0.008	-0.006	-0.025+
	(0.013)	(0.015)	(0.015)	(0.012)	(0.015)
Employed	-0.006	0.033**	0.021*	0.014*	0.008
	(0.007)	(0.008)	(0.008)	(0.007)	(0.008)
Unemployed	0.016	-0.023	-0.011	0.014	0.004
	(0.013)	(0.014)	(0.014)	(0.012)	(0.014)
Retired	0.022*	-0.008	-0.012	-0.003	-0.026*
	(0.010)	(0.010)	(0.010)	(0.008)	(0.010)
Bigtown	0.058**	0.020**	-0.013+	0.012*	0.009
	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)
Countryside	-0.033**	0.019**	0.035**	-0.019**	0.028**
	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)
Envaffected	0.074**	0.099**	0.080**	0.044**	0.060**
	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)
Envcostbear	0.035**	0.042**	0.044**	0.033**	0.056**
	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)
Highsatisfaction	0.018**	0.009	0.020**	0.032**	0.004
	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)
Left	0.056**	0.036**	0.055**	0.034**	0.054**
	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)
Middle	0.027**	0.015*	0.042**	0.017**	0.019**
	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)
Politunsatisfied	-0.007	0.026**	0.011+	0.011*	0.031**
	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)

Multivariate probit model. Average marginal effects are reported. Robust standard errors in parentheses. LR Chi^2 (240) = 7245**. Number of observations = 27,397. ** p<0.01, * p<0.05, + p<0.1.

Source: European Commission, 2019, own estimations.

These findings do not imply that high income households are more environmentally friendly in their overall ecological footprint per se. Compared to low-income households, they might have

higher total consumption, polluting more despite their higher willingness to consume green local products. Furthermore, they are less likely for recycling and the use of second-hand products.

As expected, people living in the *countryside* show less environmentally oriented mobility behaviour because the supply of public transport is less developed, but they show more energy saving activities and buy more local products. A politically *left* or *middle* orientation is positively correlated with all climate change related activities.

5.2.3 Green SOEP for Germany

The Green SOEP (Socio-Economic Panel) contains German household data for 2022. The data is restricted to Germany, but it offers additional possibilities compared with the Eurobarometer data in the previous sections. For the econometric analysis, four different indicators are used (Table 10). The indicator "very high importance of combatting climate change" describes the self-perceived attitude of the questioned person towards the relevance of climate change problems. The "strong support of a speed limit on highways" is a very interesting indicator because such an energy saving behaviour even reduces costs. Furthermore, there are different questions on the willingness to pay (WTP) for climate change mitigation of 10 percent and for an additional tax for climate change protection. Interestingly, more than 43% of the respondents show this WTP (Table 10) but only 21% support an increase of taxes on gasoline and diesel. The lower WTP might be due to the fact, that the respondents might easily calculate their additional costs of travelling by car whereas the household budget effects of a more general increase of taxes for CO_2 reduction are more diffuse and less visible.

Concerning the control variables, an indicator on the influence of communication channels measured by the sources of information (newspapers, internet) is available.

Table 10: Indicators of energy-related household behaviour in the German SOEP

Energy-related indicators	In %
Combating climate change is very important	53.53
Strong support of a speed limit on highways	31.22
Spending increase climate, change mitigation 10 percent and willingness to increase climate change tax	43.37
Support increase taxes on gasoline and diesel	21.40

Source: Frondel et al. 2023, own calculations based on Green SOEP data.

Table 11: Environmental attitudes and willingness to pay of German households

Correlates	Importance combating climate change	Speed limit	WTP	Increase Tax on gasoline and diesel
Age	0.002**	0.003**	0.004**	0.000
	(0.001)	(0.001)	(0.001)	(0.000)
Woman	0.124**	0.054**	0.011	-0.040**
	(0.012)	(0.012)	(0.012)	(0.009)
Highqual	0.029*	0.063**	0.121**	0.106**
	(0.012)	(0.012)	(0.012)	(0.010)
Employed	0.009	-0.030*	0.032*	-0.007
	(0.015)	(0.014)	(0.014)	(0.012)
Lowincome	0.038*	0.019	0.001	0.032*
	(0.017)	(0.016)	(0.017)	(0.014)
Ownproperty	0.026*	-0.002	0.034**	-0.010
	(0.012)	(0.011)	(0.012)	(0.010)
Greenparty	0.352**	0.316**	0.364**	0.374**
	(0.014)	(0.018)	(0.016)	(0.018)
Claffect	0.009	0.003	0.025	-0.025
	(0.023)	(0.022)	(0.023)	(0.017)
Highlifesatis	0.084**	0.018	0.097**	0.035**
	(0.012)	(0.012)	(0.012)	(0.010)
Newinfosources	-0.033*	-0.032**	-0.029*	-0.029**
	(0.013)	(0.012)	(0.013)	(0.010)
Trustinscience	0.179**	0.133**	0.165**	0.120**
	(0.013)	(0.014)	(0.014)	(0.012)
Observations	6,864	6,864	6,864	6,864
Wald Chi^2	829(26)	655(26)	952(26)	1030(26)
Pseudo R^2	0.10	0.08	0.12	0.16

Probit models. Average marginal effects are reported. Robust standard errors in parentheses, ** p<0.01, * p<0.05, + p<0.1. Regional dummies are included but not reported.

Source: Own estimations based on Green SOEP data.

The results show that the *age* of the questioned household member is positively correlated to all energy related indicators except the additional taxes on gasoline and diesel (Table 11). *Women* disproportionally support combats against climate change and speed limits but interestingly, their WTP is lower compared with men. Not surprisingly, the *employed* status is positively correlated to WTP but negatively connected with a support of speed limits, the indicator for costless energy savings. A high qualification (*highqual*), green votes (*greenparty*) and a high *trust in science* are significantly positively correlated to all environmentally related indicators. A *low income* is per se not a barrier for green attitudes, the respective variable is positively correlated to combatting climate change and even the indicator on additional taxes on gasoline and diesel. Probably due the relatively little share (7% in the sample) the climate change affectedness of households by extreme weather events (*claffect*) does not play a significant role.

Interestingly, people usually getting the latest news from social media such as facebook, youtube or twitter (*newinfosources*) show significantly less environmentally positive attitudes and WTP. This result is valid for all considered indicators. From a political perspective, it would be useful to better use these channels to stimulate a green energy related behaviour. A high satisfaction with life (*highlifesatis*) seems to be positively correlated to environmental awareness.

6. Support of the hypotheses based on the different data sources and summary

In the following, the results of the econometric analyses in the previous sections based on the three databases are summarized allowing a discussion of the relevance of the Hypotheses 1-3.

H1: Personal characteristics, such as age, gender or education influence green energy related behaviour and their willingness to pay.

Younger people and especially students show a higher willingness to pay (WTP) for energy to speed up the green transition, whereas older people are more likely to realize energy related measures. These results are not in contradiction because older persons are more likely to own houses or flats to realize these measures. Women show a lower willingness to pay for energy and they are less likely to implement energy saving measures, but they are more likely to use environmentally friendly travel modes and they are in favour of a speed limit. There is also a clear relationship between education level and energy related behaviour. Highly qualified persons show a higher WTP and they are more likely to realize energy related measures. The German database also shows that a preference for the green party is positively correlated to all environmentally related indicators. Interestingly, people usually getting the latest news from social media such as facebook, youtube or twitter show significantly less environmentally positive attitudes and WTP.

H2: Determinants of energy related behaviour differ between costless and cost-intensive green activities, with economic situation relevant primarily for cost-intensive activities.

People having difficulties to pay their bills as an indicator for poverty are significantly more likely to use public transport and recycle products, but they show a lower probability of buying local products or realizing cost-intensive energy saving measures and they have a lower WTP for green energy compared to richer groups. Employed people are more likely to introduce energy efficiency measures, but their support of environmentally friendly travel modes is lower, and they do not support speed limits.

These findings do not imply that high income households are per se more environmentally friendly in their overall ecological footprint. Compared to low-income households, they might have a higher total consumption, polluting more despite their higher willingness to consume green local products. Furthermore, they are less likely for recycling and the use of second-hand products.

H3: The living conditions are highly relevant for the energy related behaviour of households.

Living conditions characterised by a high level of pollution play a role for the questioned households. Those feeling a direct daily negative life effect of environmental problems show more green activities. Interestingly, living in big towns increases the probability of climate change related activities, while living in the countryside has no significant effect except a less environmentally oriented mobility behaviour because the supply of public transport is less developed.

From a political perspective, the fight against poverty and unemployment increases green energy behaviour, with the results showing that poor households are not less green *per se,* but only in respect of cost-intensive green activities. Information policy that helps to create green social norms matters, as the discussion on energy and climate change problems triggers self-perceived green attitudes and prompts green behaviour. A "green" information policy should also use new information sources such as social media (e. g. facebook, youtube or twitter) as the econometric results show that people using these sources show significantly less environmentally positive attitudes and willingness to pay for green energy.

Literature

Ajzen, I. (1991). The theory of planned behaviour. *Organisational Behaviour and Human Decision Processes* 50, 179-211.

Allcott, H., Rogers, T. (2014). The short-run and long-run effects of behavioral interventions: experimental evidence from energy conservation. *American Economic Review* 104(10), 3003-37. DOI: 10.1257/aer.104.10.3003.

Ameli, N., Brandt, N. (2014). What impedes household investment in energy efficiency and renewable energy? *International Review of Environmental and Resource Economics* 8, 101-138. https://doi.org/10.1561/101.00000067.

Andor, M. A., Fels, K. M. (2018). Behavioral economics and energy conservation – a systematic review of non-price interventions and their causal effects. *Ecological Economics* 148, 178-210. https://doi.org/10.1016/j.ecolecon.2018.01.018.

Andor, M. A., Gerster, A., Peters, J., Schmidt, C.M. (2020). Social norms and energy conservation beyond the US. *Journal of Environmental Economics and Management* 103, 102351. https://doi.org/10.1016/j.jeem.2020.102351.

Antunes, M., Teotónio, C., Quintal, C., Martins, R. (2023). Energy affordability across and within 26 European countries: Insights into the prevalence and depth of problems using microeconomic data. *Energy Economics* 127, 107044.

Aravena, C., Riquelme, A., Denny, E. (2016). Money, comfort or environment? Priorities and determinants of energy efficiency investments in Irish households. *Journal of Consumer Policy* 39, 159-186. https://doi.org/10.1007/s10603-016-9311-2.

Akerlof, G. (1980). A theory of social custom, of which unemployment may be one consequence. *Quarterly Journal of Economics* 94(4), 749-775. http://www.jstor.org/stable/1885667.

Bamberg, S., Möser, C. (2007). Twenty years after Hines. Hungerford, and Tomera: a new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology* 27(1), 14-25.

Cayla, J. M., Maizi, N., Marchand, C. (2011). The role of income in energy consumption behaviour: Evidence from French households data. *Energy Policy* 39 (12), 7874-7883. https://doi.org/10.1016/j.enpol.2011.09.036.

Chen, J., Liao, H., Zhang, T. (2024). Empowering women substantially accelerates the household clean energy transition in China. *Energy Policy* 187, 114048.

Colasante, A., D'Adamo, I., Morone, P. (2021). Nudging for the increased adoption of solar energy? Evidence from a survey in Italy. *Energy Research & Social Science* 74, 101978. https://doi.org/10.1016/j.erss.2021.101978.

European Commission (2019). Eurobarometer 92.4, December 2019. Brussels: Kantar Public [Producer], GESIS, Cologne [Publisher]: ZA7602, dataset version 1.0.0, doi:10.4232/1.13652.

European Commission (2022). Eurobarometer 97.4, May-June 2022. Brussels: Kantar Public, Brussels [Producer]; GESIS, Cologne [Publisher]: ZA7901, dataset version 1.0.0, doi:10.4232/1.14019.

Eurostat (2024). Data browser. https://ec.europa.eu/eurostat/databrowser/explore/all/all_themes?lang=en&display=list&sort=category.

Fiorillo, D., Sapio, A. (2019). Energy saving in Italy in the late 1990s: Which role for non-monetary motivations? *Ecological Economics* 165, 106386. https://doi.org/10.1016/j.ecolecon.2019.106386.

Frondel, M., Kussel, G. (2019). Switching on electricity demand response: evidence for German households. *Energy Journal* 40(5), 1-16. DOI: 10.5547/01956574.40.5.mfro.

Frondel, M., Matejko, L., Osberghaus, D., Sommer, S., Vance, C. (2023). Green SÖP Extended: The Socio-Ecological Panel Surveys 2020 and 2022. *Journal of Economics and Statistics* 243(5), 567-583, https://doi.org/10.1515/jbnst-2023-0030.

Greene, W.H. (2008). *Econometric Analysis (6th Ed.)*. New Jersey: Pearson International.

Groh, E. D., Ziegler, A. (2020). On the relevance of economic preferences, values, norms, and socio-demographics for electricity consumption. *Beiträge zur Jahrestagung des Vereins für Socialpolitik 2020*: Gender Economics, ZBW - Leibniz Information Centre for Economics, Kiel, Hamburg.

Horbach, J. (2022). Determinants of the greening of households in Europe. Research Note on behalf of the European Commission, Brussels, DOI: 10.2767/31379.

Ivanova D., Wood R. (2020). The unequal distribution of household carbon footprints in Europe and its link to sustainability. *Global Sustainability* 3(e18), 1-12. https://doi.org/10.1017/sus.2020.12.

Jakucionyte-Skodiene, M., Liobikiene, G. (2023). Changes in energy consumption and CO2 emissions in the Lithuanian household sector caused by environmental awareness and climate change policy. *Energy Policy* 180, 113687.

Kahn, M. E. (2007). Do greens drive hummers or hybrids? Environmental ideology as a determinant of consumer choice. *Journal of Environmental Economics and Management* 54, 129-145.

Keizer, K., Schultz, P. W. (2018). Social norms and pro-environmental behaviour. In: Steg, L., de Groot, J.I.M. (Eds.). *Environmental Psychology*, John Wiley & Sons Ltd., 179-188.

Kim, G., Lee, T. (2023). Understanding social innovation activities for energy transition: Evidence from experiences of social innovation agents in South Korea. *Energy & Environment*, *34*(8), 2976-2989. https://doi.org/10.1177/0958305X221116180.

Kola-Bezka, M., Leki, K. (2024). Household energy behaviour in the times of crisis: Lessons for policy initiatives from peripheral, fossil-dependent regions of the European Union. *Energy Policy* 188, 114113.

Kollmuss, A., Agyeman, J. (2002). Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behaviour? *Environmental Education Research* 8(3), 239-260.

Lange, A., Schwirplies, C., Ziegler, A. (2017). On the interrelation between the consumption of impure public goods and the provision of direct donations: theory and empirical evidence. *Resource and Energy Economics* 47, 72-88.

Lévay, P. Z., Vanhille, J., Goedemé, T., Verbist, G. (2021). The association between the carbon footprint and the socio-economic characteristics of Belgian households. *Ecological Economics* 186, 107065. https://doi.org/10.1016/j.ecolecon.2021.107065.

Liobikiene, G., Mandravickaite, J., Bernatoniene, J. (2016). Theory of planned behaviour approach to understand the green purchasing behaviour in the EU: A cross-cultural study. *Ecological Economics* 125, 38-46.

Martinsson, J., Lundqvist, L. J., Sundström, A. (2011). Energy saving in Swedish households. The (relative) importance of environmental attitudes. *Energy Policy* 39, 5182-5191.

Mezger, A., Cabanelas, P., López-Miguens, J., Cabiddu, F., Rüdiger, K. (2020). Sustainable development and consumption: The role of trust for switching towards green energy. *Business Strategy and the Environment* 29, 3598-3610.

Peersman, G., Wauters, J. (2024). Heterogeneous household responses to energy price shocks. *Energy Economics* 132, 107421.

Petrovich, B., Carattini, S., Wüstenhagen, R. (2021). The price of risk in residential solar investments. *Ecological Economics* 180, 106856. https://doi.org/10.1016/j.ecolecon.2020.106856.

Pommeranz, C., Steininger, B. I. (2021). What drives the premium for energy-efficient apartments – green awareness or purchasing power? *Journal of Real Estate Finance and Economics* 62, 220-241. https://doi-org.ezproxy.hs-augsburg.de/10.1007/s11146-020-09755-8.

Ramos, A., Labandeira, X., Löschel, A. (2015). Pro-environmental households and energy efficiency in Spain. *CAWM Discussion Paper, No. 80*. Münster: Westfälische Wilhelms-Universität Münster, Centrum für Angewandte Wirtschaftsforschung (CAWM).

Roodman, D. (2011). Estimating fully observed recursive mixed-process models with cmp. *Stata Journal* 11(2), 159-206.

Sardianou, E., Genoudi, P. (2013). Which factors affect the willingness of consumers to adopt renewable energies? *Renewable Energy* 57, 1-4. https://doi.org/10.1016/j. renene.2013.01.031.

Schleich, J. (2019). Energy efficient technology adoption in low-income households in the European Union – What is the evidence? *Energy Policy* 125, 196-206. https://doi.org/10.1016/j.enpol.2018.10.061.

Sommer, S. (2018). Switching to green electricity: spillover effects on household consumption. SFB 823 Discussion Paper Nr. 24/2018. Dortmund: University of Dortmund.

Trotta, G. (2018). Factors affecting energy-saving behaviours and energy efficiency investments in British households. *Energy Policy* 114, 529-539.

Videras, J., Owen, A. L., Conover, E., Wu, S. (2012). The influence of social relationships on pro-environment behaviours. *Journal of Environmental Economics and Management* 63, 35-50.

Vögele, S., Briska, L.H., Otte, S., Rübbelke, D. (2021). Why the trend towards gas-guzzlers? A closer look at the complex effects of social norms on German car buyers. *Energy Research & Social Science* 72, 101840. https://doi.org/10.1016/j.erss.2020.101840.

Welsch, H. (2021). How climate-friendly behavior relates to moral identity and identity-protective cognition: evidence from the European social surveys. *Ecological Economics* 185, 107026. https://doi.org/10.1016/j.ecolecon.2021.107026.

Zhang, X., Dong, F. (2020). Why do consumers make green purchase decisions? Insights from a systematic review. *International Journal of Environmental Research and Public Health* 17(18), 6607. https://doi:10.3390/ijerph17186607.

Ziegler, A. (2020). Heterogeneous preferences and the individual change to alternative electricity contracts. *Energy Economics* 91, 104889. https://doi.org/10.1016/j.eneco.2020.104889.

Table A1: Descriptive statistics - Eurobarometer 97.4 (2022)

Variable	Description of variables (all personal variables are related to the respondent)	Mean	Std. Dev.
Energy Efficiency	Made home more energy efficient in last five years: 1: Yes, 0: No	.4	.49
Envfriendlytravel	Typically most often used travel mode: Train, public transport, Privately owned bike or scooter, shared bike, scooter or moped, walking: 1: Yes, 0: No	.491	.5
Highwtp	Willing to pay more for energy: 1: 10%, 20%, 30% or above 30% more, 0: No	.344	.475
Age	Age of the respondent in years	50.61	18.03
Householdsize	Size of the household (number of persons)	2.43	1.09
Woman	1: Female, 0: Male	.535	.499
Highqual	Bachelor, master, or doctoral education: 1: Yes, 0: No	.263	.44
Houseowner	Home ownership: 1: Yes, 0: No	.725	.446
Employed	Employed: 1: Yes, 0: No	.549	.498
Student	Student: 1: Yes, 0: No	.066	.248
Retired	Retired: 1: Yes, 0: No	.295	.456
Poverty	Difficulties paying bills last year: 1: Yes, 0: No	.348	.476
Availpubtransport	Availability of public transport: 1: Very or fairly good, 0: Other	.565	.496
Countryside	Living in a country village, farm/home in the countryside: 1: Yes, 0: No	.286	.452
Internet	Everyday/almost everyday internet use at home: 1: Yes, 0: No	.776	.417
Energsubsidies	Received energy related subsidies in last five years: 1: Yes, 0: No	.111	.314
Climateaware	Personal responsibility to limit climate change or climate change frightens: 1: Yes, 0: No	.403	.49
Country dummies	1: Yes, 0: No		
AT	Austria	.038	.192
BE	Belgium	.038	.191
BG	Bulgaria	.039	.193
CY	Cyprus	.019	.137
CZ	Czechia	.038	.191
DEW	West-Germany	.039	.193
DEE	East-Germany	.019	.136
DK	Denmark	.038	.191
EE	Estonia	.038	.191
ES	Spain	.038	.191
FI	Finland	.04	.195
FR	France	.038	.191
GR	Greece	.038	.192
HR	Croatia	.038	.191
HU	Hungary	.039	.194
IE	Ireland	.039	.193
IT	Italy	.039	.193
LT	Lithuania	.038	.191
LU	Luxembourg	.019	.137
LV	Latvia	.038	.191
MT	Malta	.019	.137
NL	Netherlands	.039	.194
PL	Poland	.038	.192
PT	Portugal	.038	.191
RO	Romania	.04	.196
SE	Sweden	.04	.195
SI	Slovenia	.038	.192
SK	Slovakia	.038	.191

Table A2: Descriptive statistics - Eurobarometer 92.4 (2020)

Variables	Description of variables (all personal variables are related to the respondent)	Mean	Std. Dev.
Climateact	Green activities (Table 7) 1, 2, 3, 4, 5 or 6: 1: Yes, 0: No	.796	.403
Climtravel	Green activities 1: 1: Yes, 0: No	.278	.448
Climenergy	Green activities 2: 1: Yes, 0: No	.361	.480
Climlocalprod	Green activities 3: 1: Yes, 0: No	.436	.496
Climlesscar	Green activities 4: 1: Yes, 0: No	.188	.391
Climsechandrepair	Green activities 5 or 6: 1: Yes, 0: No	.412	.492
Age	Age in years	51.83	18.20
Female	Gender: 1: Female, 0: Male	.541	.498
Partner	Family status: 1: Partner, 0: Otherwise	.644	.479
Householdsize	Number of household members (ln)	.795	.537
Highqual	At least 21 years old when stopping full-time education: 1: Yes, 0: No	.297	.457
Diffbills	Difficulties paying bills last year: 1: Yes, 0: No	.319	.466
Upphighclass	Belonging to the middle/higher class: 1: Yes, 0: No	.007	.085
Workclass	Belonging to the working class of society: 1: Yes, 0: No	.263	.44
Housemanwife	Only working at home: 1: Yes, 0: No	.048	.214
Employed	Employed: 1: Yes, 0: No	.31	.463
Unemployed	Unemployed: 1: Yes, 0: No	.052	.222
Retired	Retired, unable to work: 1: Yes, 0: No	.334	.472
Bigtown	Living in a big town: 1: Yes, 0: No	.286	.452
Countryside	Living at the countryside: 1: Yes, 0: No	.329	.47
Envaffected	Direct daily life effect of environmental problems: 1: Yes, 0: No	.356	.479
Envcostbear	Willingness to bear environmental costs: 1: Yes, 0: No	.242	.428
Highsatisfaction	Very high life satisfaction: 1: Yes, 0: No	.266	.442
Left	Left political orientation: 1: Yes, 0: No	.253	.435
Middle	Middle political orientation: 1: Yes, 0: No	.44	.496
Politunsatisfied	Unsatisfied with national or EU policy: 1: Yes, 0: No	.561	.496
Country dummies	1: Yes, 0: No		
AT	Austria	.037	.189
BE	Belgium	.037	.188
BG	Bulgaria	.037	.19
CY	Cyprus	.018	.134
CZ	Czechia	.036	.187
DEW	West-Germany	.037	.189
DEE	East-Germany	.018	.134
DK	Denmark	.037	.19
EE	Estonia	.036	.187
ES	Spain	.037	.188
FI	Finland	.037	.188
FR	France	.037	.19
GB	Great Britain	.037	.189
GR	Greece	.037	.188
HR	Croatia	.037	.19
HU	Hungary	.037	.19
IE	Ireland	.037	.189
IT	Italy	.037	.189
LT	Lithuania	.036	.187
LU	Luxembourg	.019	.135
LV	Latvia	.036	.187
MT	Malta	.018	.134
NL	Netherlands	.038	.19
PL	Poland	.038	.19
PT	Portugal	.036	.187
RO	Romania	.039	.194
SE	Sweden	.037	.188
SI	Slovenia	.037	.188
SK	Slovakia	.038	.191

Table A3: Descriptive statistics - Green SOEP

Variable	Description of variables (all personal variables are related to the respondent)	Mean	Std. Dev.
Climatecons	Importance of combating climate change: 1: Very important, 0: No	.535	.499
Speedlimit	Strong support of a speed limit on highways: 1: Yes, 0: No	.312	.463
WTP	Spending increase climate, change mitigation 10 percent and willingness to increase climate change tax: 1: Yes, 0: No	.434	.496
Increasetax	Support increase taxes on gasoline and diesel: 1: Yes, 0: No	.214	.41
Age	Age in years	60.98	13.57
Woman	Woman: 1: Yes, 0: No	.363	.481
Highqual	Higher education entrance qualification, university degree: 1: Yes, 0: No	.401	.49
Employed	Employed: 1: Yes, 0: No	.429	.495
Lowincome	Monthly income less than 2,000 EUR	.144	.351
Ownproperty	Property of current home: 1: Yes, 0: No	.592	.491
Greenparty	Vote for green party: 1: Yes, 0: No	.132	.339
Claffect	Experienced flood in July 2021 personally: 1: Yes, 0: No	.07	.256
Highlifesatis	High life satisfaction: 1: Yes, 0: No	.674	.469
Newinfosources	Use of social media or messenger services: 1: Yes, 0: No	.242	.428
Trustinscience	Completely trust in science: 1: Yes, 0: No	.242	.428