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CLIMATE CHANGE MITIGATION MEASURES IN HOUSEHOLDS

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ABSTRACT. The article examines climate change mitigation in households. Based on a comprehensive analysis of the scientific literature, the primary measures to mitigate climate change and barriers are identified, emphasizing the involvement of all stakeholders. The main policy directions and measures to achieve climate goals in households are carefully examined based on a bibliographical and systematic analysis of the scientific literature. Based on the study, the main gaps in climate change mitigation in households are identified, emphasizing the necessary directions for future research. The main climate change mitigation policies and measures in the household sector of EU countries were systematized and evaluated.

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Keywords: energy efficiency, sustainable energy use, promoting the use of RES, behavioral change, sustainable development goals, climate change mitigation.

Introduction

Global greenhouse gas (GHG) emissions are constantly increasing, and to achieve climate goals by 2050, CO_2 emissions must be reduced significantly and immediately. Households, through their consumption patterns, are accountable for 72% of the world's GHG emissions. They are, therefore, crucial in staying within the 1.5°C target set by the Paris Agreement (Dubois et al., 2019; González-Hernández et al., 2023).

In recent years, there has been increasing interest in energy efficiency as a key factor in CO_2 reduction strategies. However, climate studies and policy frequently lack a household component (Kovač et al., 2023; González-Hernández et al., 2023; Hafez et al., 2023). An increasing amount of evidence indicates that energy efficiency increases by themselves will not be sufficient to achieve the significant reductions in emissions required to keep global warming to 2°C. Scientists are increasingly predicting that altering consumption patterns will be necessary to sufficiently reduce emissions (Bjelle E.L., 2018; Kontautienė et al., 2024; Semieniuk et al., 2021).

The classification of household climate change mitigation measures encompasses a range of strategies aimed at reducing GHG emissions. Recently, it has been accepted to broadly categorize these measures into three categories: behavioral modifications, adoption of renewable energy, and energy efficiency enhancements (Nielsen et al., 2020; Kuperstein-Blasco et al., 2022; Stankevičienė & Borisova, 2022).

The aim of this paper is to overcome the gap in scientific literature and to conduct a comprehensive review, systematization, and assessment of climate change mitigation measures in the household sector based on systematic and bibliographic literature review and empirical case studies conducted for EU countries.

In this article, we have divided climate change mitigation actions related to household energy use into three groups: 1) energy efficiency policies, 2) policies of converting to greener sources of electricity, and 3) behavior change policies or sustainable lifestyles. We have sought and presented the opportunities and challenges of each category of measures for households wishing to reduce their environmental impact.

The main policies and measures for climate change mitigation in the household sector were collected, systematized, and assessed based on the available studies in the EU.

The paper is structured in the following way: in section 1, the approach and methods of the literature review are described; in section 2, energy efficiency measures are analyzed, in section 3, renewable energy policies are explored; in section 3, behavioral change policies are elicited; in section 4 the main barriers of climate change mitigation policies in households are identified and grouped; in section 5 the case study on climate change mitigation policies and measures in the households sector of EU MS is performed.

1. Approach and methods

In order to conduct this study, a systematic and bibliographic review of the literature from the last 5 years (2018 - 2024) was conducted. The following search phrases and their combinations were used in the Scopus and WoS databases to find documents: climate change mitigation measures in households and *barriers for climate change mitigation in households*. These databases were also searched for articles classified by specific climate change mitigation measures, using keywords: *energy efficiency measures, behavioral change measures*, and *measures for promoting renewable energy in households*. After removing review articles and duplicate sources, 88 articles were chosen for further analysis.

Data analysis

The data analysis was conducted using bibliographic analysis, and the results are grouped and shown graphically in Figures 1-3.

The relationship between various concepts and study topics is illustrated by keyword network analysis (Figure 1), which also graphically displays terms from various categories in various colors. Figure 1 shows that the keywords for the topic of climate change mitigation in households cover the fields of economics, biology, psychology, marketing, climate change, alternative medicine, and energy engineering. Thus, it can be stated that the network covers all aspects of sustainability and sustainable development - economic, environmental, and social.

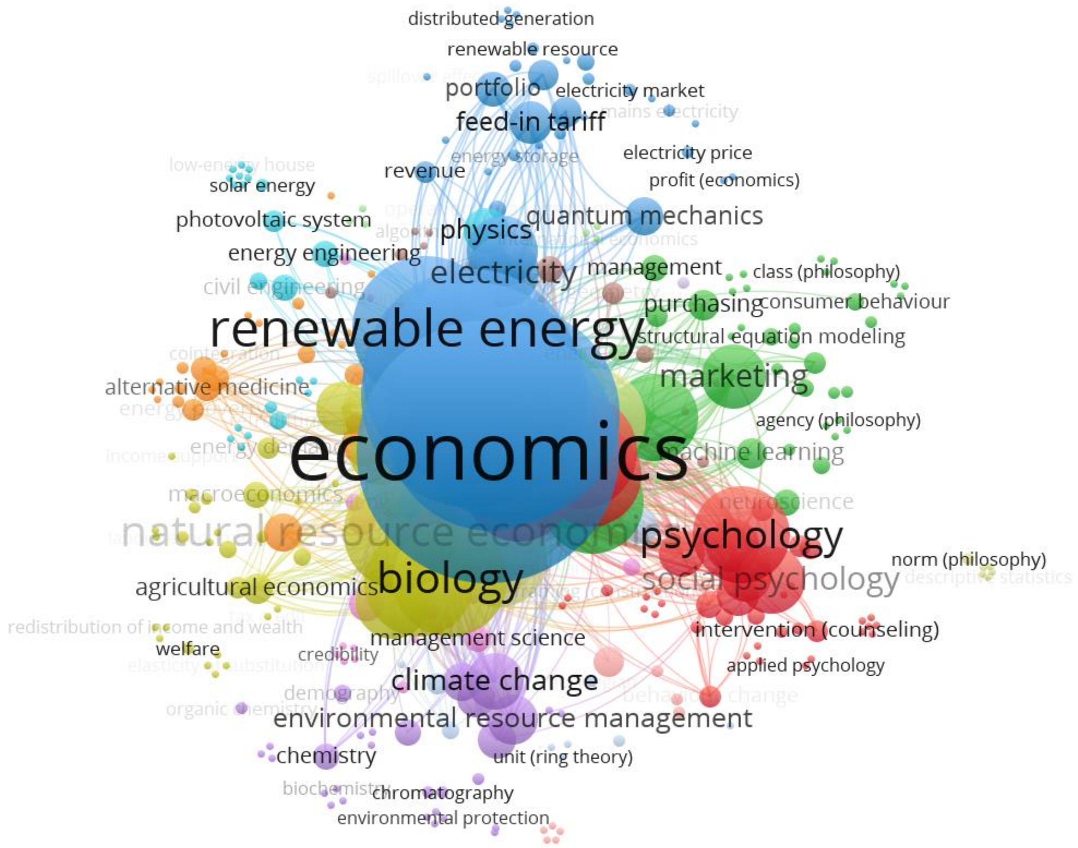

Figure 1. Keywords concurrence analysis
Source: created by the authors

Figures 2 and 3 illustrate co-authorship by country and organization. This method can assist in identifying research gaps and defining relevant activities in a variety of geographical and chronological contexts also based on the score and weight attributes. The co-authorship network by country shows that the largest co-authorship network, which can be seen in Figure 2, consists of 30 members. The scale of the figure based on the number of citations shows that the most cited documents are from Sweden and the Netherlands. The most significant centres of collaboration have developed between the USA, China, the Netherlands, the United Kingdom, and Germany. It should be noted that although most of the countries in the 41-member network are interconnected, several countries, such as Iran, Taiwan, and Ukraine, have no connections with others. This may be due to the complex geopolitical situation. Other countries that have no connections with others are Canada, Japan, as well as Poland, Slovenia, and Romania. This may indicate that the benefits of cooperation between countries are not fully exploited.

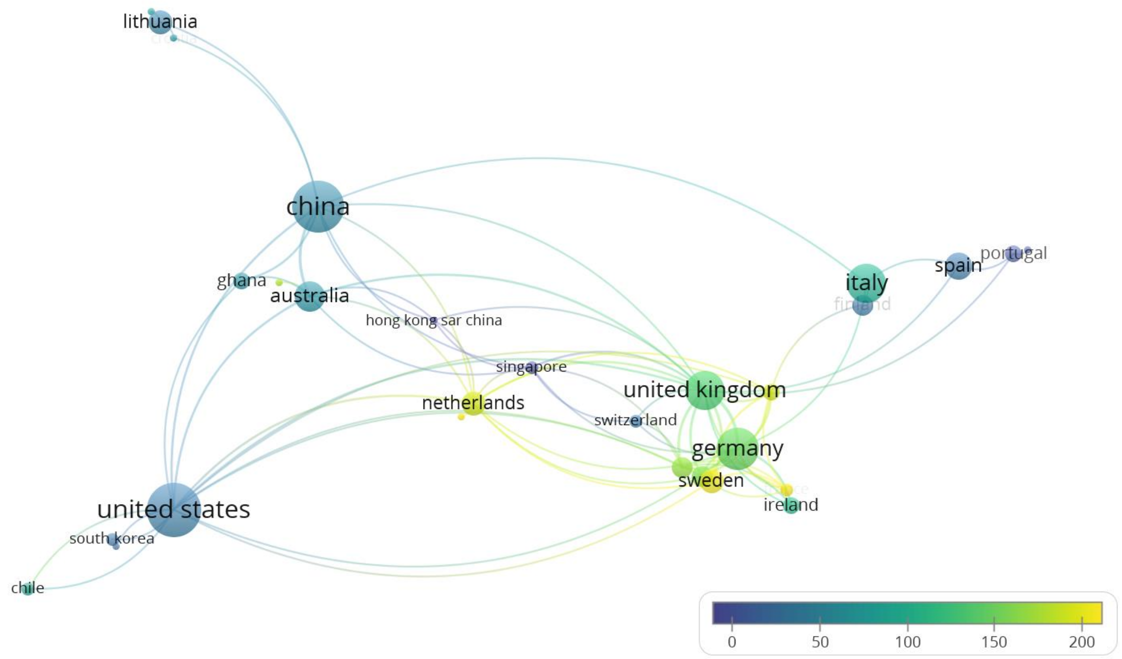

Figure 2. Co-authorship among Countries
Source: created by the authors

The analysis of co-authorship by the institution revealed a network of 195 institutions, which is depicted in Figure 3. The largest network, centered at the University of Leeds, consists of 64 members. Figure 3, which is scaled based on the number of publications per institution, shows that the Lithuanian Energy Institute, Joint Research Centre, significantly contributes to the publication of scientific articles. However, some members are not related to each other. This reflects a lack of collaboration between institutions and potential opportunities for future research.

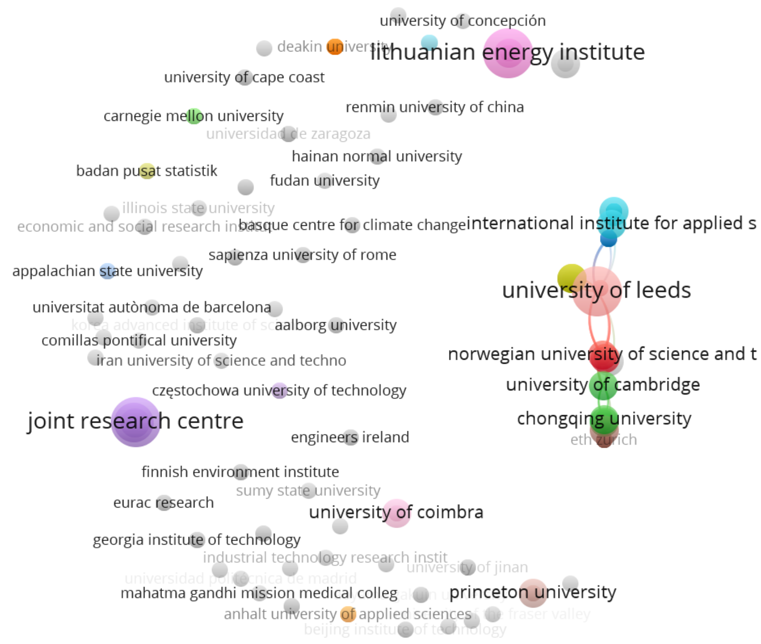

Figure 3. Co-authorship Collaboration among Institutions
Source: created by the authors

2. Energy efficiency policies

From an economic point of view, energy efficiency can be defined as a lower amount of energy needed to complete the same task or generate the same energy service (Zheng et al., 2024). The energy efficiency of housing remains one of the most important components for achieving climate goals, as well as reducing energy poverty, because, for example, in the EU, HVAC (heating, ventilation, and air conditioning) or simply heating and cooling accounts for 50% of the total energy usage of which 80% is used in buildings (Rau et al., 2020; Liu et al., 2022; Barrella et al., 2023).

Another important factor in improving energy efficiency in households is the use of energy-saving appliances (Akil et al., 2023; Kumar et al, 2023; McCarthy, 2024; Mishchuk et al., 2023; Widyanti & Włodarczyk, 2023). According to DOE (U.S. Department of Energy) estimates, about 90% of domestic energy demand is accounted for by appliances and building-related equipment such as water heaters, electric motors, lights, and refrigerators. The use of energy-saving appliances can reduce household energy use, as well as GHG emissions, by up to 30% (Parikh K.S. & Parikh J.K., 2016; Zhang et al., 2020; Silvi& Padilla Rosa, 2021). Parikh K.S. & Parikh J.K. (2016) research shows that the use of energy-efficient refrigerators and TVs can save 50%-60% of energy compared to conventional appliances. The price of energy-saving appliances is typically higher than that of traditional ones, so it is very important to encourage residents' willingness to pay (WTP) a price premium for energy-efficient appliances (Zhang et al., 2020). Researchers identify several key measures that can encourage the use of energy-saving devices in households: 1) increasing labeling's efficacy (information regarding potential energy savings); 2) government regulation (standards); 3) financial incentives; 4) lower cost of energy-saving appliances and pricing of electricity (Parikh K.S. & Parikh J.K., 2016; Silvi & Padilla Rosa, 2021).

Energy efficiency standards, incentives, and information-based techniques are the components of energy efficiency policy that help homes become more energy-efficient (Alberini, 2018). Table 1 shows all these policies and the measures assigned to them.

Table 1. Policies and measures for increasing the efficiency of energy use in households

Policy	Measures
Energy efficiency standards	Mandatory requirements for residential buildings under construction and renovation of existing housing. Energy efficiency requirements for equipment and appliances.
Incentives	Tax benefits, preferential credits, grants and subsidies, and energy taxes. White certificates, Energy Efficiency Obligation Schemes (EEOS), and incentives supporting Third-Party financing (ESCO). Technology deployment plans; incentives for creators of cutting-edge technologies.
Information-based methods	Overall information: awareness campaigns, information centers, energy audits, energy labeling programs, leading by example, information sharing, professional training, training classes, and demonstration programs, and education for vocational purposes.

Source: created by the authors, based on Alberini, 2018; Bertoldi & Economidou, 2018; Economidou et al., 2020

Energy consumption in the residential sector can be decreased and energy efficiency raised using well-thought-out and suitable energy efficiency measures (Koengkan et al., 2023). First, fiscal and financial tools like grants, loans, and subsidies adjust prices and expenses to encourage consumers to choose efficient items and deter them from making inefficient purchases (through taxes). Second, firms are incentivized to assist technological innovation by market-driven instruments such as regulatory regulations and fines. For instance, energy suppliers are subject to fines under the White Certificates schemes and duties if they fail to meet the required targets for energy savings through energy-efficient solutions targeted at end users. Third, in order to influence customers' decisions and behaviors, information and awareness tools can be used to give them vital product qualities, including energy efficiency ratings. This includes information campaigns, training, and usage feedback, as well as through smart meters and bills. Energy labeling schemes are particularly targeted product efficiency. Energy labeling plays a significant role in innovation by pushing producers to create goods that are more effective than those of their rivals (D'Adda et al., 2022; González-Torres et al., 2023).

Overall, psychological advantages and environmental attitudes and concerns have a significant beneficial influence on people' behavioral intention to purchase energy-saving appliances (Liao et al, 2020).

3. Renewable energy policies

Another way to achieve sustainable development goals and climate change mitigation is through green financing and investments in renewable energy (RE) projects (Strielkowski et al., 2019; Lyeonov et al., 2023; Maxim et al., 2022; Twumasi et al., 2022; Balcerzak et al., 2023, 2024). Renewable energy, often known as clean energy, is energy derived from water, geothermal energy, wind energy, and solar energy (Chel& Kaushik, 2018; Uddin et al., 2023). Globally, the adoption and promotion of renewable energy are greatly aided by financial incentives (Khalid et al., 2021; Mukhtarov et al., 2024; Colasante et al., 2022; Zheng et al., 2023; Agupugo et al., 2024). However, apart from financial incentives for encouraging consumer willingness to implement new renewable energy technologies, it can be singled out their environmental concern, also government regulation, and difficulties in using renewable energy (Strielkowski et al., 2019; Khalid et al., 2021; Mukhtarov et al., 2023; Sutthichaimethee et al., 2024). We divided the drivers for promoting the use of renewable energy sources or switching to more environmentally friendly sources of electricity in households into standards and incentives. It can be seen in 2 tables.

Table 2. Drivers for promoting the use of renewables in households

	Mean
Standards	Renewable portfolio standard, Quota system (Mandatory quota of RES), Eco-label; Regulatory promotion schemes for renewables; Tax conventional energy, Eco-tax, Energy tax on electricity
Incentives	RES promotion policies: Subsidies, Feed-in tariffs; Public education, Behavioral intentions

Source: created by the authors, Markard & Truffer, 2006; Alberini, 2018; Raikar & Adamson, 2020

According to Raikar and Adamson (2020), the issue from an economic standpoint is often that fossil fuel generation, such as coal and gas, is too cheap, rather than that renewable energy is too expensive. Only a portion of the production costs (private costs) are reflected in the cost to customers of power generation. The whole social costs of providing this power should, in theory, include the harm caused to surrounding stakeholders by carbon dioxide and other pollutant emissions (Raikar & Adamson, 2020). To regulate greenhouse gas (GHG) emissions, many scientists single out the carbon tax system as one of the incentives (Raikar & Adamson, 2020; Dobbins & Fahl, 2023; Hartono et al., 2023; Matsumoto, 2023).

In recent years, another tool to achieve renewable energy use goals has gained popularity - green goals, including renewable portfolio standards; hereby, utilities must produce a specific proportion of their electricity from renewable sources (Liao, 2020; Lee, 2023). The Renewable Portfolio Standard (RPS) has emerged as a potent assurance for resolving issues related to the use of renewable energy. In countries implementing the RPS, it has become easier to stimulate the growth of renewable energy by reducing government subsidies and promoting renewable energy development through market-based approaches (He et al., 2022).

On the other hand, directly subsidizing investment in the renewable energy sector is one possible policy response if the market price of renewable energy is too high compared to traditional sources (Lekavičius et al., 2020; Raikar & Adamson, 2020; Mardones, 2024). This can be accomplished by tax subsidies such as an inflation-adjusted corporation tax credit or a production tax credit (PTC) for every kWh of energy produced by eligible facilities or by legislative actions that directly subsidize sector investment (Raikar & Adamson, 2020).

However, households' decision to adopt renewable energy technology is one of the most crucial components in this process (Jackson et al., 2019; Štreimikienė et al., 2022). For this reason, behavioral economics insights should be included when analyzing household acceptance of renewable energy (Štreimikienė et al., 2022; Oláh et al., 2024; Rahmani et al., 2024).

4. Behavior change policies or sustainable lifestyles

Energy consumption and conservation and use of renewable energy resources are related to consumer decision-making and behavior. Therefore, it is not possible to ignore consumers' habits for the purpose of improving energy efficiency. In order to reduce electricity consumption, it is essential to study consumer behavior. As a result, it is necessary to draw on insights from behavioral economics to encourage households to use sustainable energy (Bonan et al., 2020; Liao et al., 2020; Štreimikienė et al., 2022; Akil et al., 2023). The researchers say that changing consumer habits could be an important alternative to achieving energy efficiency goals, and policymakers should take all initiatives that can change consumer behavior (Liao et al., 2020; de Ayala et al., 2021; Słupik et al., 2021; Akil et al., 2023). We have broken down the non-price instruments that can encourage residents to change their energy usage habits to 1) education and awareness, 2) social influence, 3) choice architecture, and 4) incentives. This can be seen in Table 3.

According to several researchers, if consumers received their energy bills more regularly and usage and pricing information was presented clearly, they would be more likely to conserve energy or buy more energy-efficient products, which would help prevent waste (Alberini, 2018; Trotta, 2020; Ruokamo et al., 2022; Xu et al., 2023).

Direct feedback can help households control their gas and electricity usage. Real-time feedback is highly effective in promoting conservation, and the installation of smart meters can be directly related to reducing energy use (Alberini, 2018; Fang et al., 2023).

The literature review revealed other instruments that aim to influence the context of the decision and encourage the desired change in behavior, such as nudges, education, and incentives for influencing residential energy consumption. The "choice architecture" or "choice context" is the collection of all options available to a person. Nudging alters this choice architecture, allowing people to act reliably and make the desired choice (Mele et al., 2021; Caballero& Ploner, 2022; Fang et al., 2023).

Table 3. Non-price instruments for changing the energy consumption habits of the residents

	Mean
Education and Awareness	Supplying informational elements such as newsletters, publications, posters, advertising campaigns, and handouts.
Social influence	People's behavior is significantly influenced by their close social groupings, including friends, family, neighbors, and other community members. Social impact elements can be classified under the following categories: - Social networks and block leaders, - Making of public commitments, - Feedback and modeling
Nudges and Choice Architecture	• Social norms and frequent feedback; • A shift in default options or green default; • A rephrasing of the context (e.g., emphasizing benefits to society rather than individual sacrifice); • The usage of eco-labels or information sharing; • The physical environment changes.
Incentives	**Financial and non-financial incentives:** - Monetary incentives (such as cash bonuses or direct payments); - Lottery winnings or discount fees; - Non-monetary incentives (such as presents or coupons that cannot be immediately converted into cash).

Source: created by the authors, based on Abrahamse & Steg (2013); Schubert, 2017; Alberini, 2018; Wallen & Daut, 2018; Grilli & Curtis, 2021; Miłaszewicz, 2022.

Even though these techniques have demonstrated promise, their efficacy could vary depending on the situation, and larger-scale implementations frequently yield less reliable results than smaller tests. This shows that while behavioral interventions show promise, they might need to be carefully planned and implemented in order to produce noticeable energy savings, and the majority of behavioral tools are more effective when used in certain combinations with other tools (Composto&Weber, 2022; Lucas, 2022).

5. Barriers to climate change mitigation in households

Various barriers prevent the market from adopting greater energy efficiency (Agyarko et al., 2020; Asante et al., 2020; Streimikiene et al., 2020) These barriers are multifaceted and include demographic, economic, behavioral, and infrastructural challenges, and understanding them is crucial to developing effective strategies to strengthen climate mitigation efforts at the household level (González-Hernández et al., 2023; Su, 2023). A thorough explanation of these obstacles can be found in Table 4.

Table 4. Household barriers to mitigating climate change

Types of barriers	The main barriers
Economic and financial barriers	• High price of energy-saving technologies • High initial capital costs • Difficulties in obtaining financing for energy-saving initiatives • Unfavourable rules for electricity pricing
Market barriers	• Issues obtaining credit • Insufficient technical or business expertise • Technology deficiency in the local market
Information and knowledge (social) barriers	• Insufficient understanding and awareness of the financial advantages of energy-saving devices • Cost-effectiveness and payback period uncertainties • RES projects and the "not in my backyard" (NIMBY) problem
Technical barriers	• Difficulties related to microgeneration technologies in buildings, • Lack of investment in research and development of increasing energy efficiency • Scarcity of technical understanding and skills
Institutional or regulatory (political) barriers	• Ineffective government policies; lack of trust in governments policy • Legal framework issues • Lack of monitoring equipment • The absence of standards or their inadequate implementation • Insufficient level of energy services
Behavioral barriers	• Negative attitude towards new technologies; resistance to change • Low priorities for the environmental concern • Insufficient saving habits • Issues of time, focus, and the information-processing skills

Source: created by the authors, based on Agyarko et al., 2020; Lu et al., 2020; Asante et al., 2020; Streimikiene et al., 2020.

Climate change mitigation measures must focus on removing barriers (Streimikiene et al., 2020; Moberg et al., 2021; González-Hernández et al., 2023; Voronina et al., 2024). We have analyzed and systematized the climate change mitigation factors by groups, distinguishing their connections with identified barriers. This relationship can be seen in Table 5.

Table 5. The relationship between household climate change mitigation barriers and measures to overcome them

Policies and measures		What barrier addressed
Economic and market measures	• ESCO model; • energy efficiency certificates; • administrative pricing tools, such as feed-in premiums and feed-in tariffs.	Economic and financial barriers; Behavioral barriers
Financial instruments	• subsidies, • grants; • credits for RES production technologies; • rebates and assurances	Economic and financial barriers; Behavioral barriers
Fiscal means	• GHG taxes;	Economic and financial barriers;

	• taxes for excessive energy consumption; • deductions from taxation; • tax credits and incentives.	Institutional or regulatory (political) barriers Behavioral barriers
Regulation instruments	• mandatory minimum efficiency standards for buildings and appliances; • management of energy demand programs; • programs for mandatory regular billing for energy used; • setting of targets for RES energy extraction (quotas)	Institutional or regulatory (political) barriers; Market barriers; Technical barriers Behavioral barriers
Information and communication means	• educational and awareness campaigns; • product labeling.	Information and knowledge (social) barriers; Behavioral barriers
Behavioral change measures	• low-cost motivational methods ("nudges"); • competence and knowledge enhancement interventions; • social initiatives	Behavioral barriers; Information and knowledge (social) barriers;

Source: created by the authors

Household climate change mitigation involves economic, social, technical, political and behavioral challenges. Greater accessibility to low-carbon alternatives, more robust government regulations, and motivating factors like support systems and the positive feelings connected to environmental effects are all needed to overcome obstacles (Moberg et al., 2021). In order to formulate effective policies, priority should be given to identifying these barriers and implementing measures that promote sustainable choices (González-Hernández et al., 2023; Su, 2023).

6. Case study: climate change mitigation policies and measures in the households sector of EU MS

The EU household sector is a significant energy user and producer of carbon emissions, mainly from heating and cooling, lighting, and energy appliances. Households account for 25-30% of the overall energy use, making them a substantial consumer in EU countries. The primary energy sources for EU households are natural gas, electricity, heating oil, renewable energy, and district heating. The main source of energy consumption and GHG emissions in residential sector is space heating (around 65-70%), followed by water heating (around 15%), and smaller shares for cooking and powering electrical appliances (Eurostat, 2024).

The residential sector contributes around 17-20% of overall CO_2 emissions from fuel combustion in EU. Carbon emissions from households have generally been decreasing, driven by enhancements in buildings' energy efficiency, increased use of renewables and stricter standards for buildings and appliances.

One of the main problems in addressing household energy efficiency is the complex and often hard-to-change nature of household behavior, which is influenced by a multitude of determinants. (Vasseur et al., 2019). Therefore, the household sector is marked as an important contributor to the European Parliament's Energy Efficiency Directive target, as it accounts for roughly one-third of the total EU energy consumption and 16% of the EU's carbon emisisons (Collado & Marina, 2021).

To understand the complex dynamics of household energy consumption, researchers have explored a variety of thematic domains, each with its own assumptions and limitations. One study found that energy demand in the residential sector is heavily affected by the living standards of energy users and that unawareness about the energy services influences energy bill. This fact does not allow for the rationalization energy use by implementing specific actions (Trotta et al., 2018).

The main energy policy documents aim to stimulate households' acceptance and implementation of energy-efficient technologies. This is a key strategy formulated by the EU and national governments to reduce GHG emissions and mitigate climate change. There is a common understanding that promoting renewables, particularly solar photovoltaic systems and electric vehicles, can benefit to energy efficiency in households, but there is also a risk that current policies can lead to unintended consequences. Financial benefits of solar PV for some households can negatively impact others, particularly those with lower incomes. There is a need for carefully designed policies that promote RES adoption while ensuring a fair allocation of costs and benefits across all consumer groups (Strielkowski et al., 2019).

Despite the complexity of the issue, there are many policies and measures that have been proposed and implemented to remove the barriers to energy efficiency in the household sector. These measures encompass economic instruments like energy and carbon taxes, subsidies, soft loans, and another financial stimulus to encourage investment in energy efficiency upgrades; regulatory approaches like building energy codes and appliance standards; information-based policies like public awareness campaigns and home energy audits; and collaborative efforts involving utility companies, local government and community actions to encourage behavioral changes and adopt energy-efficient technologies (Girod et al., 2017).

It is important to understand which policies and measures work best in order to improve future regulations and to enable EU countries to achieve desired energy efficiency targets.

Table 6 systematizes policies and measures aimed at increasing energy efficiency in households in EU member states.

One can notice that most policies and measures are found in the group of Standards for electrical appliances, and their variations are implemented in most EU countries. Then, the Subsidies group, especially common are Subsidies for efficient/renewable heating technologies and Subsidies for building renovation. The latter can be found in almost all EU member states.

Meanwhile, only a few countries implement policies and measures such as Negotiated/Voluntary agreements, Tariffs, Mandatory use of PV thermal energy, Compulsory substitution of old boilers, and VAT reduction on equipment.

Table 6. Policies and measures to increase energy efficiency in households of EU member states

Policy/Measure Type	Details	Countries Implemented
Labels	**Electrical Appliances**: Mandatory labeling	BE, BG, CY, FR, DE, EL, HU, IT, LV, LT, NL, PT, SK, SI, ES
	Heating Equipment: Mandatory labeling	BE, FR, DE, HU, IT, PT, RO, SK
Standards	**Appliances**: Minimum efficiency standards	BE, CZ, DK, DE, EL, IT, LV, LT, LU, SK, ES
	Lighting: Efficient lighting measures	BE, CZ, IE, IT, LU, RO
	Heating Systems: Control systems, pipe insulation, solar energy use	DK, LU, IT, ES, DE, HU, LV, NL, RO, SK
Subsidies	**Renovations**: For building improvements, renewables	AT, BE, BG, CY, CZ, DK, DE, FR, EL, HU, IT, LV, LT, NL, PL, RO, SI, ES, SE
	Efficient Appliances: For highly efficient models	BE, CY, DE, SK, SI
	New Construction: Supporting efficient new buildings, renewables	AT, BE, CY, CZ, DE, LV, PL, SI, ES, SE
Financial Instruments	**Soft Loans**: Energy efficiency-focused loans	BE, CY, CZ, FR, LV, LT, NL, PL, PT, SK, SI, ES
	Tax Benefits: Tax credits or VAT reductions	BE, FI, FR, DE, IT, LV, NL, PL, SE
Information/Training	**Campaigns**: Informative energy-saving campaigns	AT, BE, BG, CY, CZ, DK, FI, FR, EL, LV, LT, NL, SK, SE
	Smart Metering: Billing and usage information	AT, BE, BG, FI, FR, DE, EL, LV, NL, ES
Market-Based Instruments	**Technology Procurement**: Promoting efficient technologies	LV, SK, ES, SE
Other	**Voluntary Agreements**: Negotiated energy-saving agreements	FI
General Programs	Broad energy efficiency initiatives	AT, IE, LV, LU, MT, NL, PL

Source: created by authors based on Odyssee-Mure (2024)

Table 7 provides the impacts of the most effective energy efficiency policies on energy savings in EU countries' household sectors based on Odyssee-Mure (2024) project results.

Table 7. The impacts of the most effective energy efficiency policies on energy savings in the household sector in EU countries

Country	Policy Type	Energy Savings (2030, PJ)
Austria	Climate and Energy Strategy (General Programme)	1.13
	Renewable Energy Action Plan (General Programme)	1.61
	Energy Performance of Buildings Directive (EPBD)	1.61
Belgium	Ecodesign Directive Transposition (Mandatory Standards)	1.79
Bulgaria	Residential Building Renovation (Financial)	0.09
	Solid Fuel Stove Replacement (Financial)	0.30
Croatia	Energy Renovation of Single/Multi-Family Houses	3.90
Cyprus	Photovoltaic Systems Installation (Financial)	0.09
Czechia	New Green Savings Programme (Financial)	14.27
	Solid Fuel Boiler Ban (Mandatory Standards)	8.00
	Energy Efficiency Campaign (Information)	3.33
Denmark	Heat Pump Subsidy (Financial)	0.56
Estonia	Apartment Renovation Programmes (Financial)	0.44
Finland	Zero-Energy Building Regulations (Mandatory Standards)	2.72
France	Building Codes (Mandatory Standards)	126.64
Germany	Energy-Efficient Building Tax Incentives (Fiscal)	52.40
Greece	Rooftop Photovoltaics Programme (Financial)	0.54
Hungary	Home Renovation Subsidy (Financial)	1.34
Ireland	Residential Retrofit Programme (General Programme)	0.39
Italy	Superbonus Tax Reduction (Financial, Fiscal)	4.02
Latvia	Minimum Energy Efficiency Standards (Mandatory)	0.40
Lithuania	Renewable Energy Directive Implementation (Financial)	0.48
Luxembourg	Klimabonus Wunnen Scheme (Financial)	1.50
Malta	Electricity Tariff Structure (Fiscal)	0.02
Netherlands	National Heat Fund (Financial)	2.12
Poland	Clean Air Programme (Financial)	17.93
Portugal	Renewable Energy Microgeneration (Financial)	0.63
Romania	Long-term Building Renovation Strategy (Mandatory Standards)	34.75
Slovakia	White Goods Replacement (Financial, Market-Based)	0.12
Slovenia	Multi-Dwelling Legal Standards (Mandatory Standards)	0.05
Spain	Social Housing Rehabilitation (Financial)	3.09
Sweden	Low Energy Building Programme (Financial)	0.97

Source: created by authors based on Odyssee-Mure (2024)

As one can notice from Table 7, the key climate change mitigation policies and measures in the household sector of EU countries include building renovation schemes, renewable energy incentives, and energy performance standards. The energy savings by 2030 vary by country and policy measure, with notable contributions from large-scale programs in such countries as France (building codes, 126.64 PJ), Germany (tax incentives, 52.40 PJ), and Romania (renovation strategies, 34.75 PJ). Financial and fiscal measures, such as subsidies and tax incentives, are widely used to encourage the adoption of energy-efficient practices. Overall, these policies can significantly reduce energy consumption and GHG emissions in the household sector.

Table 8 provides the most successful policies and measures in the transport sector and their scores according to the main criteria. The criteria for ranking are the same as in previous chapters: Making a significant impact and attracting many applicants; Being cost-effective for the person or organization implementing it; Having the potential to transform the market and energy services; Being able to overcome barriers to energy efficiency; Be easy and stable to refinance financial measures; Ensure that the savings from the measure continue over time; Can be transferred between different countries; Connect to other measures and policy package; Have good practice with the measure; Avoid negative side-effects; Have positive side-effects and Be easy for relevant stakeholders to accept.

Table 8. The most successful policies and measures in the household sector of EU countries

Policy/Measure	Type	Score
Renovation of apartment buildings (2022-2030)	Financial	4.5
"Saving at Home" Programme	Financial	4.3
Renovation in Ida-Viru County	Financial	4.3
Energy Transition Tax Credit (CITE)	Fiscal	4.1
Energy Use Rules in Buildings	Mandatory Standards/Info	4.1
France Rénov (One-stop Renovation Shops)	Information/Training	4.0
PAREER-CRECE Energy Rehabilitation Programme	Financial	4.0
Austrian Federal Renovation Initiative	Financial	4.0
Energy Efficiency Agreement for Property Sector	Others	3.9
Net Metering for Residential Photovoltaic Systems	Financial	3.9
Technical Building Code (CTE)	Mandatory Standards	3.9
Regulation of Thermal Installations in Buildings (RITE)	Mandatory Standards	3.9
KfW Programme for Energy-Efficient Refurbishment	Financial	3.9
Building Codes on Thermal Performance	Mandatory Standards/Info	3.9
Better Energy Homes Retrofit Programme	Financial	3.8
Energy Performance Certificates (EPBD)	Mandatory Info	3.8
Financial Incentives for Renovation and Construction	Financial	3.8
Grants for Built Environment Energy Savings	Financial	3.7
Smart Meter Installation	Financial/Info Training	3.7
Building Regulations for New Buildings	Mandatory Standards	3.7

Source: created by authors based on Odyssee-Mure (2024)

In Table 8, the most successful energy efficiency policies in the household sector across EU countries are summarized by highlighting their type and effectiveness. Scores for these policies range from 3.6 to 4.5, reflecting their effectiveness in improving energy efficiency. One can notice that financial measures dominate, including renovation programs for buildings (e.g., Austria and Ida-Viru County in Estonia), incentives for photovoltaic systems, and grants for energy savings. Mandatory standards and information policies, such as the Energy Performance of Buildings Directive (EPBD) and technical building codes, also play a crucial role. Information and training initiatives, like France Rénov, support energy renovation efforts. Fiscal measures, such as tax credits, complement these strategies.

Conclusions

Energy efficiency and sustainable energy use in households are key measures to reduce GHG emissions and achieve climate change mitigation goals. Nevertheless, a number of obstacles prevent households from implementing effective climate change mitigation strategies. Our systematic and bibliographic analysis of the literature showed that aligning policymaking with household preferences can effectively inspire them to implement more sustainable energy use practices, ultimately reducing energy consumption and environmental impact.

Research on climate change mitigation policies and measures in the residential sector has been growing in recent years and covers all aspects of sustainable development—economic, environmental, and social. However, renewable energy investments, energy conservation, and other climate change mitigation measures are influenced by consumer choices, and there is still a lack of policy-making linking to this.

Based on empirical data analysis in 2023, the top-performing EU countries in household energy efficiency were Luxembourg, Germany, the Netherlands, France, and Latvia. The highest household energy savings in 2021 were observed in Luxemburg, Malta, Ireland, Slovenia, and the Netherlands. The lowest were in Cyprus, Bulgaria, Italy, Hungary, and Poland.

The household sector in the European Union is a major consumer of energy and producer of carbon emissions, accounting for 25-30% of the EU's total energy use and 17-20% of its total CO2 emissions. Household energy consumption is primarily for space heating, water heating, and powering appliances. Key challenges in addressing household energy efficiency include the complex and hard-to-change nature of household behavior. To reduce GHG emissions, the EU and national governments have implemented various policy measures, such as economic instruments, regulatory approaches, information-based policies, and collaborative efforts.

Standards for electrical appliances and their variations are the most widely implemented energy efficiency policies across the EU, followed by subsidies, particularly for efficient/renewable heating technologies and building renovations. In contrast, policies like negotiated/voluntary agreements, tariffs, mandatory use of solar thermal energy, compulsory boiler replacement, and VAT reductions are less commonly adopted by only a few EU member states.

The key criteria used to evaluate the most prosperous household sector policies and measures include their potential impact, cost-effectiveness, transformative ability, overcoming barriers, financial stability, long-term savings, transferability, integration with other initiatives, prior experience, and stakeholder acceptance. Estonia, Slovenia, Finland, and Cyprus are the top EU countries with successful and innovative household energy efficiency measures.

In summary, it can be stated that in order to achieve effective results in developing and implementing a policy for climate change mitigation in households, the involvement of all stakeholders and the assessment of their preferences are necessary. There are various measures to encourage climate change mitigation in the residential sector, which can be divided into energy efficiency and renewable resources policy measures. However, in order to achieve an effective policy, it is important to combine these measures with tools to promote a sustainable lifestyle. The application of financial and regulatory instruments should be supplemented by non-monetary instruments aimed at changing the behavior of residents. Solutions for sustainable energy use in households depend on consumer decision-making; therefore, one of the key measures to achieve GHG emissions reduction and solve climate change problems remains to increase the awareness and competencies of residents, which would influence the adoption of desired decisions. To create effective policies, it is essential to comprehend these interactions.

References

Abrahamse, W., Steg, L. (2013). Social influence approaches to encourage resource conservation: A meta-analysis. *Global Environmental Change*, 23(6), 1773-1785, https://doi.org/10.1016/j.gloenvcha.2013.07.029;

Agyarko, K.A., Opoku, R., Van Buskirk, R. (2020). Removing barriers and promoting demand-side energy efficiency in households in Sub-Saharan Africa: A case study in Ghana. *Energy Policy*, 137, 111149, https://doi.org/10.1016/j.enpol.2019.111149;

Agupugo, C.P., Ajayi, A.O., Nwanevu, C., Oladipo, S.S. (2024). Policy and regulatory framework supporting renewable energy microgrids and energy storage systems. *Engineering Science & Technology Journal*, 5 (8), https://doi.org/10.51594/estj.v5i8.1460;

Akil, Y.S., Mangngenre, S., Said, S.M., Amar, K., Yunus, A.M.S. (2023). Factors influencing urban consumers on selecting electricity saving home appliances for managing energy consumption in Indonesia. *Cogent Engineering*, 10 (2), https://doi.org/10.1080/23311916.2023.2287299;

Alberini, A. (2018). Household energy use, energy efficiency, emissions, and behaviors. *Energy Efficiency*, 11, 577–588. https://doi.org/10.1007/s12053-017-9597-1;

Asante, D., He Z., Adjei, N.O., Asante, B. (2020). Exploring the barriers to renewable energy adoption utilising MULTIMOORA- EDAS method. *Energy Policy*, 142, 111479, https://doi.org/10.1016/j.enpol.2020.111479;

Balcerzak, A. P., Uddin, G. S., Igliński, B., & Pietrzak , M. B. (2023). Global energy transition: From the main determinants to economic challenges. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, *18*(3), 597-608. https://doi.org/10.24136/eq.2023.018.

Balcerzak, A., Uddin, G. S., Dutta, A., Pietrzak, M. B., & Igliński, B. (2024). Energy mix management: A new look at the utilization of renewable sources from the perspective of the global energy transition. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, *19*(2), 379-390. https://doi.org/10.24136/eq.3158.

Barrella, R., Linares, J.I., Romero, J.C., Arenas, E. (2023). Evaluating the impact of energy efficiency strategies on households' energy affordability: A Spanish case study. *Energy and Buildings*,295 (15), 113289, https://doi.org/10.1016/j.enbuild.2023.113289;

Bertoldi. P., Economidou. M. (2018). EU member states energy efficiency policies for the industrial sector based on the NEEAPs analysis. *Ace Industrial Summer Study Proceedings*, 117-127, https://doi.org/10.1016/j.enpol.2020.111320;

Bjelle, E.L., Steen-Olsen, K., Wood, R. (2018). Climate change mitigation potential of Norwegian households and the rebound effect. *Journal of Cleaner Production*, 172, 208-217. https://doi.org/10.1016/j.jclepro.2017.10.089;

Bonan, J., Cattaneo, C., d'Adda, G., Tavoni, M. (2020). The interaction of descriptive and injunctive social norms in promoting energy conservation. *Nature Energy*, 5, 900–909, https://doi.org/10.1038/s41560-020-00719-z;

Caballero, N., Ploner, M. (2022). Boosting or nudging energy consumption? The importance of cognitive aspects when adopting non-monetary interventions. *Energy Research & Social Science*, 91, 102734, https://doi.org/10.1016/j.erss.2022.102734;

Chel, A., Kaushik, G. (2018). Renewable energy technologies for sustainable development of energy efficient building. *Alexandria Engineering Journal*, 57, 655–669, https://doi.org/10.1016/j.aej.2017.02.027;

Collado, R R., & Marina, E. (2021). The role of energy efficiency in assessing the progress towards the EU energy efficiency targets of 2020: Evidence from the European productive sectors. *Energy Policy*, 156, 112441 https://doi.org/10.1016/j.enpol.2021.112441.

Colasante, A., D'Adamo, I., Morone, P. (2022). What drives the solar energy transition? The effect of policies, incentives, and behavior in a cross-country comparison. *Energy Research & Social Science*, 85, 102405, https://doi.org/10.1016/j.erss.2021.102405;

Composto, J., Weber, E.U. (2022). Effectiveness of behavioral interventions to reduce household energy demand: A scoping review. *Environmental Research Letters*, 17 (6), https://doi.org/10.1088/1748-9326/ac71b8;

de Ayala, A., Foudi, S., Solà, M., López-Bernabé, E., Galarraga, I. (2021). Consumers' preferences regarding energy efficiency: a qualitative analysis based on the household and services sectors in Spain. *Energy Efficiency*, 14 (3), https://doi.org/10.1007/s12053-020-09921-0;

Dobbins, A., Fahl, U. (2023). Effects of Carbon Tax Redistribution Schemes on Energy Welfare of Households in Germany. In: *Bardazzi, R., Pazienza, M.G. (eds) Vulnerable Households in the Energy Transition.* Studies in Energy, Springer, Cham, 139-171, https://doi.org/10.1007/978-3-031-35684-1_7;

Dubois, G., Sovacool, B., Aall C., Nilsson, M. *et al* (2019). Does it start at home? Climate policies targeting household consumption and behavioral decisions are key to low-carbon futures. *Energy Research & Social Science*, 52, 144-158, https://doi.org/10.1016/j.erss.2019.02.001;

D'Adda, G., Gao, Y., Tavoni, M. (2022). A randomized trial of energy cost information provision alongside energy-efficiency classes for refrigerator purchases. *Nature Energy*, 7, 360–368, https://doi.org/10.1038/s41560-022-01002-z;

Economidou, M., Todeschi, V., Bertoldi, P., D'Agostino, D., Zangheri, P., Castellazzi, L. (2020). Review of 50 years of EU energy efficiency policies for buildings. *Energy and Buildings*, 225, 110322. https://doi.org/10.1016/j.enbuild.2020.110322;

Eurostat (2024) Energy consumption decomposition analysis on EU-27 and EU-27 members - 2023 edition. Available at: https://ec.europa.eu/eurostat/documents/3888793/18455312/KS-TC-23-006-EN-N.pdf/943cee29-14a9-4003-70f4-6ead6912f00a?version=1.0&t=1707312893910

Fang, X., Goette, L., Rockenbach, B., Sutter, M., Tiefenbeck, V., Schoeb, S., Staake, T. (2023). Complementarities in Behavioral Interventions: Evidence from a Field Experiment on Energy Conservation. *Journal of Public Economics*, 228, 105028, https://doi.org/10.1016/j.jpubeco.2023.105028;

Girod, B., Stucki, T., & Wörter, M. (2017). How do policies for efficient energy use in the household sector induce energy-efficiency innovation? An evaluation of European countries. *Energy Policy* 103, 223-237. https://doi.org/10.1016/j.enpol.2016.12.054.

Grilli, G., Curtis, J. (2021). Encouraging pro-environmental behaviors: A review of methods and approaches. *Renewable and Sustainable Energy Reviews*, 135, 110039. https://doi.org/10.1016/j.rser.2020.110039;

González-Hernández, D.L., Aguirre-Gamboa, R.A., Meijles, E.W. (2023). The role of climate change perceptions and sociodemographics on reported mitigation efforts and performance among households in northeastern Mexico. *Environ Dev Sustain*, 25, 1853–1875, https://doi.org/10.1007/s10668-021-02093-6;

Gonzalez-Torres, M., Bertoldi, P., Castellazzi, L., Perez-Lombard, L. (2023). Review of EU product energy efficiency policies: What have we achieved in 40 years?. *Journal of Cleaner Production*, 138442, https://doi.org/10.1016/j.jclepro.2023.138442;

Hafez, F.S., Sa'di, B., Gamal, S.M., Yap, T.Y.H., *et al* (2023). Energy Efficiency in Sustainable Buildings: A Systematic Review with Taxonomy, Challenges, Motivations, Methodological Aspects, Recommendations, and Pathways for Future Research. *Energy Strategy Reviews*, 45, 101013, https://doi.org/10.1016/j.esr.2022.101013;

Hartono, D., Indriyani, W., Iryani, B.S., Komarulzaman, A., Nugroho, A., Kurniawan, R. (2023). Carbon tax, energy policy, and sustainable development in Indonesia. *Sustainable Development*, 31(4), 2332-2346, https://doi.org/10.1002/sd.2511;

He, Y., Wan, L., Zhang, M., Zhao, H. (2022). Regional Renewable Energy Installation Optimization Strategies with Renewable Portfolio Standards in China. *Sustainability*, 14(17), 10498; https://doi.org/10.3390/su141710498;

Jacksohn, A., Grösche, P., Rehdanz, K., Schröder, K. (2019). Drivers of renewable technology adoption in the household sector. *Energy Economics*, 81, 216-226, https://doi.org/10.1016/j.eneco.2019.04.001;

Khalid, B., Urbański, M., Kowalska-Sudyka, M., Wysłocka, E., Piontek, B. (2021). Evaluating Consumers' Adoption of Renewable Energy. *Energie,* 14(21), 7138; https://doi.org/10.3390/en14217138;

Koengkan, M., Fuinhas, J.A., Auza, A., Ursavaş, U. (2023). The Impact of Energy Efficiency Regulations on Energy Poverty in Residential Dwellings in the Lisbon Metropolitan Area: An Empirical Investigation. *Sustainability*, 15(5), 4214, https://doi.org/10.3390/su15054214;

Kontautienė, R., Stravinskas, T., & Barkauskas, V. (2024). Forecasts of sustainable consumption in small economies. *Journal of International Studies, 17*(2), 9-37. doi:10.14254/2071-8330.2024/17-2/1

Kovač, V., Vochozka, M., Fulajtárová M., Janíková J.. (2023). Management of reduced CO2 emission production in meal delivery using point a point-to-point system. *Polish Journal of Management Studies*, 28(2), 142-160. https://doi.org/10.17512/pjms.2023.28.2.09.

Kumar, P., Caggiano, H., Shwom, R., Felder, F.A., Andrews, C.J. (2023). Saving from home! How do income, efficiency, and curtailment behaviors shape energy consumption dynamics in US households? *Energy,* 271, 126988, https://doi.org/10.1016/j.energy.2023.126988;

Kuperstein-Blasco, D., Valta, J., Mäkinen, S.J. (2022). Household support to adopt preventive innovations to mitigate climate change: A case of Finnish apartment buildings. *2022 IEEE 28th International Conference on Engineering, Technology and Innovation (ICE/ITMC) & 31st International Association For Management of Technology (IAMOT) Joint Conference*, 1-8, https://doi.org/10.1109/ICE/ITMC-IAMOT55089.2022.10033288;

Lee, K. (2023). Renewable portfolio standards and electricity prices. *Energy Economics*, 126, 106959, https://doi.org/10.1016/j.eneco.2023.106959;

Lekavičius, V., Bobinaitė, V., Galinis, A., Pažėraitė, A. (2020). Distributional impacts of investment subsidies for residential energy technologies. *Renewable and Sustainable Energy Reviews*, 130, 109961, https://doi.org/10.1016/j.rser.2020.109961;

Liao, S. (2020). Coping with the Renewable Portfolio Standards: A utility's perspective. *Operations Research Letters*, 48 (4), 393-396, https://doi.org/10.1016/j.orl.2020.05.001;

Liao, X., Shen, S.V., Shi, X. (2020). The effects of behavioral intention on the choice to purchase energy-saving appliances in China: the role of environmental attitude, concern, and perceived psychological benefits in shaping intention. *Energy Efficiency*, 13, 33–49, https://doi.org/10.1007/s12053-019-09828-5;

Liu, G., Ye, K., Tan, Y., Huang, Z., Li, X. (2022). Factors influencing homeowners' housing renovation decision-making: Towards a holistic understanding. *Energy and Buildings*, 254(1), 111568, https://doi.org/10.1016/j.enbuild.2021.111568;

Lu, J., Ren, L., Yao, S., Rong, D., Skare, M., Streimikis, J. (2020). Renewable energy barriers and coping strategies: Evidence from the Baltic States. *Sustainable Development*, 28(1), 352-367, https://doi.org/10.1002/sd.2030;

Lucas, B. (2022). Behavior Change Interventions For Energy Efficiency. *K4D Helpdesk Report 1232*, Institute of Development Studies, https://doi.org/10.19088/K4D.2022.138;

Lyeonov, S., Toušek, Z., Bozhenko, V., & Kérmárki-Gally, S. E. (2023). The impact of corruption in climate finance on achieving net zero emissions. *Journal of International Studies*, *16*(1), 142-159. doi:10.14254/2071-8330.2023/16-1/10

Mardones, C. (2024). Contribution of the carbon tax, phase-out of thermoelectric power plants, and renewable energy subsidies for the decarbonization of Chile − A CGE model and microsimulations approach. *Journal of Environmental Management*, 352, 120017, https://doi.org/10.1016/j.jenvman.2024.120017;

Markard, J., Truffer, B. (2006). The promotional impacts of green power products on renewable energy sources: direct and indirect eco-effects. *Energy Policy*, 34(3), 306-321. https://doi.org/10.1016/j.enpol.2004.08.005;

Matsumoto, S. (2023). The effects of carbon taxes on the welfare of households using multiple energy sources. *Energy Economics*, 126, 106924, https://doi.org/10.1016/j.eneco.2023.106924;

Maxim, A., Jijie, D.T., Roman, T. (2022). Why Are Households Willing to Pay for Renewable Energy? Lessons From Romania. *Environmental Economics and Management*, 10, https://doi.org/10.3389/fenvs.2022.921152;

McCarthy, B. (2024). Green, guilty, and frugal: Facilitators of energy saving and the choice of energy-efficient appliances in the Australian energy market. *Energy Strategy Reviews*, 53, 101400, https://doi.org/10.1016/j.esr.2024.101400;

Mele, C., Russo, Spena, T., Kaartemo, V., Marzullo, M.L. (2021). Smart nudging: How cognitive technologies enable choice architectures for value co-creation. *Journal of Business Research*, 129, 949-960, https://doi.org/10.1016/j.jbusres.2020.09.004;

Miłaszewicz, D. (2022). Survey Results on Using Nudges for Choice of Green-Energy Supplier. *Energies*, 15(7), 2679; https://doi.org/10.3390/en15072679;

Mishchuk, H., Czarkowski, J. J., Neverkovets, A., & Lukács, E. (2023). Ensuring Sustainable Development in Light of Pandemic "New Normal" Influence. *Sustainability*, *15*(18), 13979. https://doi.org/10.3390/su151813979

Moberg, K.R., Sovacool, B.K., Goritz, A., Hinojosa, G.M., Aal, C., Nilsson, M. (2021). Barriers, emotions, and motivational levers for lifestyle transformation in Norwegian household decarbonization pathways. *Climatic Change,* 165, 3, https://doi.org/10.1007/s10584-021-03018-y;

Mukhtarov, S., Aliyev, J., Borowski, P.F., & Disli, M. (2023). Institutional quality and renewable energy transition: Empirical evidence from Poland. *Journal of International Studies*, *16*(3), 208-218. doi:10.14254/2071-8330.2023/16-3/12

Mukhtarov, S., Aliyev, J., Jabiyev, F., & Aslan, D. H. (2024). The role of institutional quality in reducing environmental degradation in Canada. *Economics and Sociology, 17*(1), 89-102. doi:10.14254/2071-789X.2024/17-1/6

Nielsen K.S., Stern P.C., Dietz T., Gilligan J.M. et al (2020) Improving Climate Change Mitigation Analysis: A Framework for Examining Feasibility, *One Earth, 3(3),* 325-336, https://doi.org/10.1016/j.oneear.2020.08.007;

Oláh, J., Khan, K.A., Akhtar, M.A., & Chuluunbaatar, E. (2024). Take a ride on the green side: E-vehicle purchase intentions in the emerging economy context. *Economics and Sociology*, *17*(3), 267-290. doi:10.14254/2071-789X.2024/17-3/14

Parikh, K.S., Parikh, J.K. (2016). Realizing potential savings of energy and emissions from efficient household appliances in India. *Energy Policy, 97,* 102-111; https://doi.org/10.1016/j.enpol.2016.07.005;

Rahmani, A., Aboojafari, R., Taghizadeh-Hesary, F., Naeini, A.B., Mashayekh, J. (2024). Chapter 2: Consumers' behavioral economics in renewable energy. In: *A Modern Guide to Energy Economics*. Edward Elgar Publishing, , https://doi.org/10.4337/9781803927732.00010;

Raikar, S., Adamson, S. (2020). 2 - Public policy mechanisms to support renewable energy. In *Renewable Energy Finance, Theory, and Practice,* Academic Press, 9-19, https://doi.org/10.1016/B978-0-12-816441-9.00002-7;

Rau, H., Moran, P., Manton, R., Goggins, J. (2020). Changing energy cultures? Household energy use before and after a building energy efficiency retrofit. *Sustainable Cities and Society, 54,* 101983;

Ruokamo, E., Meriläinen, T., Karhinen, S., Räihä, J., Suur-Uski, P., Timonen, L., Svento, R. (2022). The effect of information nudges on energy saving: Observations from a randomized field experiment in Finland. *Energy Policy,* 161, 112731, https://doi.org/10.1016/j.enpol.2021.112731;

Schubert, C. (2017) Green nudges: Do they work? Are they ethical? *Ecological Economics, 132,* 392-342, https://doi.org/10.1016/j.ecolecon.2016.11.009;

Semieniuk, G., Taylor, L., Rezai, A., Foley, D.K. (2021). Plausible energy demand patterns in a growing global economy with climate policy. *Nature Climate Change*, *11,* 313–318, https://doi.org/10.1038/s41558-020-00975-7;

Silvi, M., Padilla, Rosa E. (2021). Reversing impatience: Framing mechanisms to increase the purchase of energy-saving appliances. *Energy Economics*, *103,* 105563, https://doi.org/10.1016/j.eneco.2021.105563;

Słupik, S., Kos-Łabędowicz, J., Trzęsiok, J. (2021). How to Encourage Energy Savings Behaviours? The Most Effective Incentives from the Perspective of European Consumers. *Energies*, *14,* 8009, https://doi.org/10.3390/en14238009;

Stankevičienė, J., & Borisova, J. (2022). Conceptual approach to valuation of climate change in EU countries through the prism of economic activities. *Economics, Management and Sustainability*, *7*(1), 6–16. https://doi.org/10.14254/jems.2022.7-1.1

Streimikiene, D., Balezentis, T., Alebaite, I. (2020). Climate Change Mitigation in Households between Market Failures and Psychological Barriers. *Energies*, *13(11),* 2797; https://doi.org/10.3390/en13112797;

Štreimikienė, D., Lekavičius, V., Stankūnienė, G., Pažėraitė, A. (2022). Renewable Energy Acceptance by Households: Evidence from Lithuania. *Sustainability*, *14(14),* 8370; https://doi.org/10.3390/su14148370

Strielkowski, W., Volkova, E., Pushkareva, L., Streimikiene, D. (2019). Innovative Policies for Energy Efficiency and the Use of Renewables in Households. *Energies*, *12(7),* 1392; https://doi.org/10.3390/en12071392;

Su, Y. (2023). The drivers and barriers of energy efficiency. *Energy Policy*, *178,* 113598, https://doi.org/10.1016/j.enpol.2023.113598;

Sutthichaimethee, P., Mentel, G., Voloshyn, V., Mishchuk, H., & Bilan, Y. (2024). Modeling the Efficiency of Resource Consumption Management in Construction Under Sustainability Policy: Enriching the DSEM-ARIMA Model. *Sustainability, 16* (24), 10945. https://doi.org/10.3390/su162410945

Trotta, G. (2020). Electricity awareness and consumer demand for information. *International Journal of Consumer Studies, 45(1),* 67-79, https://doi.org/10.1111/ijcs.12603;

Trotta, G., Spangenberg, J H., & Lorek, S. (2018). Energy efficiency in the residential sector: identification of promising policy instruments and private initiatives among selected European countries. *Energy Efficiency* 11(8), 2111-2135. https://doi.org/10.1007/s12053-018-9739-0.

Twumasi, M.A., Asante, D., Fosu, P., Essilfie, G., & Jiang, Y. (2022). Residential renewable energy adoption. Does financial literacy matter?. *Journal of Cleaner Production, 361(10),* 132210, https://doi.org/10.1016/j.jclepro.2022.132210;

Odyssee-Mure (2024). A decision-support tool for energy efficiency policy evaluation, available at https://www.odyssee-mure.eu/.

Uddin, G. S., Abdullah-Al-Baki, C., Donghyun , P., Ahmed, A., & Shu, T. (2023). Social benefits of solar energy: Evidence from Bangladesh. *Oeconomia Copernicana, 14*(3), 861-897. https://doi.org/10.24136/oc.2023.026.

Vasseur, V., Marique, A., & Udalov, V. (2019). A conceptual framework to understand households' energy consumption. *Energies,* 12(22), 4250-4250. https://doi.org/10.3390/en12224250.

Voronina, Y., Lopushynskyi, I., Grechanyk, B., Vahonova, O., Kondur, A., & Akimov, O. (2024). Economic and environmental components in the field of sustainable development management. *Calitatea , 25* (201), 7-14. DOI: 10.47750/QAS/25.201.02

Wallen, K.E., & Daut, E. (2018). The challenge and opportunity of behaviour change methods and frameworks to reduce demand for illegal wildlife. *Nature Conservation, 26,* 55-75, https://doi.org/10.3897/natureconservation.26.22725;

Widyanti, R., & Włodarczyk, A. (2023). Environmental strategies of energy companies during the covid-19 pandemic. *Polish Journal of Management Studies, 28(1),* 380-396. https://doi.org/10.17512/pjms.2023.28.1.22

Xu, Q., Li, S., Shen, L., Chang, R., Wang, Q-C., Liu, X., &Chen, Y. (2023). Pricing strategy for household energy-saving option (HESO): A novel option-based intervention for promoting household energy efficiency. *Environmental Impact Assessment Review, 98,* 106969, https://doi.org/10.1016/j.eiar.2022.106969;

Zhang, Y., Xiao, C., & Zhou, G. (2020). Willingness to pay a price premium for energy-saving appliances: Role of perceived value and energy efficiency labeling. *Journal of Cleaner Production, 242(1),* 118555, https://doi.org/10.1016/j.jclepro.2019.118555;

Zheng, M., Feng, G.-F., & Chang, C.-P. (2023). Is green finance capable of promoting renewable energy technology? Empirical investigation for 64 economies worldwide. *Oeconomia Copernicana, 14*(2), 483-510. https://doi.org/10.24136/oc.2023.013.

Zheng, J., Dang, Y., & Assad, U. (2024). Household energy consumption, energy efficiency, and household income–Evidence from China. *Applied Energy,* 353, Part A, 122074. https://doi.org/10.1016/j.apenergy.2023.122074;