D4.4|*Synthesis report on the "heating & cooling" case study*

Deliverable:	Synthesis report on the "heating & cooling" case study
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Executive summary

Reducing our final energy demand from fossil fuels is a necessary condition for establishing a more sustainable energy system across the EU. Moreover, it may offer multiple dividends by simultaneously mitigating problems with energy dependency, excessive greenhouse gas emissions, and improving the well-being of citizens. The present case study was elaborated within the framework of the ENABLE.EU research project, which has the aim to understand individual and collective energy choices in the areas of electricity, heating and cooling and transportation.

The aim of the present case study was to obtain better understanding of the factors that influence household behaviour related to heating and cooling, drawing on qualitative and quantitative research findings obtained in five countries: France, Germany, Hungary, Spain, and Ukraine.

Methodology

Based on initial scoping with pilot focus groups, each partner decided to focus on heating-related energy costs as a major problem area. We then combined secondary and primary research and qualitative and quantitative research methodologies to obtain new insight into this area. The major part of the project used focus-group-based qualitative techniques to shed light on the motivation for consumer behaviour. Focus groups make it possible to actively engage participants in a shared process of thinking. They generate a deeper understanding of the attitudes and opinions of households, the obstacles they face in their everyday lives, and the potential solutions they can identify and support.

We applied the method of participatory systems mapping (Sedlacko 2014) to help participants to build up shared scenarios regarding challenges and potential strategies for saving on heating-related expenses. In the framework of qualitative research a total of 24 focus groups were organized in the five participating countries between May 2017 and December 2017.

Country	France	Germany	Hungary	Spain	Ukraine	Total
Laymen	4	3	3	1	7	**18**
Expert	1	1	2	2	1	**6**
Total	**5**	**4**	**5**	**3**	**8**	**24**

Table E1. Number of focus groups conducted in the frame of qualitative research

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Some insights from early focus groups were also incorporated into the international household survey of ENABLE.EU. Data from 5006 households were collected, providing observations about relevant questions with responses numbering in the range of 700-1500 from partner countries.

Country	France	Germany	Hungary	Spain	Ukraine	Total
Method	On-line	F2F	F2F	F2F	F2F	
N	**1500**	**711**	**1022**	**760**	**1013**	**5006**

Table E1. Sample size of the survey implemented in participating countries

The survey tool focused on

(1) basic heating habits (e.g. indoor temperature, only heating rooms that are actually in use),
(2) challenges people face with reducing their heating-related energy bill, and
(3) public support for selected policy measures.

Results of the focus groups

Focus-group-based research shed light on the main challenges influenced by either beneficial or blocking strategies. Common challenges which are relevant to all or most of the participating countries include the following:

(1) technical status, and age and efficiency of heating system;

(2) characteristics of the dwelling in terms of age, condition, orientation, and location; state of insulation;

(3) controllability of indoor temperature;

(4) fuel types/renewable resources used for heating;

(5) level of fuel price;

(6) individual heating behaviour (preferred indoor temperature, heating heavily versus wearing more clothes, ventilation habits, heating when at home versus not at home, heating only the rooms in use etc.);

(7) diverging interests of tenants within a block of apartments and tenants and landlords.

Strategies were also collected during focus group events to help formulate policy recommendations. The strategies proposed by focus groups in the five participating countries can be classified into five themes:

(1) Information-sharing and communication (e.g. providing meaningful information on energy bills or energy saving options, practical advice on energy saving options);

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(2) awareness-raising of consumers and policy makers (eco-friendly behaviour, energy-saving attitude, avoiding illegal heating practices)

(3) community-based solutions (following opinion-leaders, self-controlled behaviour in communities, locally organised initiatives)

(4) provision of technological solutions (e.g. programmable thermostats, individual metering, alternative fuels);

(5) financial measures (e.g. affordable loans), and

(6) tools for fighting energy poverty.

Using laymen and expert groups in parallel helped shed light on the slightly different perspectives of these participants regarding energy-related information. The idea of providing more solution-oriented advice received more support from citizens than information about their energy consumption.

Results of the household survey

The survey shed light on cultural differences in heating habits and attitudes towards different policy options and reinforced the insights received from the focus groups regarding most issues. It also revealed overlapping and common issues among the five participating countries.

One of the most important insights is related to the comfort temperature which may be a significant explanatory factor for the varying heating-related energy requirements. Households in which the temperature is controlled manually are associated with higher winter indoor temperatures than households where there is no temperature control, which is in opposition to the common belief. Also, a significant share of people (some 25%) tend to overcompensate for the weather, maintaining a higher indoor temperature in winter than in the summer. Besides the energy costs of this high 'energy step', the difference between the indoor and outdoor temperature might have undesirable health effects.

Diverse interests in the case of rented dwellings and multi-apartment buildings also hinder energy-saving measures. Owners are not always interested in carrying out investments as benefits are usually enjoyed by tenants. Furthermore, in multi-apartment buildings the implementation of major refurbishments may need consensus among all inhabitants, which is a further barrier to change.

Financial challenges are present in each of the five studied countries, dominating most in Ukraine and Spain. Insufficient financial resources and the lack of available loan and subsidy programs are highly relevant problems in each country. Calculating the payback on investment seems to be a major problem in Germany and Spain, while considered to be less important by

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households in Hungary and France. People may have more pressing challenges and not feel that the issue of payback is that important.

Consumers are often locked into unsustainable lifestyles by circumstances even though they are not willing nor happy to act unsustainably. These lock-ins may have life-stage related, financial, cultural, legal or technological reasons that make it hard for citizens to reduce their energy consumption. After raising children, the elderly may find their dwellings to be too large, but still difficult to sell because of the unfavourable location or low value. Dwellings in old buildings may also be of low value compared to the prospective costs of refurbishment. Monument-protection-related legislation may not permit certain kinds of refurbishment technologies.

Citizens lack meaningful information about their energy consumption in most countries and complain about their energy bills being overly complicated. Expert focus groups in several countries, including Germany and Hungary, argued that energy bills are not easy to understand, particularly by low-income households. A significant share of people feels that getting feedback about actual energy consumption is not frequent enough, although there is large variation across countries.

Triple-dividend strategies

Some strategies were identified as offering a triple dividend in terms of reducing energy consumption and carbon footprints and improving well-being in terms of health and/or comfort.

Maintaining a healthy temperature by avoiding overheating or overcooling generates health benefits, energy benefits and cost benefits. This strategy assumes awareness-raising and trustworthy communication. Increasing the use of thermostats as a technological solution may help correct some poor heating-related habits.

Community-based projects may have benefits that go beyond the economic gains made by saving on energy costs, and the environmental benefits of less pollution. They can promote a better community life and foster inclusion, whereby shared practices encourage members of the community to discover and take advantage of energy-saving measures, and better recognise their benefits. Emphasising good practices (e.g. through social comparison) may also be useful. Affordable loans, cooperation between citizens, and the cooperation of citizens with energy service companies fall into this category.

Helping poor households through financial support to invest into reconstruction that promotes efficient energy use empowers those households economically. For example, thermal renovation creates a triple-dividend benefit – reducing the energy consumption of dwellings,

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lowering energy expenses, and even lifting households out of energy poverty, making dwellings assets that are more environmentally friendly.

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1. Introduction

It is widely acknowledged that increasing the efficiency of heating and cooling of buildings can substantially contribute to saving energy and reducing emissions. Industrial and residential heating and cooling energy use makes up a substantial share of final energy consumption in the EU, accounting for 50% in 2015, of which space heating was responsible for 27% while 1% was used for space cooling.[1]

The Heating and Cooling Strategy of the European Union[2] assigns a crucial role to the heating and cooling sector in energy transition and is aimed at improving energy efficiency in buildings and industry while targeting the integration of the building stock into the energy system by using smart, efficient and sustainable solutions.

Space heating is the largest contributor to household energy consumption, on average accounting for 64% of households' final energy use and 16% of the total final energy consumption in the EU in 2015.[3] More energy-conscious behaviour and investments in insulation or new heating technology resulting in a reduction in energy use might have a substantial effect on consumers' utility bills, depending on the amount and type of energy saved and the relevant prices. However, current research suggests that regulatory measures and interventions can be more effective if they account for the different consumer practices that influence the behaviour of households which are determined by an interplay of various factors, including socio-cultural and demographic characteristics, attitudes, values and beliefs, social norms, as well as technical and institutional constraints.[4] To understand the complex interaction between energy conservation behaviour and the effectiveness of energy efficiency measures or programmes, it is important to collect information about the current consumption practices and preferences of households, their attitudes towards changing their behaviour and implementing energy-saving measures, and the obstacles they face.

The aim of the present case study was to obtain better understanding of the factors influencing household energy choices related to heating and cooling, drawing on qualitative and quantitative research results. Focus group methodology, combined with participatory systems

[1] Heat Roadmap Europe, Profile of heating and cooling demand in 2015, http://www.heatroadmap.eu
[2] COM(2016) 51 final on An EU Strategy on Heating and Cooling, https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v14.pdf
[3] Odyssee database, https://odyssee.enerdata.net/home/
[4] ENABLE.EU (2016) Final comprehensive literature review setting the scene for the entire study, www.enable-eu.com/wp-content/uploads/2017/08/ENABLE.EU_D2.2.pdf

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mapping, was applied in the first phase, partially overlapping in its timing with the second phase that consisted of the design and implementation of a survey among households through the insertion of a relevant section in the ENABLE.EU household survey.

Focus groups make it possible to form ideas in a social context by actively engaging participants in shared thinking about influencing factors and the casual relationships that exist between them, thereby creating a deeper understanding of the attitudes and opinions of households, the obstacles they face in their everyday lives, and the possible solutions they can identify. Researchers participating in the case study were given the task of formulating a focus question relevant to their countries, around which discussion and shared thinking of participants could evolve. As cooling accounts for only a small proportion of energy consumption at present in all participating countries, research partners decided to focus their qualitative analysis on heating, by raising the central question: "How can households reduce their heating costs?"

The research was supplemented and extended by a quantitative analysis relying partially on the results of the first, explorative phase. Drawing on the relevant literature and the outcomes of the first focus group events, a questionnaire was designed to elicit information from households about their heating and cooling habits and practices, the challenges they encounter when deciding which investments to make into improving energy efficiency, and their opinions about different policy options that target energy conservation.

This synthesis report has been divided into four sections. Following this introduction, the second section describes the aim and background of the study and lays out the design of the research that incorporates both qualitative and quantitative phases, and the analysis of relevant outcomes. The third part presents the most important data related to heating and cooling in the participating countries to provide background information about the evolution of energy consumption, the composition of heating energy use by fuel, and the trends in specific energy consumption that reflect changes in energy efficiency, as these factors may contribute to understanding energy choices and behavioural patterns in the countries involved.

The 4th section of the paper investigates the most important barriers to improving the energy efficiency of heating in households based on recent literature. It looks at the state of energy affordability in the participating countries, which subject has become a core issue in present EU policy in the context of energy transition and can definitely be improved by increasing the energy efficiency of the dwellings of the households concerned. A third issue raised in this section is the relationship between environmental awareness and energy-saving behaviour. This is perhaps the most controversial issue and is related to the effectiveness of awareness-

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raising policies that are believed to be indispensable in encouraging energy conservation activities.

Part 5 unfolds the process of focus group discussions and presents the most important results of the events organised in all participating countries, highlighting the issues that were raised during most focus groups. Section 6 reviews the most interesting preliminary results obtained from the analysis of the survey data, pointing to the main differences and similarities in countries related to energy consumption practices, attitudes, perceived obstacles to energy efficiency improvements, and the subjective evaluation of policy options by surveyed households. The last section provides a summary of the most important results, highlighting the overlapping challenges and policy options related to heating energy use in the countries involved, and describes triple-dividend opportunities that can be captured by implementing policies and measures that favour the deployment of energy-saving options.

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2. Background and structure of the research

The aim of the present research was to reveal the economic constraints, demographic diversity, and the role of personal values in heating/cooling habits, as well as to investigate possible triple-dividend strategies for efficient low-carbon options. Triple-dividend options deliver economic, environmental and social benefits at the same time.

Finding affordable low-carbon options for sensitive groups may deliver a triple dividend in terms of reducing carbon footprints and housing-related costs, and lessening energy dependence.

For this purpose, we needed to take into account the fact that European consumers are quite diverse in terms of:

- the financial resources that they can allocate to low-carbon investment;
- their housing conditions, including insulation, home size, and ownership;
- their willingness to change their habitual behaviour;
- their motivation for making changes (including financial savings, self-sufficiency, and environmental awareness);
- their beliefs and misunderstandings about low-carbon options;
- their cultural and social environment.

Any efficient EU-wide strategy should consider these constraints and offer diverse solutions that are tailored to the circumstances of various social groups.
Our case study was designed to channel-in citizens' perspectives regarding the behavioural aspects of energy use and energy saving in heating and cooling. The research focused on behavioural factors that promote or hinder lifestyle changes towards reducing energy consumption. These behavioural factors have so far been under-researched.

The five participating countries were the following: France, Germany, Hungary, Spain, and Ukraine.

The research process was designed along the following steps, as summarized in the following figure.

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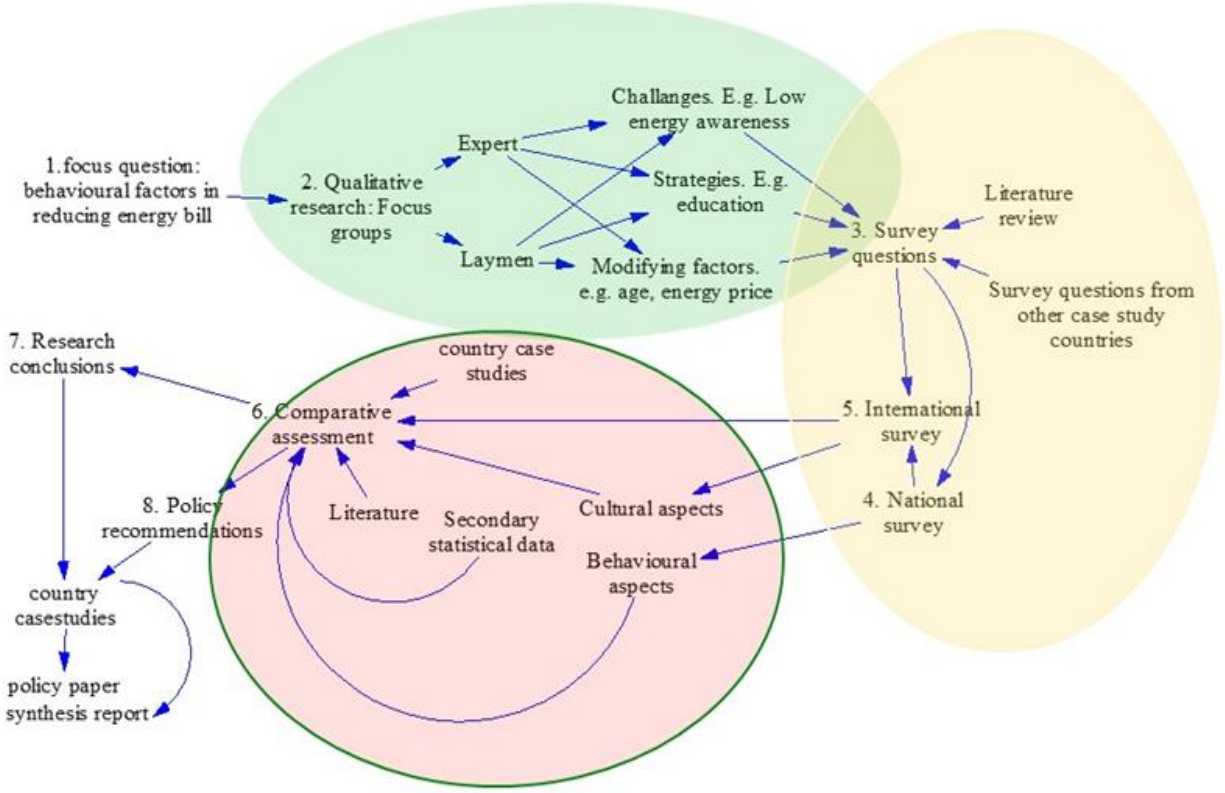

Figure 1. Research design followed during the case study.

1. Framing the focus question

The first step in the qualitative research was framing the focal question: "How can households reduce their heating costs?"

2. Qualitative study

The major part of the study, indicated by the green circle, involved citizen and expert focus groups. This process was based on the use of causal loop diagrams and the technique of Participatory System Mapping for creating a collaborative process that generates deeper understanding of consumer behaviour (Sedlacko et al., 2014). Causal loop diagrams help with visualising and analysing current patterns of system behaviour, while participatory system mapping refers to the process of involving stakeholders into this process. Focus group participants worked on identifying the challenges they face when trying to reduce their heating costs and related energy consumption.

Focus group participants also identified the strategies and policy options that could help them to cope with these challenges, and visualised the connections between the challenges and strategies. They were also asked about modifying factors that may catalyse or hinder those changes, such as energy price, level of awareness, and level of education about the issue.

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The following table shows the number of focus groups conducted in the countries involved in the Heating and Cooling case study. A total of 24 focus groups were organized, eighteen with laymen and six with expert participants, with more emphasis laid on unfolding and channelling the opinions of households into the research.

Country	France	Germany	Hungary	Spain	Ukraine	Total
Laymen	4	3	3	1	7	**18**
Expert	1	1	2	1	1	**6**
Total	**5**	**4**	**5**	**2**	**8**	**24**

Table 1. Number of focus groups conducted in the frame of the qualitative research.

The implementation of focus groups took place between May 2017 and January, 2018. Each country prepared a country case study summarizing the findings of their focus groups.

The focus group stage was followed by supplementary desktop and survey research to test the relevance of focus group results and to compare the findings with the outcomes of statistical data analysis in all the countries involved.

3. Formulating survey questions

The focus group phase overlapped with the implementation of the household survey of the ENABLE.EU project, providing a good opportunity to include a limited number of questions in the international household survey based on issues that came up in early focus groups. These questions were related to the challenges and policy options raised by participants. In addition to those, several Heating-and-Cooling-related questions were asked in the five participating countries.

4-5. Conducting the survey

Surveys were conducted in each country, then merged into a single database. The international household survey helped to test the relevance of identified challenges and policy options at the national and international level, and to reveal cultural and behavioural differences across the case-study countries. The household survey was conducted at the end of 2017 and the beginning of 2018 in the participant countries, and cleansed data was available in May 2018. Data from 5006 households was collected providing a maximum number of observations about relevant questions in the range of 700-1500 for the different countries.

Country	France	Germany	Hungary	Spain	Ukraine	Total

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Method	On-line	F2F	F2F	F2F	F2F	
N	**1500**	**711**	**1022**	**760**	**1013**	**5006**

Table 2. Sample size of the survey implemented in participating countries.

All information from the focus groups, survey, desktop research and secondary database were fed into the comparative assessment phase.

6. Comparative assessment

In the comparative assessment phase, we compared the findings of draft country case studies and collected statistical data to support these comparisons. The comparative assessment phase revealed cultural and behavioural differences across countries, as well as the common behavioural patterns and common challenges people share in different countries.

7. Compiling the synthesis report

The findings from all three phases are summarized in this synthesis report.

8. Compiling the policy paper

A policy paper, summarizing the suggestions made by focus group participants, was also prepared and can be used to supplement this synthesis report.

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3. Trends in energy consumption

3.1. Description of climate

The countries participating in this study have significantly different climates, with cold winters in Germany, Hungary, Ukraine and partly in France, and hot summers in Spain, France, Hungary and Ukraine, resulting in different characteristics in residential-heating-related energy consumption. The most significant proportion of this energy consumption is the energy used for heating, influenced by heating degree days (HDD[5]). Figure 2. provides a summary of HDD data for the different countries, based on the Odyssee database.

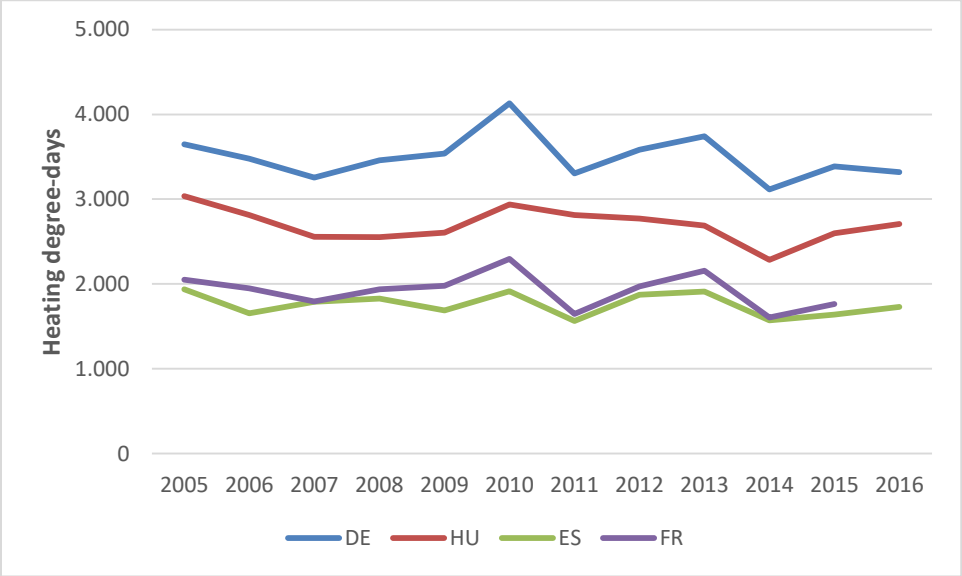

Figure 2. Heating degree days in different countries, 2005-2016 (Source: Odyssee database; the latest data for France were collected in 2015)

The data suggest that Germany has the highest need for heating (3513 HDDs on average between 2005 and 2016), followed by Hungary (2696), France (1922) and Spain (1760). There is no such data available for Ukraine, but based on its climate characteristics, it will be similar to Hungary and Germany (in given climate zones, from the north to the south of the country[6]).

[5] HDD is calculated by summarizing the differences between the reference indoor temperature (18 degrees Celsius) and the average daily outdoor temperature for the whole heating season.
[6] Some newly revealed data: http://www.seia.gov.ua/seia/doccatalog/document?id=117163.

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3.2. Energy consumption statistics related to heating

Heating accounts for the biggest share of residential energy consumption in all countries involved in this research (EEA, 2016, Hecher et al., 2017).

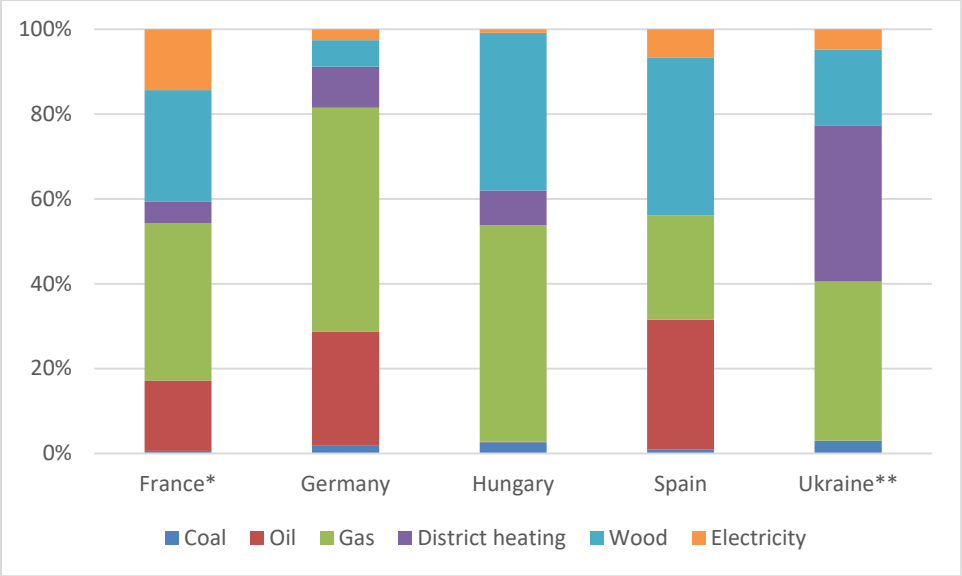

*Figure 3. Share of different fuel types in residential energy consumption for space heating (%) (2016), (*2015 for France, **2018 for Ukraine). (Source of data: Odyssee database, except for Ukraine where data are derived from the Enable household survey.)*

The structure of residential energy consumption by fuel type varies significantly among project participant countries:

- **Natural gas** is a key energy source in Germany, Hungary, Ukraine, and France, and is also relevant for Germany and Spain.
- **District heating** is still very important in Ukraine, and also present in Germany, France, and Hungary. According to the information received from country case study partners, the poor condition and low energy efficiency of this heating infrastructure plays a significant role in the decreasing share of district heating in Ukraine and Hungary.
- **Firewood** plays an important role in France, Hungary, and Spain, and is present in Ukraine, but is not very important in Germany. In recent years, data about firewood consumption show an increase in use, especially in Hungary, partly because of the change in the methodology of accounting for the use of firewood. Wood consumption is now measured

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from the demand side (consumer surveys, estimations, etc.) instead of the earlier supply-side method (the official accounts of forest management companies).[7]

- **Oil** is used in Spain, France, and Germany, but not used for residential heating in Ukraine and Hungary.
- **Electricity** is used in smaller proportions in the participant countries (with the highest proportion in France, presumably because of the high share of nuclear power in the electricity mix produced at relatively low variable cost), while **coal** is no longer a relevant energy source.

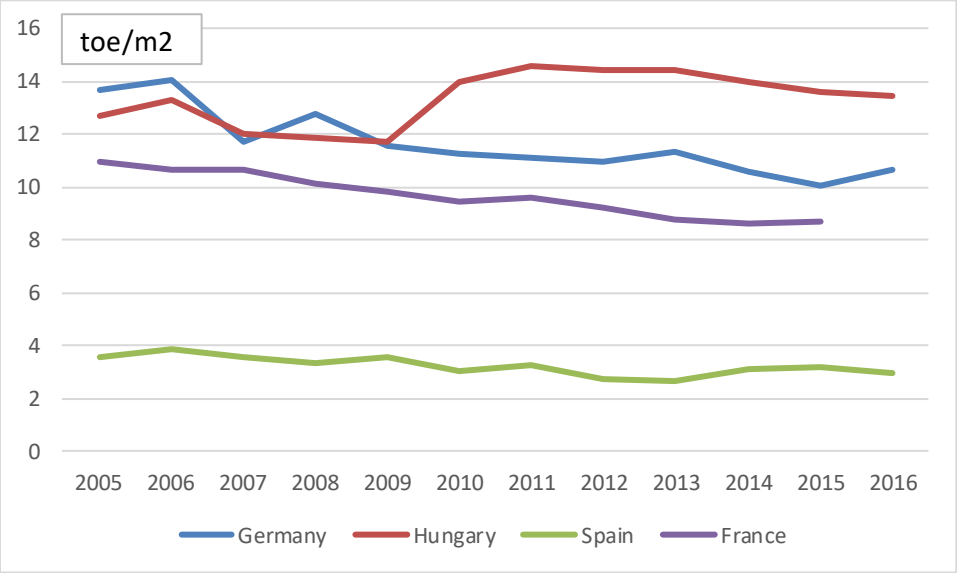

Figure 4. Residential space heating energy consumption (climate adjusted) between 2005 and 2016 (2015 for France) per m² (toe). Source: Odyssee.

Comparison of absolute toe/m² values between countries does not make sense because the differences are mostly due to variability in climate and heating needs, but the trends within countries indicate the general direction of change in specific energy use. As Figure 4 shows, the energy efficiency of heating (in terms of the energy demand per square meter) slightly improved in Germany, France, and Spain between 2005 and 2016 (2015 for France). However, in Hungary, after some initial improvement until 2009, energy efficiency has decreased. The reason for this negative change needs further investigation, but the above-mentioned change in the statistical method used to calculate the solid biomass consumption in the residential sector might partially explain the observed trend.

[7] The difference between these two methods is substantial: for 2011, 30.3 PJ consumption was published originally, which has been increased to 76.2 PJ after the recalculation. Source: REKK, Meg- megújuló statisztikák, Policy Brief, May 2017, https://rekk.hu/publikacio/64/meg-megujulo_statisztikak

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In Ukraine, the average energy consumption for heating dropped after 2014, but mostly due to an increase in prices and a reduction in the normative indicator (acceptable temperature for residential dwelling during heating period: 18°C).

Cooling is much less significant than heating in terms of energy consumed. Based on the Odyssee database, only two of the project partner countries consumed significant amounts of energy due to cooling in the residential sector (Spain, 1,65 TWh in 2014, and France, 0,58 TWh in 2014).

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4. Background information on some major heating-related issues

4.1 Main barriers to improving heating energy efficiency

The major problems raised in the country studies in relation to different aspects of heating energy consumption appear to be important in all countries, albeit to a different extent:

- **Structure and condition of buildings and heating systems**. Relatively old buildings (the most critical of which are detached houses and panel-block buildings with poor insulation) and inefficient heating systems contribute to inefficient energy use. These issues are important in all countries, but perhaps most in Hungary and Ukraine (Novikova - Vorsatz, 2007, Nagy, 2007, Yearwood Travezan et al., 2013). Furthermore, in these two countries, especially in Ukraine, district heating supply systems are generally outdated and in bad technical condition, further decreasing heating efficiency (Doroshenko, 2012). The situation is slowly getting better in Ukraine, and depends on the initiatives of local authorities (for instance, the central heating system in Lviv has been significantly renovated in recent years due to the efforts of municipal authorities).
- **Energy poverty of households.** Energy poverty refers to the phenomenon that households have difficulty obtaining access to sufficient amounts of energy in their dwellings to satisfy their basic needs for reasons of inadequate resources or housing conditions (ADEME, 2016, Fülöp and Lehoczky-Krsjak, 2014). This issue is partly related to inefficient buildings and heating systems and partly to the issue of general poverty (Insight_E, 2015). Energy poverty is significant in all countries (even if a harmonised and fully comprehensive understanding of the notion is lacking). Among energy-poor households, the following categories are overrepresented: i) households living in detached houses, ii) one-member households, and iii) households with children (especially if there is only one adult in the household) (Fülöp and Lehoczky-Krsjak, 2014). Furthermore, energy poverty and (income) poverty are closely related issues, so they need to be approached jointly (Insight_E, 2015).
- **Heat-waves in summer.** Heat-waves increase energy demand and affect many households in different countries**.** While these events are presently uncommon, heat-waves raise more attention than cold waves as their effects are more visible and sudden (Niel and Beaumel, 2010). This issue is mostly important for Spain and France, but their significance is also growing in Hungary and Ukraine.
- **Lack of consciousness and insufficient information**. In many cases, households do not have sufficient information about how they can improve their energy efficiency, or what

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the most appropriate options are that generate win-win situations considering investment needs.

- **A lack of financial resources** for investing in energy-efficiency improving measures is a widely documented general obstacle to change (Szlávik et al., 2000, Alberini and Bigano, 2015, Ministère de l'Environnement, 2017, ADEME, 2017).

- **Owner-tenant conflicts**. In the case of rented dwellings, the interests of owners and tenants of buildings are different. Owners are not always motivated to implement investments that pay back only in the long term, while tenants are more interested in having lower rents than making potential savings through their energy bills in the long term (Schreiner, 2015). Furthermore, in multi-apartment buildings, the implementation of major refurbishments may require consensus among all inhabitants, which is a further barrier to change (Blasch et al., 2017, Tiefenbeck et al., 2016).

- **State-regulated energy prices**. If governments keep energy prices low artificially, there is no incentive for households to decrease their energy consumption or to invest in efficiency improving measures. This has been a big issue especially in Hungary and Ukraine in the past decades (Szlávik et al., 2000), and still represents a barrier (see Sebestyénné Szép, 2018, on the link between state-driven price decreases in the residential sector and the ceteris paribus increase in household energy consumption).

However, beyond these barriers there seems to be a strong demand to improve energy efficiency, reduce CO2-emissions and household energy costs, while addressing energy poverty at the same time, thus realizing triple-dividend options (see, for example, Novikova and Vorsatz (2007), ADEME (2017)).

4.2. Energy affordability issues

Depending on the different definitions of energy poverty, the share of energy-poor households ranges between 5-20% in most partner study countries, with an even higher share (25.1%) in Ukraine (Fülöp and Lehoczky-Krsjak, 2014, Insight_E, 2015, Schreiner, 2015, ADEME, 2017).[8]

Beyond objective indicators, energy poverty can also be approached through a subjective evaluation of energy affordability. Eurostat data (based on the EU-SILC survey) permits a comparison of participating countries (except for Ukraine) along some aspects of energy affordability.

[8] Self-assessment by households of the availability of individual goods and services, State Statistical Service of Ukraine, 2016, http://ukrstat.gov.ua/druk/publicat/kat_u/2016/dop/05/dop_sddotp15pdf.zip

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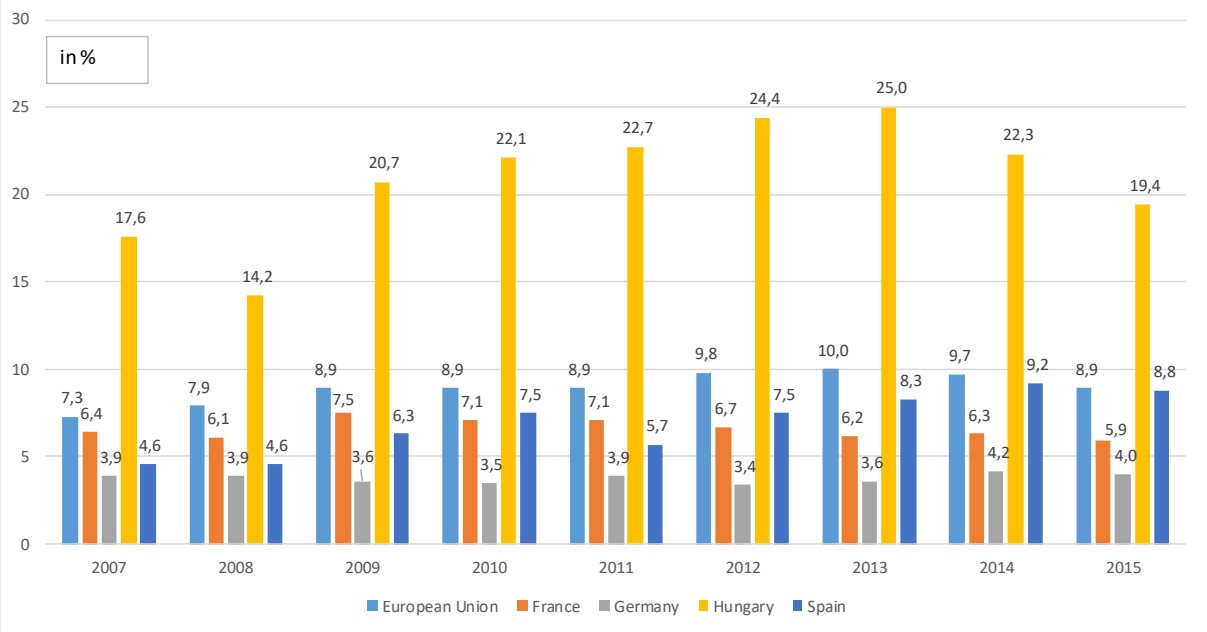

Figure 5. Share of households in percentage with arrears on utility bills (source: Eurostat).

One indicator of affordability is whether residential consumers are capable of paying their utility bills on time. Eurostat data indicate the following:

- In Germany, the share consumers being in arrears with utility bills (3-4% between 2007 and 2015) were far below the EU average. For France and Spain, these values (6-7% and 5-9% respectively) were still below the EU average. However, in Hungary the relevant shares (14-25%) are far above the EU average (Eurostat database). There is no comparable data on Ukraine, but the situation is reported to have improved in recent years.
- After the financial crisis in 2009, all countries had somewhat higher values.
- The most vulnerable consumers in this respect are single adult households with children (based on the Eurostat database, the proportion of the former in arrears with utility bills was only slightly below 40% in Hungary, and around 20% in other countries).
- For Hungary, the proportion of those in arrears with utility bills is also high compared to the proportion in arrears in general (including mortgage or rent, utility bills, or hire purchase, – all in all from 16 - 27% based on Eurostat data), suggesting that utility bills are a very common field of arrears.

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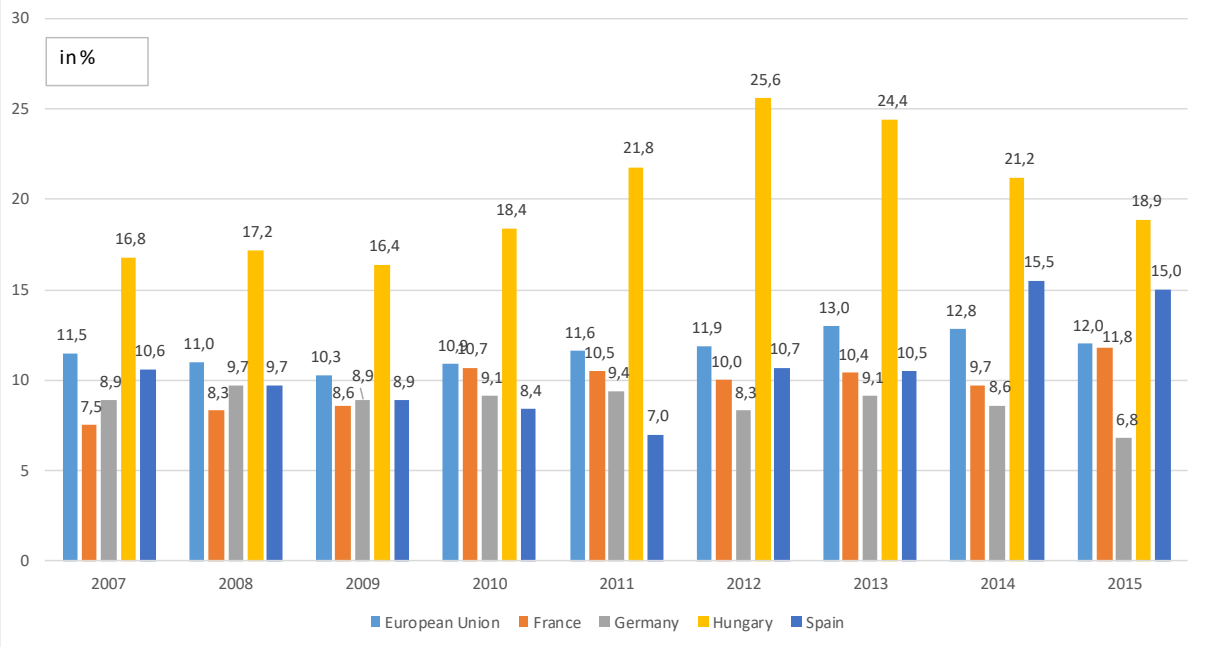

Figure 6. Share of households unable to keep home adequately warm (%) (source: Eurostat).

Inability to keep homes properly warm is another indicator of energy affordability. Based on the Eurostat (EU-SILC) data, the following can be highlighted:

- In Germany, France and Spain this indicator ranged below or around the EU average (10-13% between 2007 and 2015). Hungary was an outlier in this field again, with values between 16 and 26%. There is no relevant data in this respect for Ukraine; however, according to the household survey, 6.3% of respondents indicated having an average household winter temperature of 17°C or below, while 22.5% claimed it was 18-19°C. Both parameters were not typical of Ukraine for a long time because of the artificially low prices for households at the time.
- In the years after the financial crisis, the indicator for inability to keep homes properly warm was also slightly higher for most countries.
- Most affected household types are single-person households and single adult households with children (the value for the indicator ranging between 14-24% for the EU average, based on the Eurostat database).

On the whole, the most sensitive groups in terms of affordability issues (such as energy poverty in general, as covered earlier) based on the Eurostat data are single households and parents (especially single ones) with children.

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4.3. Environmental awareness

Environmental awareness is a complex issue, and it is hard to provide comparable data about countries. However, based on the Eurobarometer surveys (Eurobarometer 468 in 2017), some comparisons can be made:

- Overall environmental awareness has slightly decreased over time (the share of 'very important' answers to the question 'How important is protecting the environment to you personally?' was 56% in 2017, 53% in 2014, 58% in 2011 and 64% in 2007 at the EU level).
- Regarding differences between countries, 'very important' responses to the above-described question amounted to 64% in France, 57% in Spain, 54% in Germany, and 49% in Hungary in 2017.
- Willingness to reduce energy consumption (including heating) due to environmental concerns varied between countries from 44% in France, 36% in Germany and 33% in Spain, to 29% in Hungary. (Ukraine was not covered by the Eurobarometer survey, but the challenging financial and economic situation in the country, together with security threats, suggest that only a moderate share of consumers pay attention to the environmental issues surrounding energy consumption.) Only a minor part of Ukrainian society, mostly young and middle-aged, educated people with an average-medium-level income report to having environmental concerns as a driver for changing behaviour regarding heating. However, due to the challenging economic and financial situation, private households in particular have started switching from gas to biomass, while generally reducing consumption of all types of energy ever the heating period.
- Over time, willingness to reduce energy consumption has decreased at the EU level from 53% in 2011 to 35% in 2017.

There are several explanations for the latter phenomenon (decreasing willingness to cut energy consumption for environmental reasons). Citizens may consider they have done the most they could easily do to save energy, so making further savings might be too much of a burden. Also, decreasing energy prices may play a role. In the household survey of the present project, some awareness and behavioural aspects related to energy consumption were addressed (see Section 6).

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5. Results and discussion of the focus groups

5.1. Purpose and steps of focus group discussions

The purpose of focus group discussions was to identify the causalities which influence the outcomes of our energy-consuming behaviour and which allow to formulate formulating policy implications that can help shift energy-related consumer behaviour in a more sustainable direction. The chosen methodology for the focus group discussions was the compilation of causal loop diagrams and participatory system mapping, a process described step by step below (Sedlacko et al., 2014). The composition of focus groups and the results are described in the country case studies in a detailed and comprehensive way (they are contained in the Appendix).

Step 1 involved determining the focal question (central construct) which should be at the centre of the causal loop diagram. The focal question was constructed during the first expert focus group discussion for the whole project. ***The central construct was determined to be the size of the heating bill,*** as a quantitative indicator of energy consumption, and the focus question was thus "How can households reduce their heating costs?". If a heating bill increases, this reflects either higher energy consumption, or an increase in energy prices. Conversely, a decrease in the heating bill indicates either lower measured energy consumption or lower prices.

Step 2 consisted of identifying the challenges which had to be addressed to influence the central construct: to reduce the energy consumption stemming from heating to foster more sustainable and affordable heating energy use (i.e. a triple-dividend objective). Challenges often represent problems which have to be solved in order to reach the goal of reducing energy consumption in a sustainable way (such as dealing with the price of heating energy and the poor insulation of houses). Due to the number of challenges, they had to be reduced to the most relevant 5-7.

Step 3 was about identifying strategies which may influence the challenges and thus change the central construct (the size of the heating bill). Strategies could include, for instance, wearing warmer clothes at home or using governmental incentives to finance refurbishment. In this phase it was not yet determined how these strategies influence the challenges (i.e. increase or decrease them): the task is to identify strategies which affect challenges. This is why the strategies had to be formulated in a neutral way.

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Step 4 involved identifying the moderating factors which are behind the strategies, and which moderate their impact on challenges. Moderating factors are variables which may increase or decrease. The impact of an increase or decrease in moderating factors on the strategies (the direction of association between them) and hence on the heating bill was analysed in Step 5. In Step 4 we were mainly concerned with identifying possible moderating variables in a way which reflected the idea that they can increase or decrease.

Step 5 consisted of finding potential causal relationships between the thus-far identified constructs (moderating factors, strategies, challenges and the focal question). In this phase we sought to show how changes in one construct influence another construct, and in which direction. Arrows were drawn by participants to indicate whether the increase in one construct increases or decreases another construct. It is important to note that those changes were considered ceteris paribus: as if all other relationships remained unchanged. Changes in multiple behavioural patterns at the same time need further explanation. In the focus group discussions, we analysed the relationships one by one.

On the causal loop diagrams, the main arrows linking two constructs show how the elements are related (e.g. a moderating factor has an impact on a strategy, a strategy has an impact on a challenge, and a challenge has an impact on the heating bill). The small arrows placed next to the main arrows mark the direction of the relation between variables. If two variables are related positively, then the small arrows point in the same direction (↑↑ or ↓↓), while in case of a negative relation the arrows will point in a different direction (↑↓ or ↓↑).

It is important to note that the interrelationships between moderating factors, strategies, challenges and, finally, changes in the central construct, can be even more complicated than shown by causal loops. However, the focus group discussions usually had a time limit and the participants decided which interrelationships to discuss in detail and which ones to ignore.

The initial system maps were created by the participants themselves (by using flipcharts, markers, and Post-it notes). Based on these, the REKK team created the final, clarified version using VENSIM system mapping software (see appendices for examples from each country).

In the following sections, a summary of the main challenges and strategies that were identified in focus groups will be provided on a country-by-country basis in alphabetical order. This is followed by a presentation of the issues overlapping among the studied countries.

5.2. Focus group results in France

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In the French national context, four focus groups were organised with households who were interested in the topic of heating and who had already encountered difficulties with heating their home or affording their heating energy bills. One focus group was also convened with experts working mainly on the issue of energy poverty in this field. The focus groups were held in Paris and its suburbs, each with 4 - 7 participants in an environment conducive to informal exchange. The causal loop diagram of one of the focus groups is illustrated in Appendix 1.

Identified challenges in France

- **Poor insulation** is often a problem, especially in old dwellings. The investment that is required appears to be too high and off-putting for many people.
- **Poor ventilation and humidity** in dwellings lead to **condensation and mould growth** on walls and windows. Several participants had experienced or are still living in a situation where cold is perceived more, heating bills go up rapidly even though dwellings are not heated well, and in bigger houses heat is poorly distributed across rooms. In some extreme cases, participants have observed drops of water and large mould stains on walls, as well as mildewed furniture. They also fear for the health of their families, especially for children, in relation to the risk of respiratory diseases.
- **The characteristics of the dwellings are inadequate.** The positioning within a building or in relation to the sunlight is not optimised, no neighbours in adjacent dwellings are heating, dwellings are too big for the inhabitants, inhabitants have specific heating needs, etc.
- **Difficult dialogue between tenants and landlords.** Most tenants who participated explained that their landlords have **little interest in renovating dwellings** (e.g. by upgrading boilers or installing double glazing). Landlords often do not have any interest in financing work for tenants – according to the participants, they have no incentive nor willingness to invest in a place where they do not live. Besides this, tenants find it difficult to talk to landlords that they rarely see, or who sometimes do not even respond to them. The situation is similar in **social housing** where the landlord cannot be identified as a single person. In this situation, several participants explained that when they ask for any assistance or identify a problem, their requests remain unanswered and they do not know to whom to turn.
- **Lack of control over heating and the related bills.** Some participants stressed that the district heating in their dwelling tends to heat insufficiently well. Some believe this is due to the dysfunctions of heating systems because they work well for their neighbours. Individual tenants or owners struggle to be listened to, cannot install their own heating systems, and can hardly attempt any work since installing external insulation in co-ownership or social housing requires general insulation work for the building and hence the agreement of all owners or action by the social landlord. Furthermore, some tenants

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emphasise the lack of involvement of other potential stakeholders such as building caretakers and hygiene services who could help them. They despair when facing the challenge of inefficient district heating that they cannot turn off and still have to pay for through high charges. They often are afraid of purchasing and using additional methods of heating such as small electric radiators/convectors that might finally help them feel warm because it means paying twice for heating. Last but not least, the lack of control over heating does not encourage energy saving. If heating is considered too high for a household, they cannot turn it off. Their energy consumption is therefore not a matter of individual choice.

- **Choice and price of energy for heating.** Participants often highlighted the difference between electric and gas heating in terms of price (most felt that electric heating is more expensive), comfort (i.e. the sensation of cold and dry air was stronger with electric heating) and installation. However, they showed many misunderstandings and reported how they struggled to find the right information about the types of heating system and the possibility of using a thermostat. Many have heating systems and an energy source that do not match their types of dwelling and consumption needs – e.g. a household that lives in a big, poorly insulated house and heats with electrical equipment. Most vulnerable participants stressed their fear of simply turning on the heating when they are cold and the fear of receiving the bill at the end of the month – talking in terms of potentially thousands of euros. On the other hand, some participants in more comfortable financial situations highlighted their willingness to pay slightly more for energy from renewable sources.

Several additional challenges were mentioned, but less frequently and in less detail, notably: misunderstandings about how the system works, complicated energy bills, fear of breakdowns and hence not turning off the heating when not needed, the cost of removing an old heating system (e.g. radiators) on top of the installation costs of a new system, difficulty finding reliable professionals or independent advice, differences of opinion, awareness and behaviour between household members, the financial impossibility of moving out of an insalubrious dwelling, and a tendency to self-restrain energy use.

Identified strategies

To deal with these challenges, households repeatedly mentioned several strategies which fall into two main types of action – their own efforts, and external support. **Personal efforts include:**

- **Relying on themselves using tactics** that are perceived as beneficial, such as wearing warm clothes, using lined curtains, airing dwellings regularly and at moments of the day

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when the outdoor air temperature is as high as possible, heating rooms before going to bed and then turning heating off completely for the night, closing shutters at night and taking advantage of a boiler installed in the kitchen or bathroom for heating the room. They also adopt 'eco-gestures', including the appropriate use of radiators, using more economic cycles on washing machines, etc. which can save up to €600 each year according to experts. Several participants even consider heating as an element that structures the way they organise their day. One participant, for instance, mentioned that after coming home he starts cooking rather than turns on the heater to create heat through cooking, but also because hot food creates a sensation of warmth. However, it also seems that some people tend to caulk up and block all places where cold air could enter the dwelling, a dangerous solution that some participants seemed to ignore.

- **Getting informed:** Participants mentioned that they search on the internet, do online simulations and read trusted websites, such as consumer-oriented advice blogs. They also rely a lot on word of mouth and on local newspapers. Some people even cite Do-It-Yourself activities.
- **Programming the thermostat**: Several participants mentioned the benefit of being able to set different temperatures depending on the time of the day, sometimes even room by room. Nonetheless, use of the thermostat remains suboptimal as some people mention that they forget to program it, or they struggle to set the appropriate temperature for the entire dwelling (e.g. different temperatures in multi-storey houses). This programming option is frequently mentioned by participants and offers the possibility to individually control temperature and to adapt heating to one's needs and life rhythm.
- **Investing and undertaking long-term refurbishment work**: This is especially done by house owners who have relatively greater financial means than many of the participants who rent apartments. The main work that is undertaken includes changing to double-glazed windows, new doors and heating boiler upgrades. Several participants had also changed to future-oriented roof and/or wall insulation and heating systems (e.g. to aerothermal heating). Insulation appeared to participants to be the most efficient solution to many challenges, including reducing the heating energy bill, but it is also an expensive strategy. It is challenging to finance a full refurbishment, but the more complete and the better the renovation in terms of quality, the more gains for the household and for the community, said the experts. The return on investment takes a long time in most cases, households being thus reluctant to make such radical commitments.

Among the strategies mentioned, many households highlighted their reliance on **external support** (mentioned as being necessary for managing the challenges):

- **Relying on financial support from public and private organisations**: e.g. the "loft insulation for 1€" measure of the Energy Solidarity Pact programme, validated by the government and financed by energy suppliers to insulate lofts for 1 euro; subsidies from

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the National Housing Improvement Agency (ANAH) for low-income owners; social energy tariffs, energy checks in 2018; mass retail energy premiums; tax deductions/credits; no-interest loans.

Public support or NGO help through guidance, advice and mediation, especially in the case of the most vulnerable households. Local authorities are the first in line to support vulnerable households - including departmental and city councils, social, hygiene and health services: households in precarious situations can look for information and seek help through local authorities. For example, in the focus group's city of Montfermeil, the Red Cross "Thermal walks" initiative led by the Red Cross is designed to observe the characteristics of each walker's house from the outside thanks to a thermal imaging camera that helps with assessing the building's materials and insulation, and in this way raises awareness among participants about energy loss. The walks are not part of a strategy for reducing bills as such, but a trigger for people to improve their housing. Similarly, guided "energy visits" at home help make a basic diagnosis of the energy consumption and equipment of households. The department of Val-de-Marne participated in an experiment involving thermal renovation, recruiting Energy Ambassadors, young people with subsidised contracts (financed by the state and the department) who were trained to consider all dimensions of the challenge, i.e. technical, social, health and communication.

Their mission consists of visiting households who have inquired about energy-related support at the city hall because of their difficult situation. They provide basic diagnoses of dwellings that raise inhabitants' awareness of potential energy savings and subsidies they can apply for. Afterwards, they stay in touch with them to provide advice when needed, and visit them a year later to observe whether any changes have been made (i.e. an evaluation of the process - change of habits and/or renovation works). Listening to the experience of households, the Ambassadors' mission seems to be a highly beneficial programme as many participants highlighted the need for trusted interlocutors who are neutral and very aware of the topics.

Some additional strategies mentioned included a) requesting social housing (or new apartment allocation): a radical solution that involves moving out of an insalubrious dwelling but it takes time (often years) to get a positive reply, so this is rather a long-term uncertain strategy, while in private housing, however, it appears to be very difficult for households with a low income to find a new dwelling as a significant initial deposit is required; b) Calling on Mediation actors: more neutral support can be requested from the National Energy Mediator or from the National Agency for Information on Housing (ANIL) and its local subsidiaries (ADIL). The National Mediator is a public authority whose mission is to find solutions to litigation with energy companies and to provide energy consumers

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with information about their rights. ADIL mainly gives legal and tax advice and is especially focused on providing vulnerable households with information about their rights and obligations. They also support them to access housing; c) Going to court as a last resort: this extreme solution was tried by a tenant participant who had tried all the available options she was aware of.

5.4. Focus group results in Hungary

A total of five focus group discussions were carried out between May and November 2017. The groups targeted for the case study were the following: a) two expert groups specialized in energy-related policy making/research/engineering, b) two laymen groups – in one of them some sensitive inhabitants were represented in terms of low monthly income; the other group mainly consisted of university teachers and doctoral students who were not experts in energy-related topics; and c) one laymen group of municipality representatives of a small Hungarian city. The causal loop diagram of one of the focus groups is illustrated in Appendix 3.

Identified challenges

- **Room temperature:** Room temperature is a challenge because physiological needs are difficult to change and if a household has small children or elderly people in the family, there can be requirements which overwrite the importance of the heating bill.
- **Controllability of room temperature (temporally and spatially)**: It is a challenge both regarding time and space because systematically controlling heating during the day or room by room is rather difficult in many houses and apartments. It requires the right technology, awareness and also knowledge of the energetic features of the building to control room temperature in a way that leads to reduced heating costs. Time spent at home also influences heating costs.
- **Number of heated rooms:** Decreasing the number of heated rooms in the house is often a way of decreasing heating costs, practised especially by elderly people. However, it is an ambiguous challenge, because it may have adverse effects on the temperature conditions of the whole house, the heating system itself and also on the health of the family.
- **Efficiency of the heating technology**: Efficiency plays an important role in heating; however, a more efficient heating technology does not necessarily result in lower energy bills, patterns of heating behaviour also influence the outcome. Technological characteristics are often a barrier to changing heating habits and reducing the size of the heating bill.
- **Unnecessary extension of heating season:** some households start heating too early and finish it too late.
- **Difficulties of financing boiler replacement**: This is a widely known problem in society: many households face financial difficulties when it comes to investing into replacing their old boiler.

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- **Lack of information (about good solutions)**: Whether the result of ignorance or lack of communication, this is a problem for many people.
- **Financing insulation**: When thinking of supplementary insulation, many people are not aware of the payback period and the features of insulation.
- **Replacement of doors and windows**: Since this usually involves a significant investment, it is also regarded as challenge.
- **Mixed heating, including renewables**: This can be a challenge both in terms of technological opportunities and the availability of alternative fuels. Furthermore, heating costs do not necessarily decrease drastically when increasing the proportion of renewables in heating. Behaviour patterns like saving preferences or pro-environmental attitudes are also important and should be considered. Some people start wasting energy if it becomes cheap which leads to a rebound effect, while others do not change their habits and their heating costs become lower when switching to renewables.
- **Availability and price of heating fuels** (mainly in the case of firewood and district heating) vary across a wide range across regions.
- **Pensioners tend to shift from wood/coal or even gas to electricity heating** leading to higher heating costs because heating a dwelling to the same temperature with electricity is usually more expensive.
- **Characteristics of the building:** this can be a significant challenge depending on how big, how old, how energy efficient, how well insulated the apartment or the house is, and in which direction it is oriented (North, South, West, and East).
- **Traditional architecture**: shading with trees, using gravity ventilation and utilising other traditional ways of moderating the impacts of outdoor temperature (cooling down the house if it is hot outside, or the reverse, keeping it warm when it becomes colder outside) are not so widely known and used within the country as is possible and necessary.
- **Heating with wood taken from illegally cut trees** (where relevant in terms of the heating system). This is a challenge because it is an illegal behaviour which is used to decrease heating costs, but the outcome is ambiguous. We need a sophisticated policy toolset to change this behaviour. It is a highly sensitive issue.
- **Heating with household waste** is a huge problem because it is illegal, unhealthy and fully unsustainable. It is difficult to detect the source, penalise and reduce this practice. Pressure from the community will definitely play an important role in the solution, because the health and well-being of a whole community (neighbours, the village, etc.) is negatively affected by this behaviour.
- **Using collected biomass (lop and top, sticks) for heating** is a challenge in a sense of its scale. On a small scale it is not a huge intrusion into the ecosystem, but on a large scale it is.

Identified strategies

- **Following the reference group** refers to taking over and copying good examples from reference groups (family, neighbours, celebrities, etc.). The emphasis is on the direction the reference group goes in, not on the phenomenon of "following others" because simply

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following the crowd may have a pejorative association in society. It is important that we talk about good examples here, meaning that we collect those behaviours which show the desired direction of sustainable energy consuming behaviour (related to heating).

- **Knowledge of a direct relationship between energy consumption and the energy bill**. Many people are not aware of what their energy costs consist of and how big the share of heating is in their energy bill. This also depends on the method of heating (with biomass, gas, electricity, renewables, etc.). Knowing the relationship between our heating behaviour and the amount of the bill is important regarding taking steps to reduce the bill.
- **Environmental awareness – beyond cost awareness.** Environmental awareness can make a difference because it helps exclude unsustainable changes related to heating costs, while a pure cost-awareness focused approach does not guarantee sustainable solutions.
- **Collecting information from different sources** is a strategy which may have an impact on the challenges, especially in cases where a lack of information is the barrier to action. The behaviour of people is largely influenced by practical information coming from local sources and mouth-to-mouth information. This is usually more influential than receiving consumption-related information on bills or getting practical advice through national media.
- **Energy awareness** includes interest in and knowledge about different technologies, as well as seeking sustainable solutions.
- **Testing new ways of heating** which were not implemented before but may be new solutions is a good strategy for those who highly appreciate technological development.
- **Habitual behaviour**. People who have a strong habitual orientation are reluctant to change their behaviour, even if information is given about the negative impacts of those habits. In their case, further research is necessary to explore which messages or policy measures could be effective at evoking behaviour change, as those people strongly stick to their habits and cannot be convinced with rational argumentation.
- **Proper clothing.** There can be different habits even within a family in terms of how many layers of clothes people wear at home.
- **Consideration of optimising temperature** when at home. Optimising temperature means that the thermostat is set at a lower temperature at night and that the use of different rooms is also considered when heating the house.
- **Different levels of temperature comfort** is not just an issue of awareness: people may have different physiological needs, resulting in different temperatures at which they feel comfortable.
- **Effective use of a programmable thermostat**: even if many households have a programmable thermostat, awareness of how to appropriately use it should be raised. Lack of knowledge can be a barrier which needs to be managed. The improper use of programmable thermostats may result in higher energy consumption instead of optimising the temperature and decreasing heating costs.
- **Ventilation:** people often use excessive ventilation instead of programming their programmable thermostat. The appropriate and effective way of ventilation is a subject of debate.
- **Laziness, carelessness, breaking the law due to lack of enforcement of regulations.** These strategies were mentioned in relation with the challenge of using waste for heating.

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Some people do not care about consequences and are lazy about managing their waste and their heating in the right way. Additionally, if a local municipality is not strict enough about enforcing regulations and does not penalise the prohibited behaviour of waste burning, irresponsible people do not feel they are forced to comply with rules.

- **(Mainly financial) barriers prevent significant steps being taken:** this is a destructive strategy which is the main reason behind the challenge of irresponsible behaviour. This is a strategy which often blocks individuals from positively changing their behaviour, hinders change (e.g. in the case of dependency on an old boiler) or leads to irresponsible behaviour (like heating with waste).

Supplementary research on individual preferences related to behavioural change

The necessity of reducing consumption provokes various individual reactions and the issue is also highly relevant with regard to cutting energy consumption. Q-methodology was used to test the different preferences of people related to behaviour change. The main objective of this research – exclusively carried out in Hungary – was to explore and interpret the priorities of individuals when it comes to the need to adapt habits and lifestyles to changes in consumption circumstances.

Q-methodology was developed by William Stephenson (Stephenson, 1953) for systematically analysing human subjectivity. It is mainly regarded as a qualitative method because it focuses on the subjective nature of attitudes, opinions and value systems. However, it is based on a combination of qualitative and quantitative methodological elements. The main objective of Q-methodology is to typify opinions related to a given issue by means of quantitative analytical techniques. It operates using "reverse" factor-analysis, which, instead of creating latent variables from variables, classifies respondents' preferences into various factors (opinion-groups) based on the similarity or divergence of their opinions. The qualitative nature of the methodology is due to the fact that it requires neither a certain sample size as a precondition for reliable quantitative analysis, nor representativeness. The methodology is therefore not suitable for substituting representative surveys, but it helps the researcher to recognise the shapes of priorities and behaviours. Due to its specific features, Q-methodology serves as bridge between qualitative and quantitative research methodologies, combining the advantages of both research traditions (Brown, 1996, p. 561.).

Q-methodology applies the special Q-sort technique for data collection. The researcher provides the respondents with cards showing statements and respondents are asked to rank the randomly numbered cards according to their preferences. They are assisted with an evaluative scale provided in advance. Respondents first get acquainted with the topic and the content of the cards, then start sorting them, comparing cards to one another and giving

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special consideration to each and every statement in order to be able to rank them. The evaluative scale in our case contained 11 (-5…+5) categories.

The sorting results in the individual rank order of each respondent. These rankings are called Q-sorts. In the evaluation process the method compares the Q-sorts in pairs and determines their correlations. The process results in an inter-correlation matrix, out of which factors can be generated by means of principal component or the centroid method. In the current research, principal component method was used. Factors are typical Q-sorts containing the 'common denominator' of individual opinions. By means of VARIMAX or manual rotation, factors can be transformed into a simpler factor structure, which makes findings easier to interpret.

The research included 46 statements (the statements are summarised in Appendix 4). General statements are supposed to express personal reactions related to negative changes in wealth and constraints in consumption, while specific statements are connected to different elements of human lifestyle like working, spending leisure time, transportation, eating, consumer behaviour, meeting physiological needs, and pro-environmental behaviour – including energy awareness, etc. In order to meet the requirements of the methodology, 41 people were involved in the research (21 women and 20 men).

Six factors were identified which reflect different types of behaviour preferences: status orientation, strong habitual behaviour, risk aversion, well-being and welfare orientation (combined), strong pro-environmental and health orientation, conscious planning, spending and saving preferences. In the case of three preference types, energy-related policy options (resulting from the focus groups) can be applied quite well. Energy awareness as such seemed not to be an explicit preference, although it is included partly in pro-environmental orientation, partly in saving preferences.

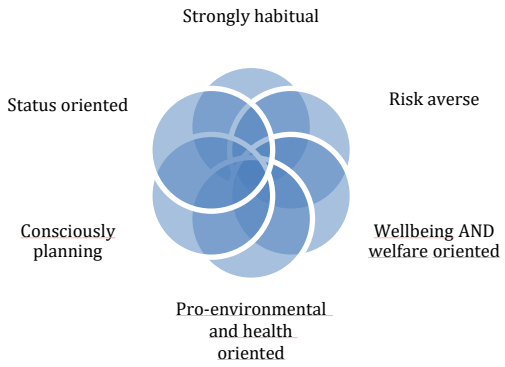

Figure 7. The six factors of Q-sorts, reflecting dominant behaviour types.

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In the case of strong habitual behaviour, very low or no willingness exists to change current lifestyles, even if circumstances make less consumption necessary. However, new heating-related technological solutions and devices (like new thermostats, or a completely new heating technologies) could be useful for people with such preferences as they do not necessarily require behaviour change. However, the right communication to promote those technological solutions is crucial.

For people with strong pro-environmental and health preferences, rising awareness of healthy ways of heating which are also more environmentally friendly – like reducing the room temperature and wearing a pullover, or ventilating consciously – can be an effective policy to (further) change behaviour towards sustainability. For those who have conscious planning, spending and saving preferences, focusing on the patterns of saving, as well as providing advice about practical solutions in terms of heating may be appropriate.

5.5. Focus group Results in Spain

Three focus group discussions were carried out in Spain (one in December 2017 and two in January 2018), which targeted different populations in order to test potential differences: Focus Group 1 with academics, Focus Group 2 with citizens, and Focus Group 3 with energy experts. Focus Group 1 with academics took place in Bilbao with ten participants from the Basque Centre for Climate Change. The second focus group was organized with eight participants selected along a range of different socio-demographic characteristics. The participants were recruited strategically in order to ensure heterogeneity for certain characteristics: age, type of residence, number of members, children or no children, location (urban or rural), level of income and work status (employed, unemployed, retired). The third focus group was conducted with experts in energy-related engineering, business and research. The causal loop diagram of one of the focus groups is illustrated in Appendix 4.

Identified challenges

- **Household incomes and energy price.** Considering the three focus groups, there are some recurring challenges which can be aggregated into different topics. Factors such as household incomes and energy price are collected within the topic of economics. These have a positive effect on the heating bill, which means that as both income or price increases, keeping all the rest constant (i.e. ceteris paribus), the energy bill will increase.
- **Infrastructure, insulation, orientation of houses**. In terms of issues related to the **infrastructure** or building itself, both **insulation** and the **orientation of the houses** can help reduce the size of the heating bill. That is, the more insulation buildings have, the

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smaller bills are, and the more oriented towards a sunny area (in a southerly direction), the lower bills are. Square meters and cubic meters have a positive effect on the heating bill which means that houses with more rooms, ceteris paribus, require more heating and thus incur a higher bill.

- **Temperature gradient, physical activity at home, number of members and children or elderly people.** Variables related to lifestyle group, such as the **temperature gradient** (that is, the difference between indoor and outdoor temperature), or **physical activity at home** have, ceteris paribus, a negative effect on the heating bill. Other factors, such as **number of members and children** or no children **at home** have, ceteris paribus, a positive effect on the heating bill.
- **Technological variables** were only mentioned in the focus group with academics and experts in energy. These include the **efficiency level of the heating system**, the **house energy rating** and the **level of control of temperature**, which is higher for individual heating systems compared to central heating systems. All these variables have a negative effect on the heating bill.

Identified strategies

- **Investment into insulation**, **thermal insulation**: The three focus groups mentioned **investment in insulation** and they also considered that good **thermal insulation** practices (e.g. use of blinds, opening windows to air the room, etc.) are also important for reducing energy consumption.
- **Educate people about energy saving** was another strategy only mentioned by Focus Group 1 with academics. However, it is important to note that this factor is very much dependent on the level of environmental awareness.
- **Use of thermostats**, preferably programmable thermostats which offer different ways to save energy. Participants mentioned that using a thermostat in the right way may contribute to reducing energy consumption.
- **Habits at home**: Participants also considered that **habits at home** can influence energy consumption in relation to heating. For example, some participants argued that one can reduce heating consumption on cold days by putting on an additional jumper when at home. Another strategy that was mentioned was the fact that one may not turn on the heating if one is not planning to stay long at home.
- **Taxes versus managing energy poverty.** The most significant differences between the three focus groups were taxes and energy poverty. The academic group and the expert group considered that **taxes** on bad habits (e.g. setting extreme room temperatures) could be very effective in managing heating consumption. The citizens' group incorporated in the discussion people who have economic difficulties paying their energy bill, and the

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issue of energy poverty was recurrently brought up in the discussion. This group also expressed a strong preference for having policies that could help them to understand energy bills. Reducing the bill may be effectively done by promoting more careful or sustainable use of the heating system.

- **Subsidies:** The citizen group mentioned that subsidies could increase the penetration of renewable energies. The academic group and expert group thought that subsidies could be effective for increasing investment in insulation, while education related to energy savings and environment is necessary for changing habits at home.
- **Energy price:** The citizens group thought that energy prices are manipulated by politicians and a few big energy companies. For that reason, they mentioned that an increase in competition between energy firms could lead to a reduction in the final energy price, although this could generate an increase in energy consumption.

5.6. Focus group Results in Ukraine

In total, 116 persons participated in the six focus groups held in different regions of Ukraine: the capital - Kyiv, the North (Pereyaslav of Kyiv region), the South-East (Dnipro), the West (Lviv, Ivano-Frankivsk,) and the Northern-West (Rivne). The cities and towns were chosen in order to achieve regional representativeness and cover both bigger and smaller settlements. A separate event was organized with experts, including a round table and a following series of meetings. The causal loop diagram of one of the focus groups is illustrated in Appendix 5.

Identified challenges

- **Temperature inside and outside of buildings** influences directly the heating bill in renovated or new buildings through regulations and metering.
- **Room temperature** is one of the most important factors that influences the heating bill, but it is conditioned by availability of metering and regulation apparatus in a separate space (room, flat, separate building etc.). It may be effectively regulated in new or renovated buildings. For the majority of old buildings (built mainly before 2000) with central heating systems it is mostly an unsolved problem so far at the level of individual apartments but might be partly regulated through the introduction of an individual metering and distribution substation for multi-apartment houses, operated by a condominium. It is also a relevant issue for very old buildings with autonomous (separate) heating systems.
- **Ventilation systems**: the absence of an effective ventilation system is considered to be a challenge that directly impacts energy bills. If such a system does not work at all or works ineffectively, people use other possibilities (open windows, for example) to stimulate air

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exchange. Soviet-style ventilation included small windows which were supposed to remain open constantly for incoming air, and ventilation exhaust ducts. Such systems became ineffective after the construction of modern plastic windows without air holes, and thus many apartments have insufficient air exchange, with supporting problems like fungus, and overly high or too low levels of humidity, etc.

- **Quality of heating services**: depends on the behaviour of heating service providers. Sometimes providers look for additional benefits and provide poor quality services; for example, intervening in the working of metering apparatus; maintaining a high water temperature in central heating systems when it isn't necessary; miscalculating bills; using poor quality energy resources for autonomous heating (gas pressure can be below standard conditions, coal can be used with non-combustible additives), etc. An inappropriate quality heating service results in high bills. In Lviv, according to case study findings, central heating systems are renovated and modernized, so the level of heat losses in transportation systems is quite low (10% on average according to city council statistics).
- **Fuel types and prices**: fuel prices impact what types of fuel are used, but mostly affect individual heating systems, as central heating systems are tied to one fuel type (mostly gas) and district heating systems can switch to cheaper types of fuel only if they are modernized. The trends to switching from coal or gas to wood or biomass is rather due to easier access to the latter fuel types than ecological factors. Ukrainians became accustomed to overconsumption and ignorance of the ecological consequences of heating, but high prices have created changes in behaviour.
- **Availability of metering apparatus**: this is not used broadly but is considered a very important parameter which influences heating bills. The problem is still that not all multi-flat buildings are equipped with metering apparatus. A potential solution would be to organize condominiums to install metering and regulation apparatus using their own money. After the Ukrainian law "On Commercial Accounting for Thermal Energy and Water Supply" was adopted in July 2017, all buildings connected to external heat supply networks must be equipped with metering apparatus, but it is not clear for consumers how the law will be implemented and who will pay for this. Another problem that was mentioned is that consumers want to install personal metering apparatus (for flats), but the vertical system of heat pipelines do not allow this.
- **Availability of regulators**: these are considered a factor that help reduce heating bills by changing the flow intensity of the heating system, but only in cases when the building or a flat is equipped with metering apparatus.
- **Characteristics of buildings and heating zone**: these were considered as very important issues because in ineffective/non-modernized buildings consumers pay more for heating services than in new or modernized ones, and currently many apartments are still being measured and billed according to heating zones, and bills are calculated based on

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normative rates for heat for one square meter. The technical parameters of the building and insulation, and its quality, as well as any energy efficiency measures that have been implemented, directly influence bills. The higher the energy efficiency of a building, the lower the heating bill. Many consumers primarily pay attention to this factor and consider it the main one in shaping the bill. However, many buildings are neither modernized in terms of energy efficiency nor equipped with regulators. Given that heating transportation systems have already been updated, those buildings continue to consume a lot of thermal energy and it is often very hot inside because consumers cannot regulate the incoming heat medium.

- **Type of heating system (individual/central/district)**: individual heating systems are considered the most cost efficient and flexible in terms of providing autonomy; central heating systems are mostly ineffective because of the very limited insulation and lack of modernization; district heating systems might be flexible enough and affordable if they are new or modernized.
- **Consumers' behaviour**: this is an important challenge, as there are consumers who undertake energy efficiency measures on their own, but there are also many consumers who wait for central or local authorities to implement energy efficiency measures instead of them.

Identified strategies

- **Investment opportunities in energy efficiency measures:** these have become part of a strategy to support improvements in energy efficiency in the country. Despite low support in financial terms (800 million UAH for 2017) from the state under the "Warm loans" programme, an EBRD initiative "QI-Energy" to provide incentives for private consumers in energy efficiency, regional, district and municipal support programs has been introduced. The above programs are considered the first steps in preparing an appropriate background for an energy efficiency fund which should become functional in early 2019.
- **Awareness of energy efficiency behaviour**: starting from 2014, energy efficiency became an important topic for discussion in mass media, TV and radio. This strategy finds support from the state: for instance, in the form of videos with best practices, guidelines for "Warm loans", energy audits and rehabilitation. Many activists who started out on their own implementing energy efficiency measures have become opinion makers and examples to follow.
- **Autonomy in heating:** this is very relevant for private households and in cities where due to a reduced number of residents and the collapse of industries the average cost of heating has gone up and incomes are growing much more slowly. For many consumers, having an autonomous heating system becomes one of the ways to cut bills and increase

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independence from communal services which are still managed as they were during the time of planned economies, with calendar dates for switching on and off, minimum care for consumers' needs, and ignorance of problems in cases of emergency. Given the above, many Ukrainians put enormous effort into getting disconnected from central heating systems, even in spite of resistance from local authorities and communal utility enterprises.

- **Trends:** different strategies promoted through certain channels, including the state and business. As examples, focus groups named a trend towards increase numbers of gas connections in late 1990 and in 2000 which was promoted by energy companies at the regional level – and indirectly supported through regulated, low prices by the state. Since 2014, the opposite trend has been promoted by the state, including the special focus of the state programme "Warm loans" – involving remuneration of part of loans for switching to non-gas boilers.
- **Willingness to economize/save money/cut bills:** most consumers have a very clear reference to the economic impact of their behaviour: the heating bill. This includes a wide range of attitudes - from total ignorance of savings in cases when the consumer receives a subsidized amount of heat that is clearly more than they need, to very careful regulation of heating apparatus on a daily basis by those on a moderate income who have to pay the whole price for the heat they consume. However, the second group differs also in its details because some consumers install solar collectors, while other install boilers using the cheapest types of solid fuels.
- **Promotion of the self-governing of buildings:** before the Ukrainian Law "On housing and communal services" was adopted, consumers in multi-flat buildings were not active in self-organizing regarding condominiums. However, further governmental regulations have stimulated them more and more. Lviv FG underlined the necessity of the Government's role in self-governing buildings and promoting energy efficiency and energy saving. One of the primary measures is the decision that was adopted to conduct energy audits for each building. This shows the "black holes" in the energy efficiency of building and stimulates consumers to renovate them. The same Lviv FG expressed the idea that local authorities should decide on the unbundling of heat supply and heat transportation services in order to create the conditions for the development of a thermal energy market. Therefore, condominiums would have the chance to choose heat suppliers with more attractive prices.

Despite the main differences in the approaches of consumers to energy consumption in the regions of Ukraine, as well as the strategies for lowering bills, there are also similarities because of the same national legislation (Ukrainian laws on electricity, alternative energy sources, alternative fuels, energy performance of buildings, etc.), regulations (adaptation of EU directives on energy efficiency and energy saving, energy tariff policy, etc.) and programs (on

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using funds for energy efficiency and energy saving, short- and medium-term measures to reduce natural gas consumption, National Action Plan for Energy Efficiency until 2020, etc.).

5.3. Focus group results in Germany

To close the research gap about the heating behaviour of energy-poor households, and especially to identify potential consumption reduction strategies, three focus groups discussions with energy-poor households and one focus group discussion with energy experts were conducted in Germany. The focus groups were administered in Münster, Germany, in the winter of 2017/2018. Elderly people, i.e. those older than 65 years or retired, were chosen as the target group for many reasons: first, literature suggests that elderly people consume relatively more energy.[9] Second, they have a wealth of experience with their energy consumption and the amount of their heating bill. Finally, both old-age poverty and demographic change are currently significant political and societal problems in Germany.

The causal loop diagram of one of the focus groups is illustrated in Appendix 2.

Identified challenges

- **Degree of insulation**: participants argued that a higher degree of insulation decreases heating demand. The reason is that with better insulation, warm air tends to stay in the dwelling and cold air is less likely to enter. Insulation is considered as a major investment challenge. Only home-owners can decide to insulate; however, tenants also pay heating bills.
- **Individual heating behaviour**: This challenge covers all behavioural/habitual factors that influence energy consumption. Among these, wearing (not wearing) warmer clothes, airing behaviour and heating unused rooms were mentioned.
- **Legislation**: participants mentioned the Energy Performance Certificate and an 'energy distribution key', designed to help distribute the costs of energy in multi-family dwellings among residents. The Energy Performance Certificate was seen as a factor that could decrease the amount of the heating bill, because tenants can compare dwellings with

[9] Brounen, Kok, Quigley (2012), Residential energy use and conservations: Economics and demographics, European Economic Review, 56(5), 931-945.
Brounen, Kok, Quigley (2013), Energy literacy, awareness, and conservation behavior of residential households, Energy Economics, 38, 42-50.

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respect to their energy efficiency. The distribution of shared energy costs was seen as a major challenge and, from a moral perspective, as unfair.

- **Size of dwelling**: the larger the size of the dwelling, the more rooms need to be heated.
- **Number of adjacent dwellings**: detached houses consume more heating energy than houses in a closer neighbourhood. The same argument holds for apartments: dwellings in the basement or in the attic will consume more energy because they cannot use the heat stemming from adjacent dwellings.
- **Share of bill, influenced by neighbours' consumption**: this challenge only holds for multi-family dwellings where common heating costs are split among the residents according to a fixed rule (energy distribution key). The participants of the focus group perceived this as unfair, because their own consumption reductions do not necessarily decrease the size of the heating bill.
- **Technical status of heating system**: this includes both the age of the heating system and whether consumption is manageable (e.g. through thermostats). Old heating systems consume more energy, and one participant in particular claimed to suffer a non-manageable heating system. The efficiency of the heating system is also an issue here.
- **Options of suppliers and resources**: Both having more resources to choose from (oil, gas, and renewables) and more suppliers will reduce heating costs because consumers can switch to the cheapest resource and supplier. However, switching costs need to be taken into account, which may be rather high given the administrative burden and transaction costs particularly for the elderly, as well as because of a lack of market transparency. Participants also argued that the use of renewable resources for heating (for example, heating pumps) would reduce costs, as less non-renewable resources need to be bought from the supplier.
- **Room temperature**: If rooms are heated to a higher temperature, heating costs rise.
- **Number and duration of people at home**: Having guests or relatives staying at home increases energy consumption because more rooms are heated for a longer time period.
- **Outside temperature (weather)**: Long and cold winters affect the heating bill because rooms need to be heated more to create a comfortable temperature.
- **Heating costs**: The price of energy affects the heating bill. Participants focused in particular on the lack of transparency of prices due to state regulations (taxes, fees).
- **Payback period of investment**: If it takes a long time until investments reach their break-even point, fewer people will invest because they are uncertain about future states. The questions arose whether residents would still be living in the same house, whether there would be newer, more efficient technologies which could have been a better investment, etc.

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- **Number of decision makers concerning renovations/investments**: Too many different owners in one multi-family dwelling can block group decisions because of different interests.
- **Cost splitting between tenants and home-owners**: The expert participants mentioned tenant-homeowner conflicts as a major barrier. It is often unclear who will/should pay for investments. This conflict hampers important investments in energy efficiency.
- **Comprehensibility of the energy bill**: the experts argued that energy bills are not easy to understand, particularly by low-income households. Many households do not know how individual items contribute to the heating bill (energy prices, consumption, fixed costs) and whether this amount is relatively high or low.
- **Housing costs**: Unemployed people receive money from the state for housing costs. This amount, however, is rather limited. Hence, unemployed/low-income people usually live in apartments with low housing costs, which are also in a bad condition from an energy efficiency perspective (insulation, etc.).
- **Number of thermostatic valves/degree of hydraulic adjustment**: thermostatic valves can be used for hydraulic adjustment. With hydraulic adjustment, all radiators have the same temperature. Without hydraulic adjustment, some radiators will stay cold but the heating system will keep attempting to increase their temperature.

Identified strategies

- **Information provision**: Information should be provided regarding the environmental consequences of energy consumption. Within this context, the participants also asked for a general explanation of federal climate policies and of climate change itself. They were particularly concerned with contradictory information from different sources and information being not understandable. In addition, the participants asked for more comprehensible explanation of energy bills.
- **Legal regulations about efficient and sustainable heating systems**: Tenants suffer from home-owners not investing in energy-efficient heating systems, thus policymakers should intervene and introduce a legal obligation to invest in new heating systems or refurbish existing ones. This strategy launched a discussion among participants about whether legal regulations or incentives should be introduced to increase investments in energy efficiency. The moderating question of whether legal prescriptions are financially feasible generated agreement among participants.
- **Individual-level billing**: Participants noted that energy bills are apportioned among all the neighbours according to their apartment size, without relation to actual consumption. The participants concluded that individual billing, without any shared cost component where technologically feasible, would reduce the influence of the energy consumption of

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neighbours. Hence, there would be a stronger incentive to save energy, as such savings would directly reduce the energy bill.

- **Federal incentive programs**: examples were mentioned such as favourable credits for energy efficiency investments and subsidies for energy-efficient heating systems. Incentive programs are also supposed to increase the uptake of investment into insulation, as they provide financial incentives that might be necessary to compensate for high upfront investment costs.
- **Subsidies for renewable energy resources used for heating**: subsidies are understood to decrease prices, thus making renewable energy resources cheaper compared to conventional resources, such that more of the former (e.g. air-to-heat-pumps, geothermal heating) can be used for heating.
- **Political information campaigns**: providing information to increase environmental awareness and to inform citizens about habitual behaviours that can save energy.
- **Diversification of energy sources**: with more renewables and more energy resources in general, households are less dependent on one single supplier/resource.
- **Efficient energy markets/ Legal price regulations**: Efficient (i.e. unregulated) markets are supposed to provide transparent prices, and therefore increase understanding of energy prices and make different resources comparable. Further, participants understood that unregulated prices should be the lowest prices because taxes increase the pure market price. Legal price regulations are thus evaluated as a negative strategy.
- **Participation of tenants in decision-making**: Participants who rented an apartment felt left out and unacknowledged in home-owners' decision-making. They asked for more regulation, without specifying what kind, which would mandate the inclusion of tenants in decision-making.
- **Allowing simple majority votes**: Because home-owners tend to block each other's decisions, participants argued in favour of simple majority votes. These should ease decision-making and speed up the agreement process.
- **Financial incentives to save energy**: according to the experts, the state pays the heating costs of unemployed persons, thus they have no financial incentive to save energy. Making unemployed people pay their heating costs would provide the necessary incentives.
- **Investment in public housing**: More investment would increase the quantity and the quality of apartments available to low-income households.
- **Awareness of comfort and health benefits**: the experts argued that households should be made more aware of the comfort and health benefits of energy-efficient housing.
- **Number of smartphone apps**: Smartphone apps are evaluated as a strategy to reduce heating costs. They could allow for a better understanding of how heating costs emerge and what can be done to save. Because of the "gamification" of the topic, such apps are often used and are attractive to less educated households.

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- **Possibility to refund (higher) housing-rents to unemployed persons**: If the state paid higher housing costs for unemployed persons, they could afford to live in better-insulated houses and would thus consume less energy.
- **Degree of lobbying**: the experts mentioned abolishing lobbying as a general side remark. Lobbying is supposed to increase inefficient legislation (e.g. legal regulations about hydraulic adjustment, which is not enforced). In particular, lobbying is believed to have negative effects on low-income households thus it is perceived negatively.

Some causal loops related to the focus group illustrated in Appendix 2 are explained here:

Causal loop 1 "refurbishment of the heating system":

The higher the financial burden (i.e. the rent) for tenants, the less likely the refurbishment of the heating system. Tenants may oppose such refurbishments if the cost of the investment is distributed to tenants who are not able to bear a higher rent. If there were a way to manage the refurbishment of heating systems without putting too much financial burden on the tenants, this would increase the efficiency of heating systems and thus reduce amount of heating bills.

The higher the number of audits and the degree of auditing of standards, the more effective legal minimum standards will be, and the more refurbishment of heating systems will take place. Thus, the efficiency of heating systems can be increased. This argumentation highlights the belief of participants that many legal standards are not enforced. Hence, policy should also target the enforcement and monitoring of legislation to increase efficiency of energy use.

Causal loop 2 "federal incentive programs":

The higher the amount of social and/or financial benefits, the more federal incentive programs and the more subsidies on insulation will be used. This argumentation holds for both monetary benefits and for social benefits such as positive impacts on the global climate or relief for tenants from the energy cost burden. Participants argued that these benefits should be increased or promoted more. The more federal incentive programs and the more subsidies on insulation are used, the more (efficient) insulation will be installed. Better insulation reduces the size of heating bills.

The higher the degree of academic consulting in political decisions, the more effective federal incentive programs will be designed. This argumentation also concerns the trustworthiness of political incentive programs and thus their uptake. It mirrors an implicit concern of ad hoc policies. If federal incentive programs are better designed and generate higher levels of trust, the more investment is made into insulation.

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Although not further discussed in the focus group, the same causal loop would apply to the challenge "efficiency of the heating system". Causal loops are explained in detail in the country case studies.

5.7. Common results in the countries

The common challenges which are relevant to all or most of the participating countries are the following:

- The technical status and age of the heating system, as well as its efficiency: the technical condition and the age of heating systems often hinder their efficient energy use.
- Characteristics of the dwelling in terms of age, condition, orientation, location: if the whole dwelling is old and/or in bad condition, is oriented or located unfavourably in terms of weather conditions, this increases heating-and-cooling-related energy consumption.
- Issues with insulation: bad or no insulation decreases the efficiency of heating.
- Thermostat-related challenges: having a thermostat (or not), using the thermostat in the right way to save energy and influence energy consumption.
- Fuel types used for heating/use of renewable resources for heating: Different fuel types have different efficiencies and various environmental impacts. The availability of the necessary infrastructure is an issue. The availability, affordability, price and proper use of renewables are also challenges in several regions.
- Fuel price and fuel price differences: Beyond the availability of different fuel types, their cost is often a challenge, especially for poor, vulnerable groups of society. The cost of different fuel types also has an influence both on the choices and the difficulties of households.
- Difference between inside and outside temperature: many households ignore the fact that cooling should be adjusted to the outside temperature in terms of not setting a drastically different temperature inside compared to the outdoor circumstances. Even in winter, maintaining a healthy indoor temperature that avoids overheating is important both for health and energy efficiency reasons.
- Individual heating behaviours: there are obviously significant differences between the preferred temperature, the habit of heating heavily and the habit of wearing more clothes and maintaining a lower temperature, ventilation habits, heating when at home versus when not at home, etc.
- Sharing of the energy bill by a block of apartments: this often results in a lack of motivation to save energy by heating more rationally, as such heating bills do not directly depend on the heating behaviour of individual households but the behaviour of the whole dwelling.
- Conflicts between tenants and landlords in terms of investing into a more efficient heating system or into insulation, lack of participation in decision-making: landlords are often not

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interested in investing into a more efficient heating system, even if this investment would increase the value of their property. Tenants are more concerned by this issue, but they struggle with the lack of interest of the landlord and the fact that they have no voice in decision-making related to the investments within the dwelling.

- Conflicts within multi-apartment houses related to investing into renovation: decision making in multi-apartment houses is a difficult process where the voting rules and financial commitments that are required may block the necessary investments into renovation of the house or the heating system.

The strategies behind those challenges can be captured in five themes: (1) Information sharing and communication, (2) awareness raising of consumers and policy makers, (3) promoting the availability of technological solutions, (4) financial measures, and (5) tools for fighting energy poverty. The **similar strategies** in the five countries in those themes are the following:

- **Information-sharing and communication**: e.g. Provision of information to households in various formats about the energy market. Information provision appears to have many benefits: it would induce investment in more efficient insulation and heating systems, households would become more aware of the options they have to switch to other suppliers and more aware of how to heat "correctly" from a behavioural or habitual point of view. Further, households would better comprehend their energy bills and have a higher level of environmental awareness. All these benefits would lead to a reduction in heating consumption. Multichannel communication focusing on different types of information is also a necessary strategy.
- **Awareness-raising of consumers and policy makers**: e.g. when promoting incentive programs both the social and financial benefits should be highlighted, including positive impacts on the global climate or the relief of tenants' energy cost burden. Many incentive programs already exist, but households are not aware of them or do not understand them. Emphasizing the healthy winter indoor room temperature to reduce overheating, promoting the use of thermostats and building communication on reference group influence also can be effective awareness-raising strategies.
- **Promoting the availability of technological solutions**: e.g. supporting the spread of individual metering, make new heating technologies, community-based solutions and different fuels available to the public, promotion of renewable energies and supporting R&D investment are common strategies here**.**
- **Financial measures**: e.g. Incentive programs such as subsidies or favourable credits – the state should be active at promoting and subsidizing energy-efficiency improvement investment opportunities and installing and using renewable energies.
- **Tools for fighting energy poverty:** e.g. provision of social support for investments that improve the energy efficiency of houses and increase the value of whole estates.

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Rethinking and modifying the supporting system for socially vulnerable consumers may also be an effective strategy.

Detailed strategies as proposed by focus group participants for managing the identified challenges to reduce heating-related energy consumption and the size of energy bills in parallel are provided in a separate Policy Paper.

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6. Data analysis of the household survey

Aiming at addressing the citizen involvement and attitudes towards the low-carbon energy transition in Europe, ENABLE.EU conducted a nationally representative survey in the 11 project partner countries – Bulgaria, France, Germany, Hungary, Italy, Norway, Poland, Serbia, Spain, Ukraine and the United Kingdom. The survey methodology included a specific block of questions covering each of the case study topics, including that of heating. The survey will enrich understanding of the drivers and barriers that affect individual and collective energy choices across the countries (See Appendix 6 for the survey tool used for the heating and cooling case study).

The questions regarding habits, challenges and policy options were obtained as an outcome of the pilot focus groups and some early laymen focus groups within the project, thus the design of this block reflected citizen participation and citizen opinion. The specific block regarding heating was conducted in the five participating case-study countries only, and covered three major sets of questions:

- Heating habits and patterns that impact energy costs, including winter and summer indoor temperature comfort level in dwellings, how households control the main heating equipment most of the time, and whether they heat only the rooms that are in use or the whole dwelling.
- Challenges citizens face when aiming to reduce their energy consumption, including a lack of financial resources, lifestyle lock-in that is difficult to overcome, owner-tenant problems, lack of feedback on energy consumption, insufficient knowledge about easy and practical energy-saving solutions, inconvenience of the refurbishing process.
- Public acceptance of different policy options aimed at changing behaviour; for example, those related to information-sharing, awareness-raising, promoting the availability of technological solutions, financial measures, community-based solutions and tools for fighting energy poverty.

In the following a brief overview is provided about the major findings of the heating-related survey.

6.1. Indoor comfort temperature

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Focus groups identified the winter indoor temperature and heating habits as major factors affecting energy-related costs. The survey shows substantial differences across countries regarding the required indoor temperature people tend to maintain in their dwellings.

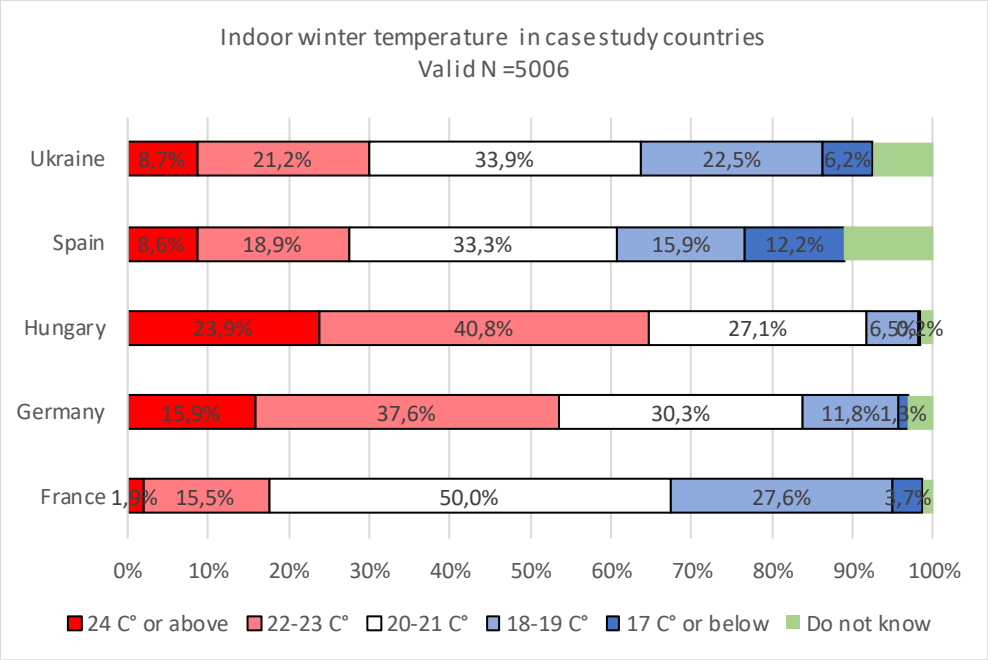

Figure 8. Self-reported winter indoor temperature in the case-study countries.

For the purpose of this study, 20-21°C is considered neutral, and the all-country average winter indoor temperature is around this range. There is significant variation among countries, though. In France, the legally recommended indoor temperature is 19°C, while in Hungary even 21°C would be considered too low. The recommended temperature values in the European standard EN 15251:2007 are a minimum 20°C for winter. Above 22°C, perceived as the comfort temperature by some, is considered overheating. Overheating is more common in Hungary and Germany. This phenomenon can be explained by overcompensation for the cold climate, cultural factors, the reduced availability of temperature control equipment in Hungary, and the impact of historically low energy prices. The low winter indoor temperature in Spain and Ukraine may be explained by cultural and technological factors. In Spain, 7.8% of households do not have a heating system but frequently use other auxiliary heaters such as portable radiators.

Moreover, as the next table shows, a significant share of people (25.7%) tend to maintain a higher indoor temperature in winter than in the summer in respective countries. Overheating during wintertime and overcooling during summertime may have adverse health impacts. For example, when entering/exiting an air-conditioned building from/to outdoors people may suffer not only thermal discomfort but also even potential health problems (Jing et al. 2015).

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In a study by Boardman et al. (2005), 18-21°C was considered the neutral temperature zone, and adverse health impacts were reported at a temperature of above 24°C or below 16°C. Indoor temperature has a significant impact on energy consumption and energy costs, thus differences in indoor temperature may explain the significant variation in energy consumption under otherwise similar conditions.

		Summer temperature						
		24 C° or above	22-23 C°	20-21 C°	18-19 C°	17 C° or below	Do not know	Total
Winter temperature	24 C° or above	2,9%	1,4%	2,5%	1,8%	1,8%	0,4%	10,8%
	22-23 C°	7,9%	5,1%	6,4%	3,3%	1,3%	1,4%	25,5%
	20-21 C°	10,7%	8,4%	9,1%	4,2%	1,8%	2,6%	36,7%
	18-19 C°	5,0%	4,7%	3,6%	2,5%	1,1%	1,3%	18,2%
	17 C° or below	2,5%	0,6%	0,8%	0,2%	0,2%	0,2%	4,5%
	Do not know	0,4%	0,2%	0,2%	0,0%		3,6%	4,4%
Total		29,3%	20,4%	22,6%	12,1%	6,2%	9,4%	100,0%

Table 3. Reported summer and winter indoor temperature in households in the case-study countries. (N=5006).

6.2. Availability of control equipment

Insufficient availability of temperature control equipment may partially explain the overheating problem as highlighted in several focus groups. Still, we found that manual adjustment of the temperature is more frequently associated with overheating than a lack of control equipment.

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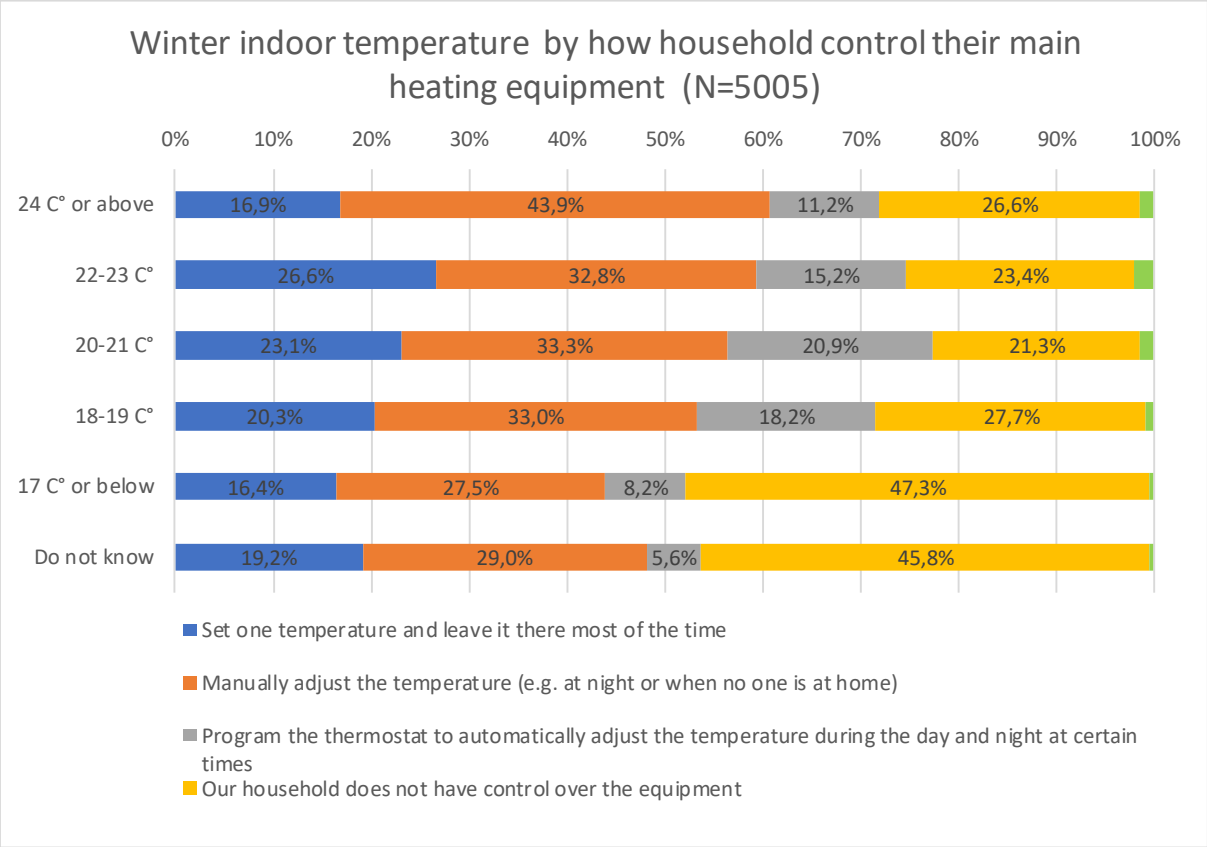

Figure 9. Winter indoor temperature according to how households control their heating equipment

Promoting the spread of thermostats (preferably programmable ones) may contribute to a healthier indoor temperature. District heating service companies may also help by keeping the temperature in the optimal range for their customers.

6.3. Heating habits

Heating only the rooms that are actually in use was considered a way of reaching energy savings by focus groups. Countries vary widely regarding how common this practice is amongst their citizens, with the highest share measured in Spain (51.6%) and France (47.7%) and lowest share self-reported in Ukraine (26%) and Hungary (28.9%). Germany scores in the middle with its 38%. Explanatory factors include culture, age, and the availability of technological options for turning down the temperature in selected rooms. Older people are more willing to heat only some rooms.

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6.4. Challenges citizens face in case-study countries

Challenges citizens face when intending to reduce their heating-and-cooling-related energy costs overlap in the case-study countries. Still, there are challenges that are more dominant in certain countries than in other countries. In this section the relevance of different challenges in the case-study countries is discussed. In the survey tool we used a Likert scale, with possible responses ranging from 1 (not at all) to 5 (very much). To ease graphical interpretation, the response rates for 'somewhat' and 'very much' were combined on most figures.

Financial challenges

Financial challenges are present in each of the five studied countries, dominating most in Ukraine and Spain. Insufficient financial resources and the lack of available loan and subsidy programs are highly relevant problems in each country. Calculating the payback on investment seems to be a major problem in Germany and Spain, while this is less relevant in Hungary and France. People may have more pressing challenges and not feel that the issue of payback is that important.

'Lock-in' related challenges

According to Sanne (2002), consumers are often locked into unsustainable lifestyles by circumstances even though they are not willing nor happy to act unsustainably. These lock-ins may have life-stage related, financial, cultural, legal or technological reasons that make it hard for citizens to reduce their energy consumption. Those circumstances may not be relevant for the vast majority of citizens, but may still be pressing for sensitive groups such as those belonging to lower income brackets, the elderly who live in the countryside, or families with small children. After raising children, the elderly may find their dwellings to be too large, but still difficult to sell because of the unfavourable location or low value, creating a kind of life-stage related lock-in. Emotional attachment also plays a role, of course. Dwellings in old buildings may also be of low value compared to the prospective costs of refurbishment. Monument-protection-related legislation may not permit certain kinds of refurbishment technologies.

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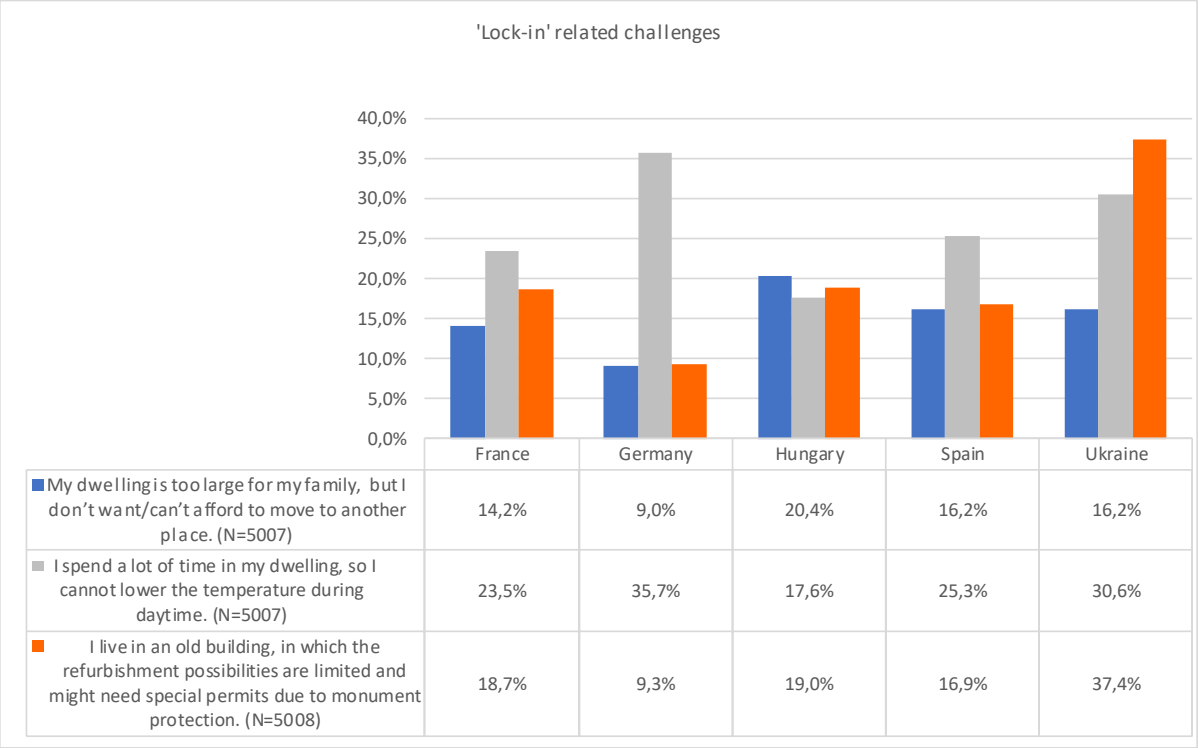

	France	Germany	Hungary	Spain	Ukraine
My dwelling is too large for my family, but I don't want/can't afford to move to another place. (N=5007)	14,2%	9,0%	20,4%	16,2%	16,2%
I spend a lot of time in my dwelling, so I cannot lower the temperature during daytime. (N=5007)	23,5%	35,7%	17,6%	25,3%	30,6%
I live in an old building, in which the refurbishment possibilities are limited and might need special permits due to monument protection. (N=5008)	18,7%	9,3%	19,0%	16,9%	37,4%

Figure 10. Lifestyle lock-in in the case-study countries (% of valid responses).

Retired people, and the unemployed or other economically inactive people complain more about their inability to lower the temperature during the daytime since they spend most of their time at home. Economically inactive people also include housewives and parents with small children. For them, lowering the daytime temperature is not an option for saving money.

These 'lock-ins' are present in each country.

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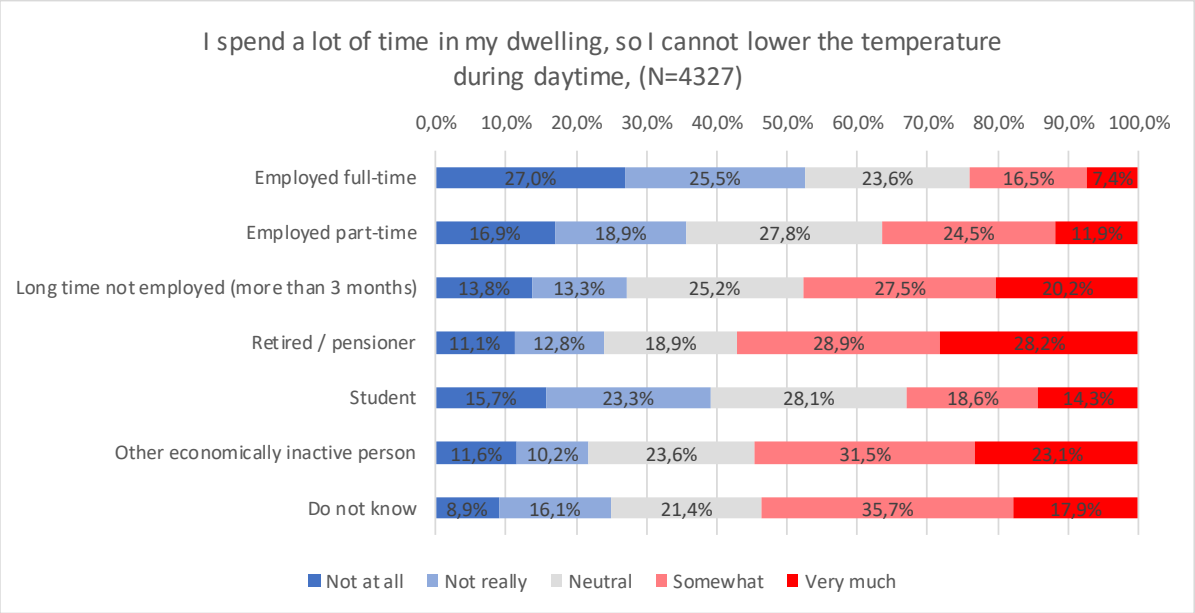

Figure 11. Time spent at home by employment status.

Challenges due to conflicting interests of occupants

Disinterest or the conflicting interests of owners and tenants in multiple-apartment houses were mentioned as factors hindering energy-saving investments. This problem proved to be most pressing in Germany, although it was present in other countries, too. In Germany in multi-apartment dwellings, common heating costs are split among the residents by using a so-called energy distribution key, thus individual household reductions in consumption do not necessarily decrease the size of the heating bill. It is also often unclear there who will/should pay for investments. This conflict hampers important investment into energy efficiency. Amongst the five countries, Spain has the highest share of citizens living in buildings with two or more flats (73%), while the second is Ukraine with 50%. This may explain the high score on the second statement that their energy bills also depend on the energy consumption of other households.

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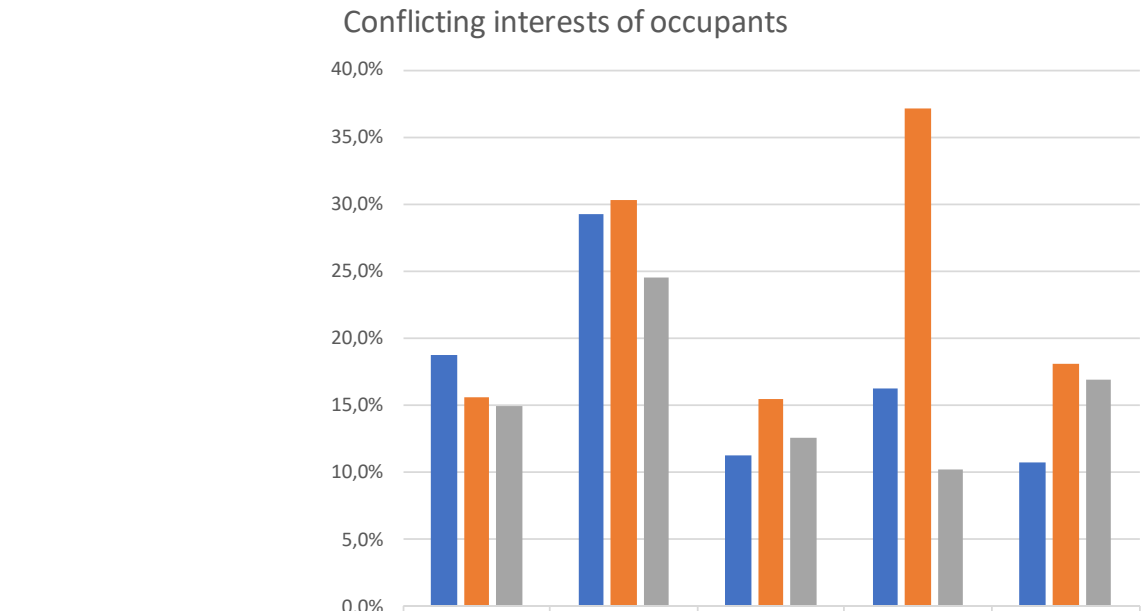

	France	Germany	Hungary	Spain	Ukraine
In the dwelling where I live, the owner and the tenant is not the same person, and at least one does not want to invest in energy-saving measures. (N=5008)	18,8%	29,2%	11,3%	16,2%	10,8%
Besides my own energy consumption habits, my energy bill also depends on the energy consumption of other households in the house. (N=5005)	15,6%	30,4%	15,4%	37,1%	18,1%
I feel discouraged because my neighbours are not energy-conscious. (N=5006)	14,9%	24,5%	12,6%	10,3%	17,0%

Figure 12. The challenge of conflicting interests of occupants.

Information-related challenges

Citizens lack meaningful information about their energy consumption in most countries and complain about their energy bills being overly complicated. Expert focus groups in several countries, including Germany and Hungary, argued that energy bills are not easy to understand, particularly by low-income households. This insight was underlined by the survey results: in Germany over two-thirds of people complained that energy bills were too complicated.

A significant share of people feels that getting feedback about actual energy consumption is not frequent enough, although there is large variation across countries: in Hungary only 14% of people identified this as a problem, while almost half of German respondents agreed with the statement. In Germany, most households receive their energy bill just once a year. In France, monthly billing is more common, so this could partly explain the different answers.

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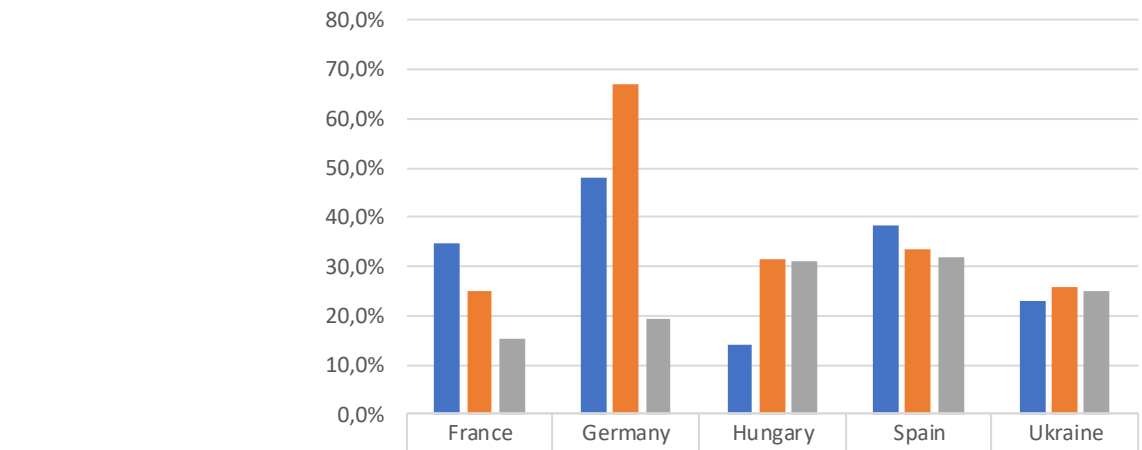
The exception is still Hungary, where annual billing is common, although people still show less interest in more frequent billing.



	France	Germany	Hungary	Spain	Ukraine
I don't get frequent enough feedback on my actual energy consumption. (N=5008)	34,6%	48,0%	14,0%	38,5%	23,1%
My energy bill is too complicated, I cannot interpret it. (N=5005)	24,9%	67,1%	31,6%	33,6%	25,8%
I don't have individual metering in my dwelling. (N=5009)	15,4%	19,3%	31,3%	32,0%	25,1%

Figure 13. Insufficient feedback about energy consumption (% of valid responses).

6.5. Policy options

After asking for the major challenges, we also addressed the issues regarding some general policy options raised by focus groups. The following charts show the most important results.

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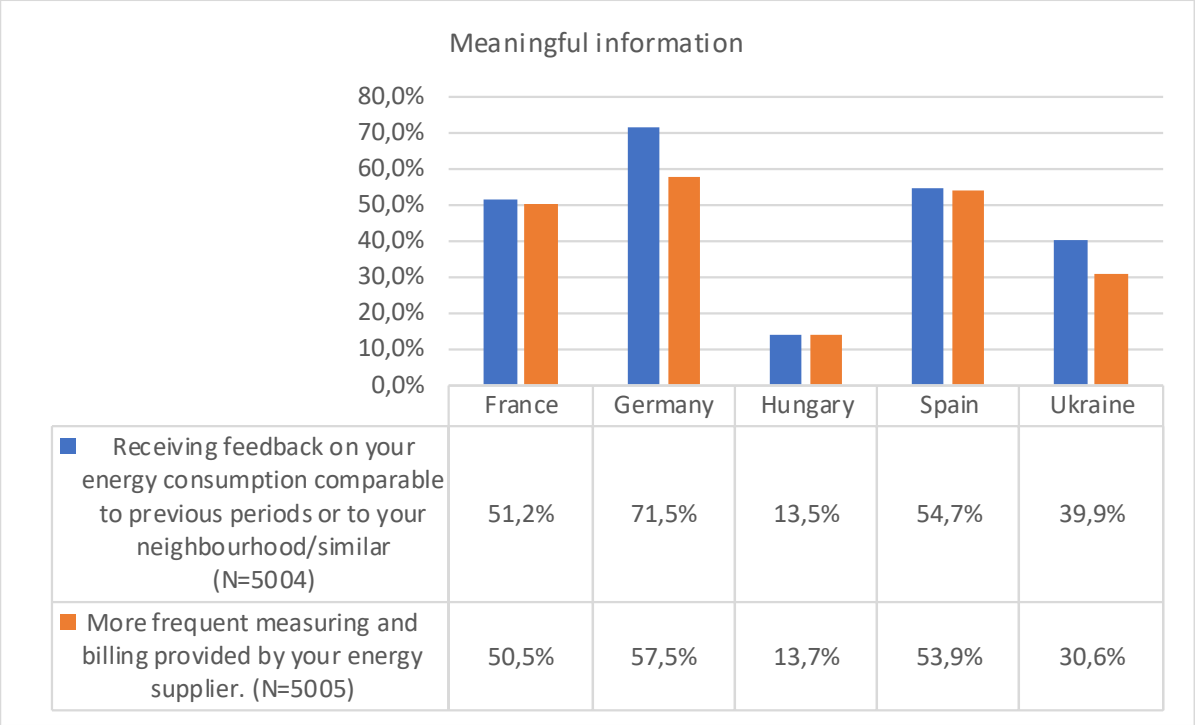
Improved feedback about energy consumption



	France	Germany	Hungary	Spain	Ukraine
Receiving feedback on your energy consumption comparable to previous periods or to your neighbourhood/similar (N=5004)	51,2%	71,5%	13,5%	54,7%	39,9%
More frequent measuring and billing provided by your energy supplier. (N=5005)	50,5%	57,5%	13,7%	53,9%	30,6%

Figure 14. Public support for improving feedback about energy consumption (% of valid responses).

Most people would welcome more frequent and more meaningful information regarding their energy consumption: information comparable to previous periods or similar households seems to be especially useful. The only exception is Hungary, where citizens expressed less desire for such kinds of data.

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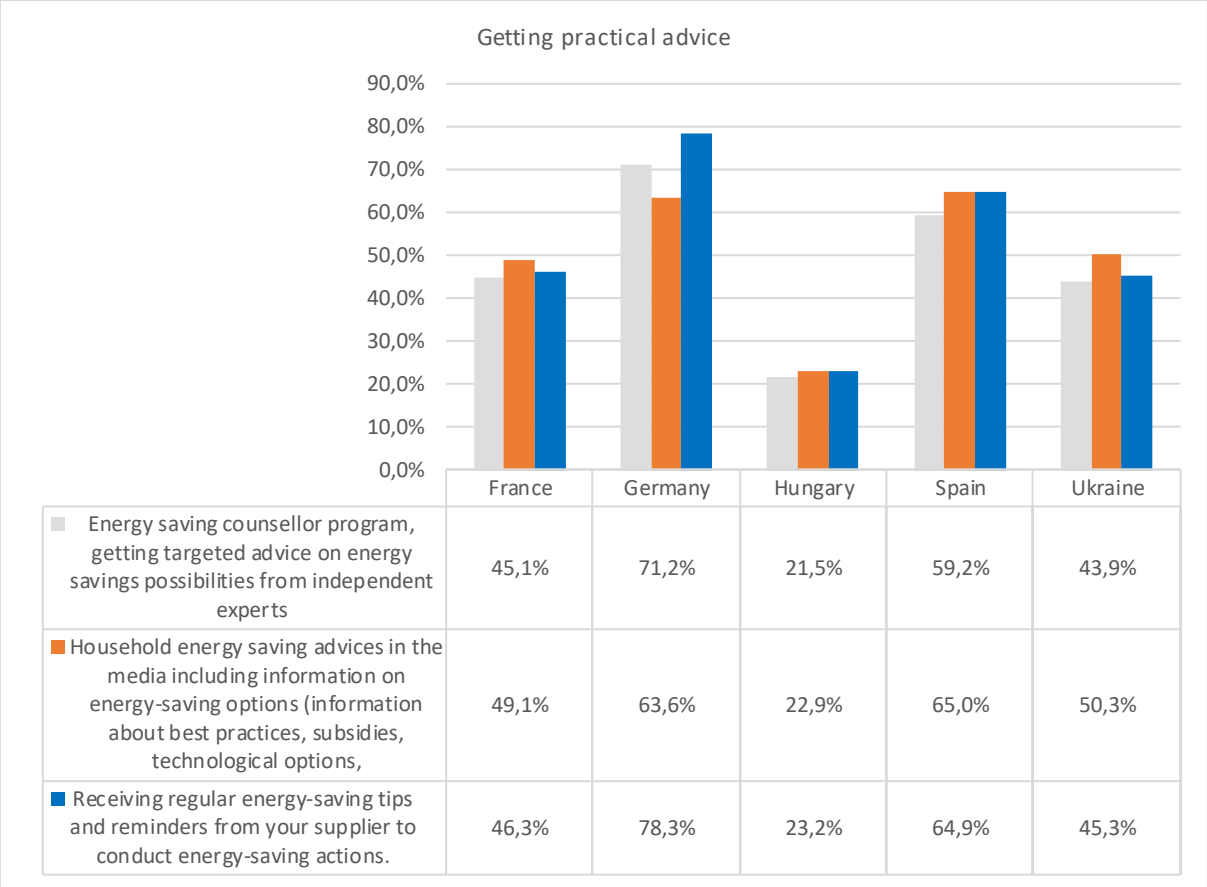
Awareness-raising, receiving targeted energy-saving advice



	France	Germany	Hungary	Spain	Ukraine
Energy saving counsellor program, getting targeted advice on energy savings possibilities from independent experts	45,1%	71,2%	21,5%	59,2%	43,9%
Household energy saving advices in the media including information on energy-saving options (information about best practices, subsidies, technological options,	49,1%	63,6%	22,9%	65,0%	50,3%
Receiving regular energy-saving tips and reminders from your supplier to conduct energy-saving actions.	46,3%	78,3%	23,2%	64,9%	45,3%

Figure 15. Public support for targeted energy advice (% of valid answers).

In Hungary and Ukraine, getting practical energy-savings tips and targeted advice is appreciated more than getting dry information about energy consumption. Still, Hungarian citizens seem to be more resistant towards such information than their other European counterparts. This finding may relate to the low level of trust between service providers and consumers, and less trust in top-down information. Decreasing energy costs due to the Hungarian government's utility cost reduction program may also play a role. Cost-savings due to the program are printed on utility bills, which may contribute to the perception that utility costs are lower.

Community-based solutions

On average, more than half of all respondents supported community-based solutions These include refurbishing houses with the help of the local community or organisations involved in

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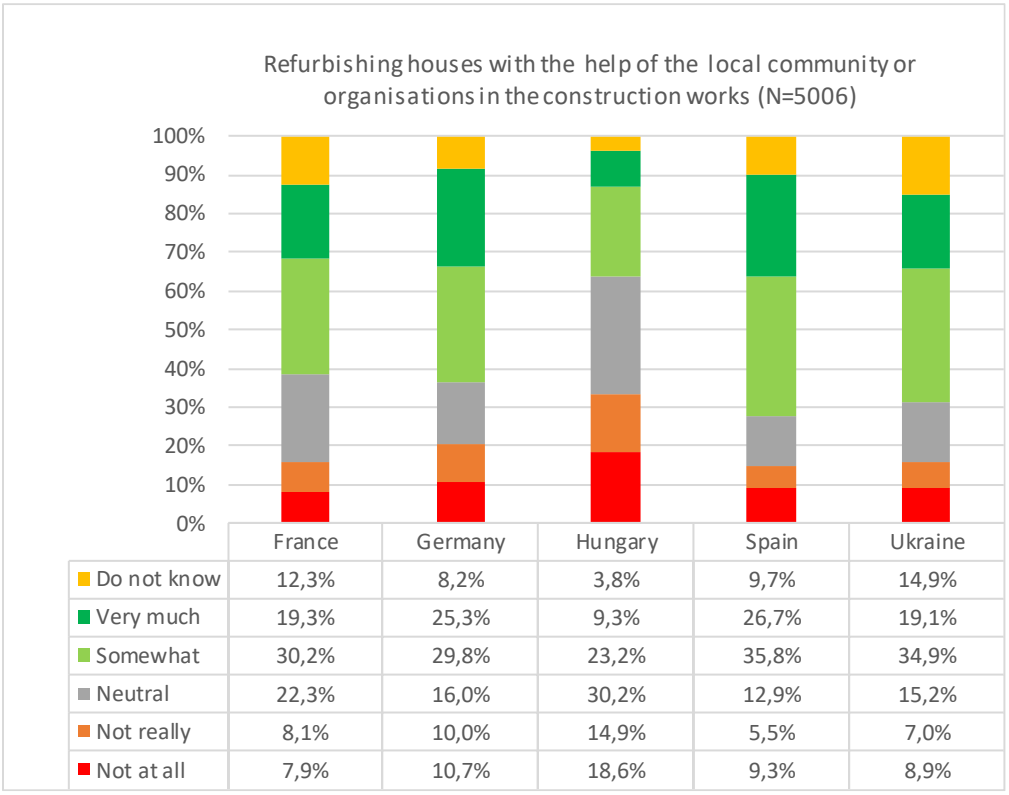
construction works at an affordable price. People can help each other with construction work and reduce costs. Refurbishing dwellings with the help of an energy service company or an energy supplier in a way that the resulting energy-savings finance the investment also partly falls into this category, if a local service provider is involved in the process.

This option received quite a bit of support in all countries, even in countries less receptive towards getting more energy-related information. In Spain 62.5% of people said they would welcome community-based help, and even in Hungary the acceptance rate was over 30%. Community-based solutions include:



	France	Germany	Hungary	Spain	Ukraine
Do not know	12,3%	8,2%	3,8%	9,7%	14,9%
Very much	19,3%	25,3%	9,3%	26,7%	19,1%
Somewhat	30,2%	29,8%	23,2%	35,8%	34,9%
Neutral	22,3%	16,0%	30,2%	12,9%	15,2%
Not really	8,1%	10,0%	14,9%	5,5%	7,0%
Not at all	7,9%	10,7%	18,6%	9,3%	8,9%

Figure 16. Public support for local community-based solutions (% of all responses).

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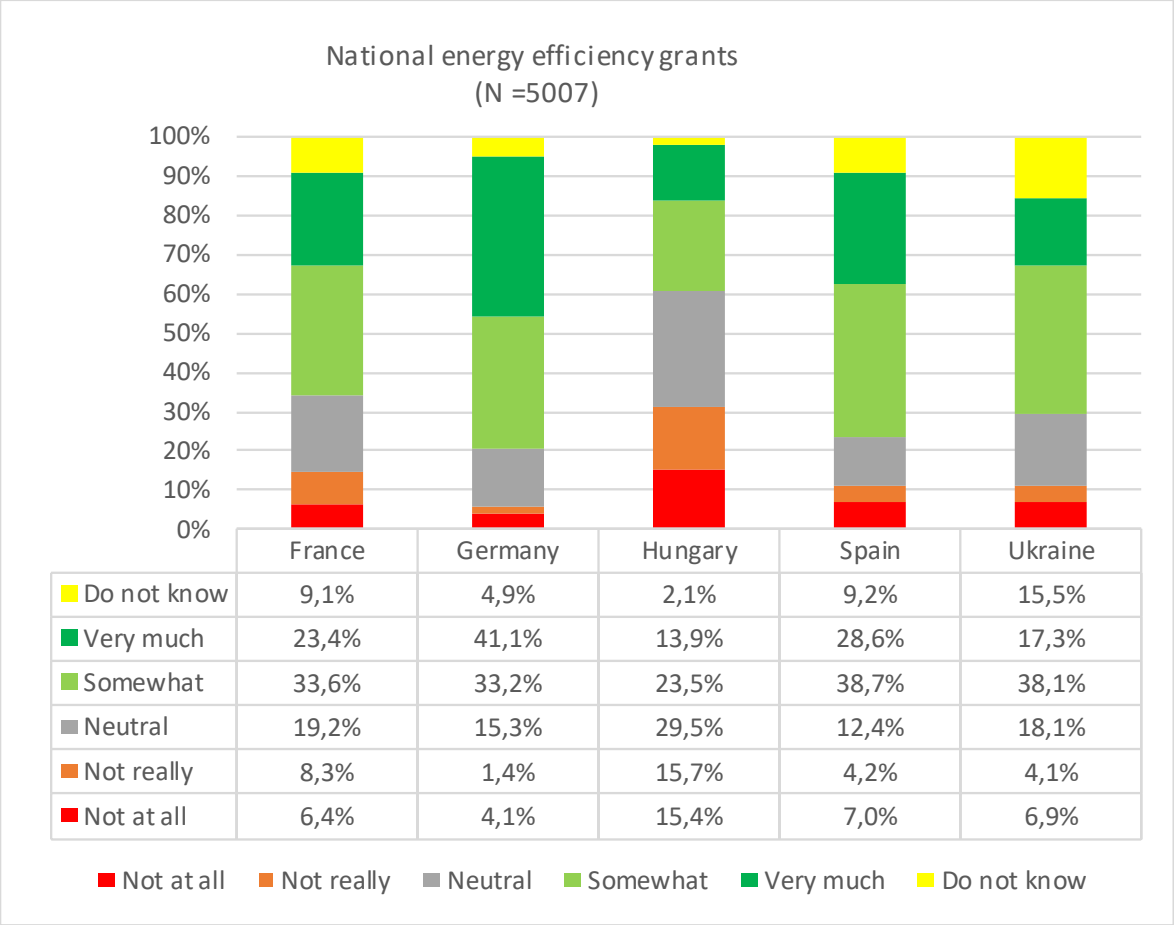
Information support



	France	Germany	Hungary	Spain	Ukraine
Do not know	9,1%	4,9%	2,1%	9,2%	15,5%
Very much	23,4%	41,1%	13,9%	28,6%	17,3%
Somewhat	33,6%	33,2%	23,5%	38,7%	38,1%
Neutral	19,2%	15,3%	29,5%	12,4%	18,1%
Not really	8,3%	1,4%	15,7%	4,2%	4,1%
Not at all	6,4%	4,1%	15,4%	7,0%	6,9%

Figure 17. Public support for getting information about national energy-efficiency grants (% of valid responses).

People expressed significant interest in getting national energy efficiency grants and assistance with applications. The help of an energy service company would also be appreciated, provided that the resulting savings finance the investment.

Tools for fighting energy poverty

Expanding the energy subsidies programs (e.g. social tariffs, financial aid for covering heating bills, providing free firewood) would help deprived people and would also contribute to phasing out some illegal and harmful heating practices. The highest support for this option was found in Germany and Spain, and the lowest in Hungary. Still, expanding the energy subsidy programs was among the most supported policy options in all countries.

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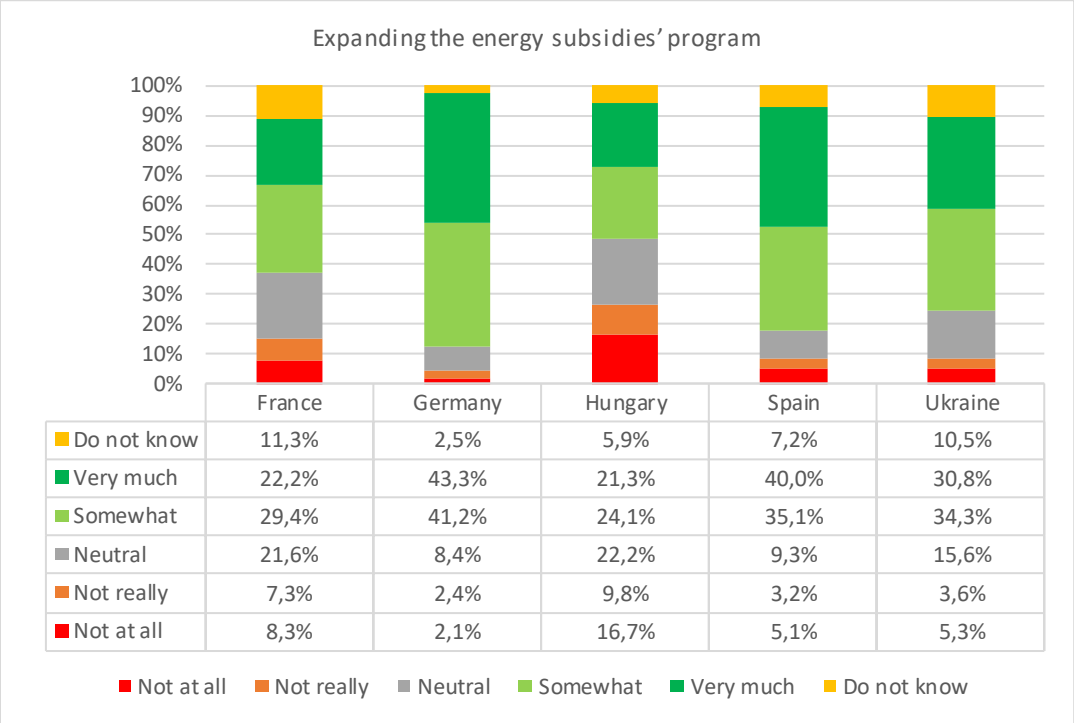

	France	Germany	Hungary	Spain	Ukraine
Do not know	11,3%	2,5%	5,9%	7,2%	10,5%
Very much	22,2%	43,3%	21,3%	40,0%	30,8%
Somewhat	29,4%	41,2%	24,1%	35,1%	34,3%
Neutral	21,6%	8,4%	22,2%	9,3%	15,6%
Not really	7,3%	2,4%	9,8%	3,2%	3,6%
Not at all	8,3%	2,1%	16,7%	5,1%	5,3%

Figure 18. Public support for expanding the energy subsidies program.

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7. Summary and conclusions

This report synthesised the outcome of the research conducted by the project partners in France, Germany, Hungary, Spain and Ukraine based on a consciously elaborated research design. The structure of the research itself provides clear and novel insight regarding the analysis of the main challenges and response of the society to heating-related behaviour change.

The statistical analysis and the literature review provided the input for the setup and the methodological considerations of the focus group discussions which were carried out via participatory system mapping. The outcome of the early pilot and laymen focus group discussions – challenges, strategies, moderating factors and causal loops, as well as formulated policy options related to decreasing the heating bill and hence, total energy consumption, were used as input for compiling the questionnaire-based survey. Although the significant variety of questions raised in the focus group discussions had to be limited to some focal issues for the survey, the coherence of the research is obvious. Qualitative and quantitative methods supplemented each other and provided a more holistic and sophisticated overview of the main issues related to behaviour towards energy consumption in heating. With the help of this complex research strategy and design, causal relationships could be detected and explained, going beyond descriptive statistics. The roots of the main challenges, the potential individual and community-based strategies for overcoming these challenges, as well as individual behaviour patterns could be understood in a deeper and more comprehensive way, supporting the formulation of well-crafted policy recommendations and making them well founded and authentic.

European consumers are diverse in terms of: heating requirements; financial resources that can be allocated towards low-carbon investment; housing conditions including insulation, home size, ownership; their preferences, willingness and motivation to change their habitual behaviour; their motivation for making changes; their beliefs and misunderstandings about low-carbon options. Still, most challenges and policy options identified during the focus groups overlap in several countries and could be grouped into a limited set of themes that may be tackled with similar policy options.

Challenges overlapping in several countries

There were several common challenges which are relevant to all or most of the participating countries:

- technical status and age of the heating system,

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- characteristics of the dwelling in terms of age, condition, orientation, location
- issues of insulation: poor or no insulation decreases the efficiency of heating,
- fuel types used for heating/use of renewable resources for heating,
- fuel price and fuel price differences,
- difference between inside and outside temperature,
- individual heating behaviour,
- sharing bills between blocks of apartments,
- conflicts and difficult dialogue between tenants and landlords connected to issues regarding investment into more efficient heating systems or into insulation.
- Differing interests within multi-apartment houses related to investing into renovation: decision making in multi-apartment houses is a difficult process in which voting rules may block the necessary investments into house or heating system renovation.

Strategies behind those challenges are various and were highlighted on a country basis. Policy recommendations for using appropriate strategies and managing the identified challenges in order to reduce heating-related energy consumption and the size of energy bills in parallel are provided in a separate Policy Report.

Strategy options that overlap in several countries

The policy recommendations made by citizens are related to the following areas.

Regarding **information-sharing and communication**, common ground for policy recommendations in the participating countries can be detected regarding the following issues: (1) provision of easily understandable practical information about energy-saving solutions, metering and behavioural patterns, (2) multichannel communication for reaching various target groups with appropriate messages, and (3) use of independent, trustworthy parties for successfully influencing the energy-related behaviour of the society.

Related to **awareness raising,** the participants of the focus groups in every country agreed that raising awareness regarding (1) energy-efficient behaviour, (2) the interrelationship between energy consumption and its impacts on the environment, on our health, and on the costs of the household, as well as regarding (3) good examples and the easy ways (and benefits) of behaviour change are crucial in policy making.

Technology-related policy recommendations were similar in terms of (1) supporting the availability, the cost efficiency and the affordability of new, more sustainable technological solutions for heating. In addition, (2) promoting the modernisation of buildings for better insulation, thermal conditions and ventilation, (3) promoting individual metering and the use

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of thermostats, and (4) making use of community-based solutions (this can be achieved by experimenting locally and seeing what works and what does not).

Policy recommendations related to **financial measures** were similar in stressing both (1) the need to provide more financial incentives for using more renewable energy, switching to more energy-efficient solutions, solving conflict situations (e.g. between landlords and tenants), and (2) the need to penalise the overconsumption of energy and polluting ways of heating.

Related to the tools for **fighting energy poverty**, policy recommendations commonly focused on (1) the need for social support for higher-scale investment into improving the energy efficiency of the houses of vulnerable families, and (2) the need for various social schemes.

Added value of the research

The added value of the research was how it successfully integrated laymen and expert focus group perspectives during the focus groups. Channelling some issues into the representative survey of the ENABLE.EU project was also done in as much as the timeline of the project made it possible. Thus, the heating section of the survey reflected the participatory nature of our research as questions were based on suggestions made by citizens during focus groups. This participatory approach to the survey is unique in the research.

The use of laymen and expert groups in parallel also shed light on the slightly different perspectives laymen and experts had regarding energy-related information. Solutions-oriented information and advice about energy saving received more interest from citizens than information about energy consumption data. Citizens in Hungary seemed more reluctant to receive additional information about any kind.

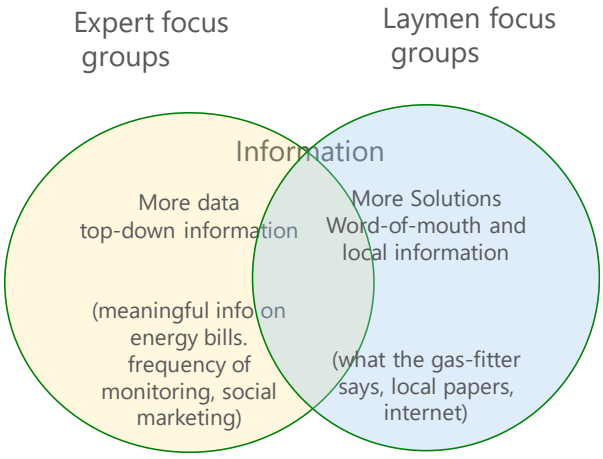

Figure 19. Different perspectives of experts and laymen.

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Focus group participatory research shed light on some understudied topics regarding the behavioural factors involved in energy saving. One of them is the role of the comfort temperature in energy saving. Focus groups indicated that the winter comfort temperature might increase due to changing behaviour regarding clothing at home. Thermal adaptation was also mentioned as a reason for heating requirements, when households have the option to lower temperature either manually or by using a thermostat. These issues were then converted into survey questions.

Our survey reinforced the insights received from the focus groups regarding most issues. The comfort temperature varies widely across countries, which may be a significant explanatory factor for the varying heating-related energy requirements. Households in which the temperature is controlled manually are associated with higher winter indoor temperatures than households where there is no temperature control, which is in opposition to the common belief. Also, a significant share of people (some 25%) tend to overcompensate for the weather, maintaining a higher indoor temperature in winter than in the summer. Besides the energy costs of this high 'energy step', the difference between the indoor and outdoor temperature might have undesirable health effects.

The differing interests of inhabitants in the case of rented dwellings also hinder energy-saving measures, as the interests of the owners and tenants of buildings are different. Owners are not always interested in carrying out investments that pay back only in the long term, while tenants may be more interested in lower rents than making potential savings through their energy bills in the long term (Schreiner, 2015). Furthermore, in multi-apartment buildings the implementation of major refurbishments may need consensus among all inhabitants, which is a further barrier to change.

Focus groups also highlighted the annoying and illegal practice of using garbage for heating purposes. This practice is used to save on energy costs by lower income bracket households, but it impairs health, pollutes the environment, and is perceived of as an annoyance by neighbours. This problem causes a disturbance for a significant share of citizens in Ukraine and Hungary.

Thus, our qualitative research indicated the need for more research regarding the behavioural aspects of heating-related energy-saving options.

Triple dividend options

A very important purpose of the focus group discussions and the surveys was to identify triple dividend policy options which go beyond even win-win situations in terms of being beneficial

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from three policy aspects – economic, social and environmental – and thus create acknowledgeable added value.

Creation of environmental, economic and health dividends: Providing information through different communication channels about the required temperature results in less energy consumption, creating less environmental load, savings on energy costs, and a healthier lifestyle. Different communication channels are important here, as different target groups have to be approached in different ways. Price-sensitive and cost-sensitive consumers can be reached with information on how much they can save by decreasing the temperature 1°C, while those who specifically care more about their health can be better influenced by information about how much healthier it is to maintain the proper, not too high, temperature in the house. Environmentally conscious consumers can be mobilised with the message that energy efficiency causes less environmental pollution due to less energy consumption. Emphasising good practices may also be useful here. If our neighbours can live comfortably at a lower temperature in the winter and pay much less for energy use, this may also have an impact on us. Similarly, if society is made aware that people in wealthy countries do not heat their homes at such high temperatures, it will make people who tend to overheat their homes reconsider their habits and superfluous spending. Building trust and using trusted channels for communicating heating-related advice is crucial. Local information channels such as local newspapers and word-of mouth information may have more impact than national media.

Similarly, a properly designed insulation programme also appears to be a triple-dividend solution: less energy is consumed, making significant savings for households, along with less emissions and a healthier lifestyle.

Creation of economic, environmental and community-based dividends: Community-based projects can go beyond generating the economic benefits of saving energy costs and the environmental benefits of less pollution, but also result in a better community life and inclusion. Shared practices can have a reinforcing impact on members of the community, encouraging them to find energy saving measures reasonable, and to better recognize their benefits. Fair individual billing, as opposed to paying a share of a common energy bill, may also contribute to the triple dividend by reducing suspicion and finger-pointing among neighbours, while creating a common interest in making energy saving investments.

Creation of a health-related, social and environmental dividend: Managing the challenge of heating with waste will also result in a triple dividend. Informing people about how dangerous and detrimental this practice is to their own health – while not forgetting about the negative environmental impacts and social tension in the settlement because of the health impacts on neighbours, the smell, etc. – may change this behaviour, resulting in better

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individual and settlement-level health conditions, less social tension and a cleaner environment.

Creation of an economic, social and environmental dividend: Helping low-income bracket households through financial support to invest into refurbishment of more efficient-energy heating systems empowers those households economically. They will be able to pay back loans from the savings they make as a result of more efficient resource use and hence, less energy costs, while lessening energy consumption is beneficial to the environment as well. Social investment at the EU level should be considered as a form of economic investment - for example, for thermal renovation which creates a triple dividend benefit – reducing the energy consumption of dwellings, lowering energy expenses, and perhaps even lifting households out of energy poverty and making the dwelling an asset that is more environmentally friendly.

Limitations and directions of future research

We found that most challenges and policy options overlap across several countries. Still, our research was limited to only five case-study countries, thus generalization to all European countries cannot be made on the grounds of the present research. Further research is needed to reveal specific country-dependent issues in other countries. Also, due to the limited length of the survey tool and timing of different tasks in the ENABLE.EU research project, we could only add a very limited number of heating-related questions to the survey, thus the major part of our findings still remain qualitative and explorative. Further quantitative research is needed to confirm the relevance of these findings.

Furthermore, the various issues raised in the focus group discussions and the Q-methodology are worth further investigation. They have the potential to be the basis of a relevant platform for stakeholder involvement in creating effective consumer policy measures for reducing the energy consumption of society, thereby promoting sustainability.

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References

ADEME (2016). La précarité énergétique. http://www.ademe.fr/expertises/batiment/quoi-parle-t/precarite-energetiquehttp://www.ademe.fr/expertises/batiment/quoi-parle-t/precarite-energetique [accessed on 15.01.2018, last updated in 2016]

Alberini, A., Bigano, A. (2015). How effective are energy-efficiency incentive programs? Evidence from Italian home-owners. Energy Econ., Frontiers in the Economics of Energy Efficiency 52, 76–85.

Azhar, Inam et al. (2015): "Using causal loop diagrams for the initialization of stakeholder engagement in soil salinity management in agricultural watersheds in developing countries: A case study in the Rechna Doab watershed, Pakistan." Journal of environmental management 152: 251-267.

Blasch, Boogen, Filippini, Kumar (2017). Explaining electricity demand and the role of energy and investment literacy on end-use efficiency of Swiss households, Energy Economics.

Doroshenko V. (2012). Problems and prospects of improvement. Donbas National Academy of Engineering and Architecture, Ukraine.

EEA (2016). Household energy consumption per dwelling by end-use. European Environmental Agency. URL https://www.eea.europa.eu/data-and-maps/daviz/energy-consumption-by-end-uses-2 (accessed 4.24.18).

Eurobarometer 416: http://ec.europa.eu/commfrontoffice/publicopinion/archives/ebs/ebs_416_en.pdf

Eurostat database: http://ec.europa.eu/eurostat/web/income-and-living-conditions/data/database

Eurostat indicators: http://ec.europa.eu/eurostat/statistics-explained/index.php/EU_statistics_on _income_and_living_conditions_(EU-SILC)_methodology_-_economic_strain_linked_to_dwelling

Fülöp O.; Lehoczki-Krsjak A. (2014). Energiaszegénység Magyarországon. Statisztikai Szemle, 92:8-9., 820-831.

Hecher, M., Hatzl, S., Knoeri, C., Posch, A. (2017). The trigger matters: The decision-making process for heating systems in the residential building sector. *Energy Policy* 102, 288–306.

https://energypedia.info/images/b/bd/D2.1_Tools_and_Procedures_for_Engaging_Stakeholders_in_TRANSrisk_Case_Study_Analysis.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727524.

Insight_E (2015). Energy poverty and vulnerable consumers in the energy sector across the EU: analysis of policies and measures. Project report.

Martinuzzi, André, Michal Sedlacko, and Jill Jaeger. "Linking sustainable consumption and growth debates following a systems-thinking approach." Knowledge Brokerage for Sustainable Development: Innovative Tools for Increasing Research Impact and Evidence-Based Policy-Making (2016): 251.

Ministère de l'Environnement, de l'Énergie et de la Mer (2017). Quelle prise en compte de l'environnement au sein des foyers?

Nagy, P. (2007). Building thermal modernization. Nyiregyhaza.

Niel, X.; Beaumel, C. (2010). Le nombre de décès augmente, l'espérance de vie aussi. Insee Première.
https://www.insee.fr/fr/statistiques/1281155https://www.insee.fr/fr/statistiques/1281155 [accessed on 21.12.2017]

Novikova, O., Vorsatz, D. (2007). Carbon dioxide mitigation potential in the Hungarian residential sector. Report on behalf of the Ministry of Environment and Water of the Republic of Hungary. pp. 89.

Odyssee indicators: http://www.odyssee-mure.eu/private/definition-indicators.pdf

Sanne, C. (2002). Willing consumers—or locked-in? Policies for a sustainable consumption. Ecological Economics, 42, 1–2, 273-287.

Schreiner (2015). Auf der Suche nach Energiearmut. Eine Potenzialanalyse des Low-Income-High-Costs Indikators für Deutschland, SOEPpapers, 811-2015.

Sebestyénné Szép T. (2018). A hatósági árcsökkentés lakossági energiafelhasználásra gyakorolt hatásának vizsgálata indexdekompozícióval. Közgazdasági Szemle, LXV, 185-205.

Sedlacko M., Martinuzzi A., Ropke I., Videira N. and Antunes P. (2014). 'Participatory systems mapping for sustainable consumption: Discussion of a method promoting systemic insights'. Ecological Economics 106: pp. 33-43.

Szlavik et al. (2000): Carbon mitigation in Hungary: Challenges for a sustainable national energy policy. Periodica Politechnica Ser. Soc. Man. Sci., 8:2, p. 103-120.

Stephenson W. (1953): The study of behavior: Q-technique and its methodology, University of Chicago Press, Chicago

Tiefenbeck, Goette, Degen, Tasic, Fleisch, Lalive, Staake (2016). Overcoming Salience Bias: How Real-Time Feedback Fosters Resource Conservation, Management Science.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727524.

Yearwood Travezan, J., Harmsen, R., van Toledo, G. (2013). Policy analysis for energy efficiency in the built environment in Spain. Energy Policy 61, 317–326.

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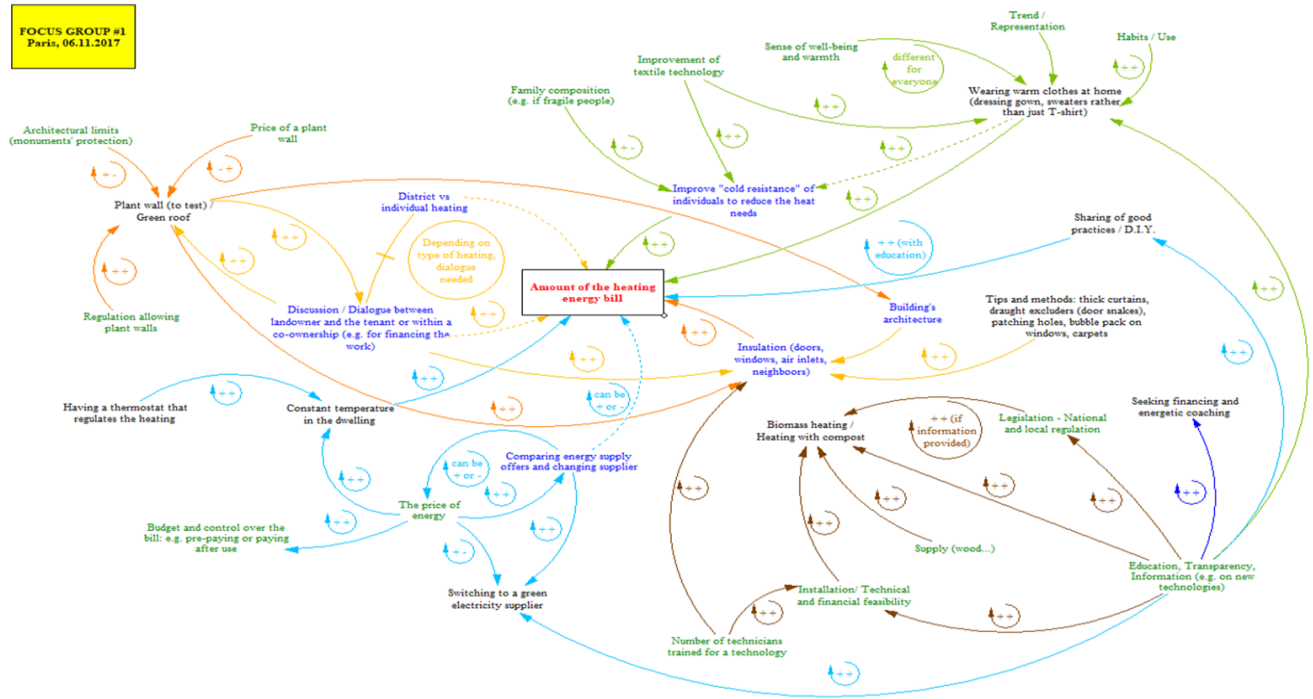
Appendices

Appendix 1. Causal loop diagram of non-expert focus group No. 1, France.



Explanation of colours: Challenges are blue, strategies are black, moderating factors are green

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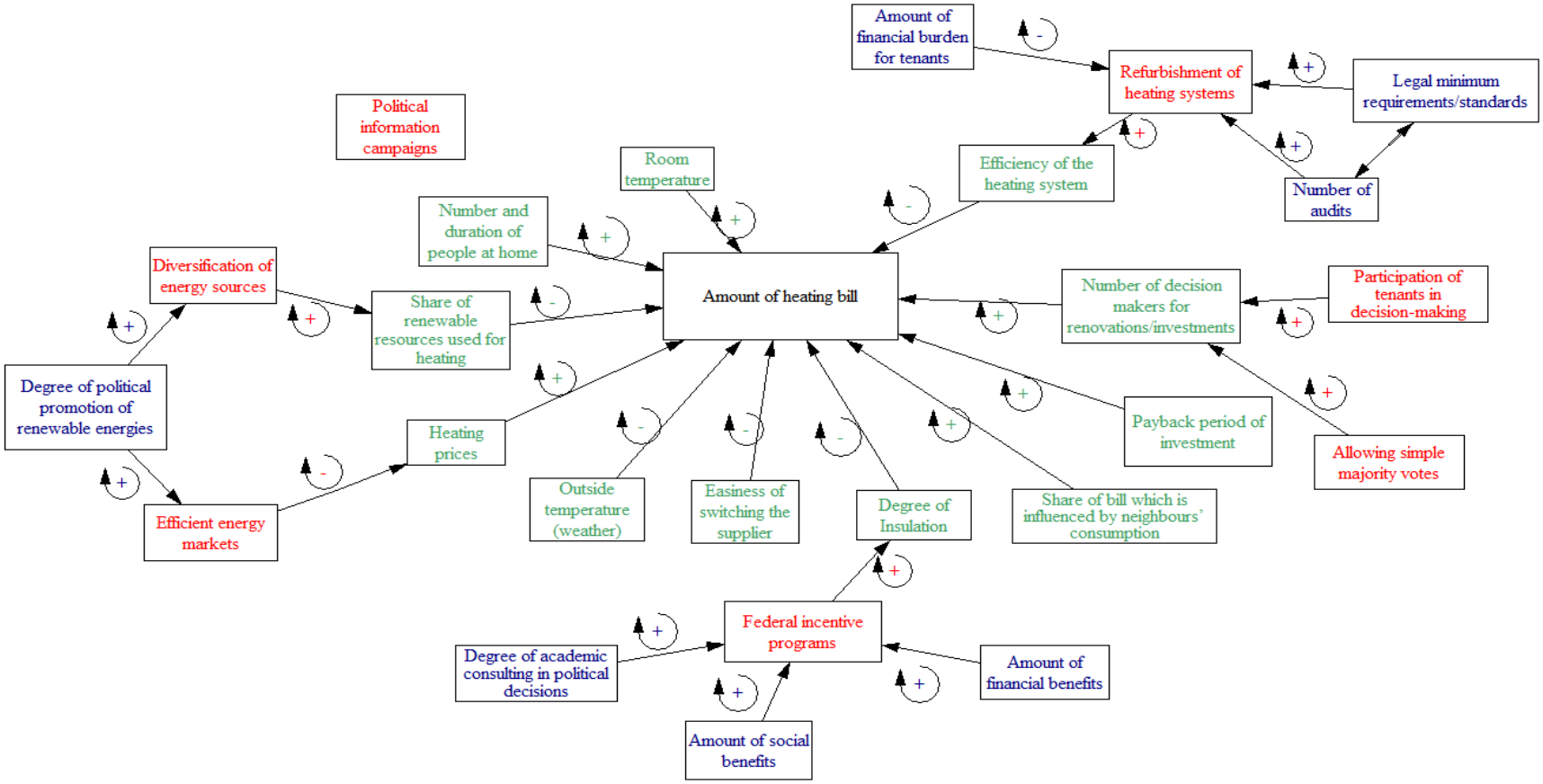
Appendix 2. Causal loop diagram of non-expert focus group, 24.11.2017, Germany.



Explanation of colours: Challenges are green, strategies are red, moderating factors are blue

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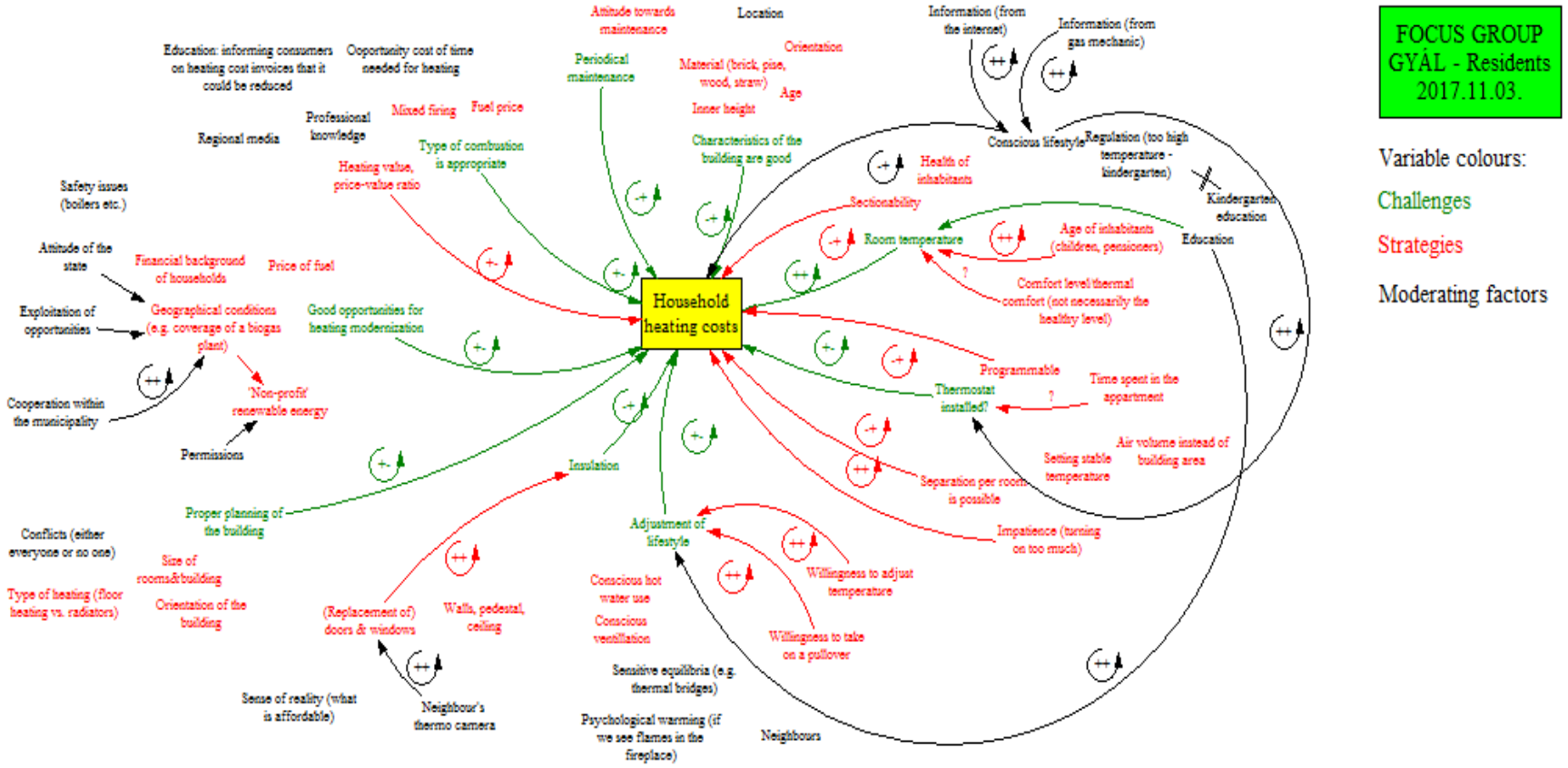
Appendix 3. Causal loop diagram of the laymen focus group – residents of Gyál, Hungary



FOCUS GROUP
GYÁL - Residents
2017.11.03.

Variable colours:

Challenges

Strategies

Moderating factors

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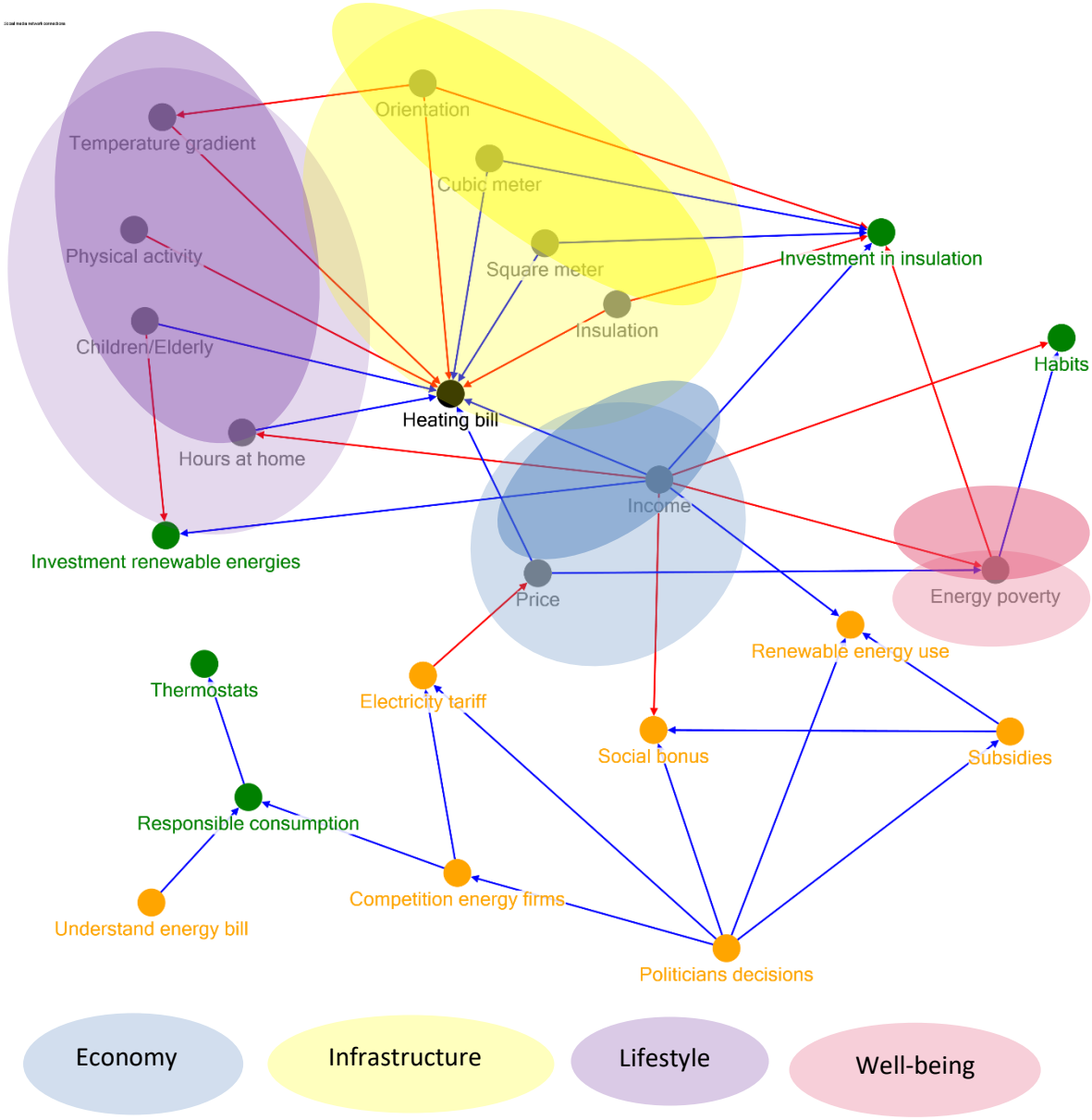
Appendix 4. Graphic visualisation of Focus Group 2 with households from Bilbao, Spain.



Explanation of colours: Grey concepts represent the factors influencing the heating bill. Green concepts represent individual actions and orange concepts represent policy measures. The blue array represents positive connections (↑↑ or ↓↓) and red arrays negative connections (↑↓ or ↓↑). The grey concepts are organised into four groups according to thematic issues: (1) Economy; (2) Infrastructure; (3) Lifestyle; (4) Well-being.

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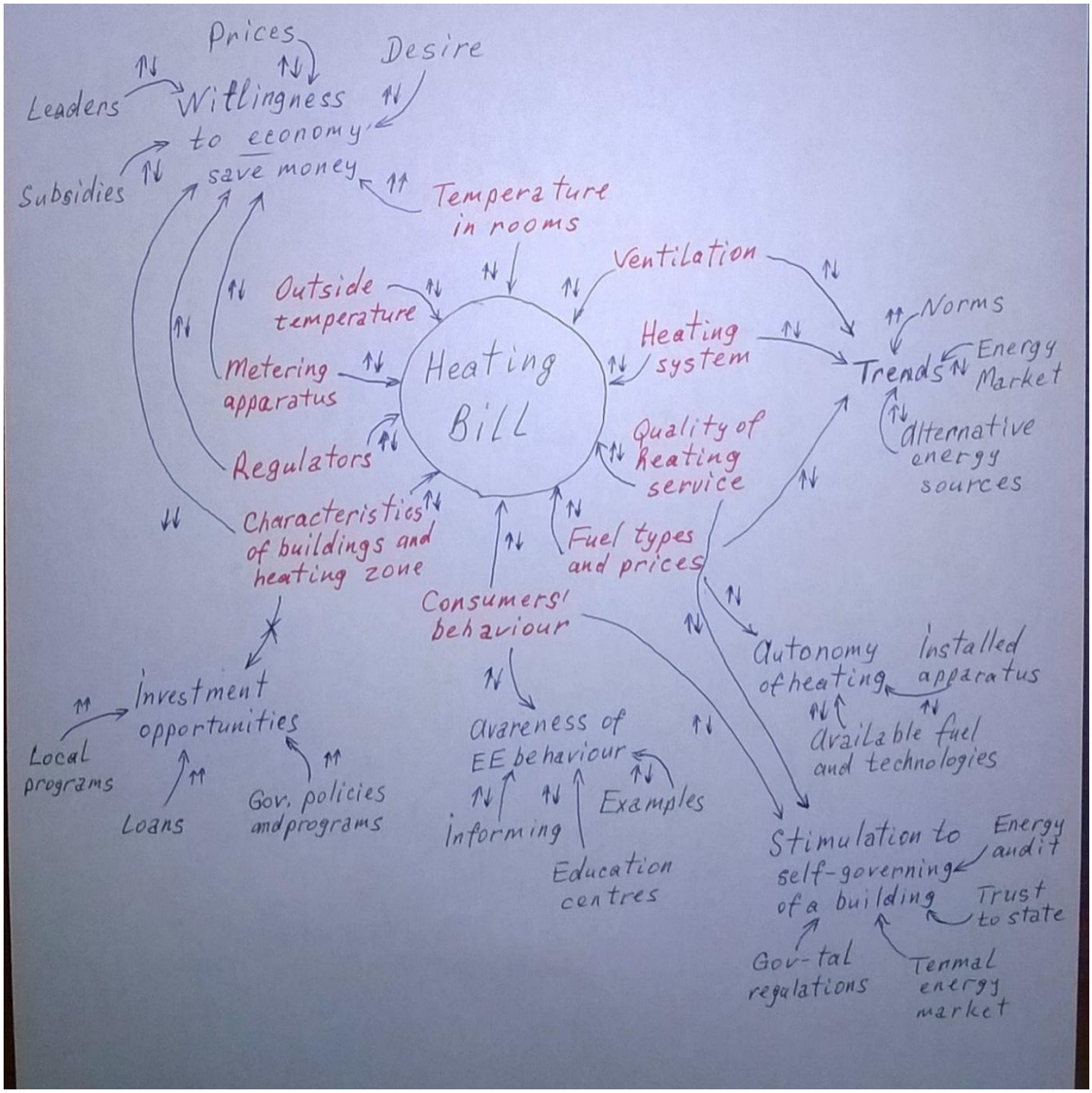
Appendix 5. Causal loop diagram of the Focus Group in Lviv, Ukraine



Explanation of colours. Strategies are dark blue, challenges are red, moderating factors are black

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Appendix 6. Survey tool used in the case study

Heating and cooling questions: to be asked ONLY in the following countries: France, Germany, Hungary, Spain, Ukraine

Section C – heating and cooling

C1. What is the usual temperature in your dwelling when you are at home, during the winter and the summer?

One answer per row

		24 C° or above	22-23 C°	20-21 C°	18-19 C°	17 C° or below	Don't know
A.	Winter temperature	1	2	3	4	5	99
B.	Summer temperature	1	2	3	4	5	99

C2. Do you use an air conditioner to cool your dwelling?

Only ONE answer

1. Yes	Continue with the NEXT question
2. No	Skip the NEXT question

C2A. Approximately what percentage of your electricity bill does cooling account for?

1. .....%
99. Don't know

C3. Which of the following best describes the way you heat your dwelling?

Only ONE answer

1. The room temperature is the same in all the rooms.
2. We heat only the rooms that are in use.

C4. What are the major challenges you would face if you wanted to reduce the heating/cooling costs of your household? Please indicate on a scale from 1 to 5 how much the following statements describe your situation!

One answer per row

	Not at all	Not really	Neutral	Somewhat	Very much	Not applicable	Don't know
A. I don't have the money to invest into refurbishment or supplementary insulation.	1	2	3	4	5	6	99
B. I cannot get a loan with favourable conditions to	1	2	3	4	5	6	99

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	upgrade my heating system or insulate the house.						
C.	There is no subsidy available which would allow me to invest in refurbishment.	1	2	3	4	5	6	99
D.	I cannot calculate the payback of my investment in refurbishment/ renewable technology.	1	2	3	4	5	6	99
E.	My dwelling is too large for my family, with high heating costs, but I don't want/can't afford to move to another place.	1	2	3	4	5	6	99
F.	In the dwelling where I live, the owner and the tenant is not the same person, and at least one does not want to invest in energy-saving measures.	1	2	3	4	5	6	99
G.	I spend a lot of time in my dwelling, so I cannot lower the temperature during daytime.	1	2	3	4	5	6	99
H.	I don't have individual metering in my dwelling.	1	2	3	4	5	6	99
I.	It is not worth to refurbish my old and inefficient dwelling, because construction works would be very expensive relative to the value of the dwelling.	1	2	3	4	5	6	99
J.	Besides my own energy consumption habits, my energy bill also depends on the energy consumption of other households in the house.	1	2	3	4	5	6	99
K.	Refurbishing our block of flats needs the consent and financial contribution of all tenants, which is difficult to obtain.	1	2	3	4	5	6	99
L.	I live in an old building, in which the refurbishment possibilities are limited and might need special permits due to monument protection.	1	2	3	4	5	6	99
M.	I think that the renovation would be burdensome as it involves noise and the presence of workers.	1	2	3	4	5	6	99

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C5. Please indicate on a scale from 1 to 5 how much the following reasons influence your heating/cooling energy savings?

One answer per row

	Not at all	Not really	Neutral	Somewhat	Very much	Not applicable	Don't know
A. I don't get frequent enough feedback on my actual energy consumption.	1	2	3	4	5	6	99
B. I don't pay much for heating; paying the bill is not a problem for me.	1	2	3	4	5	6	99
C. My energy bill is too complicated, I cannot interpret it.	1	2	3	4	5	6	99
D. I use my garbage for heating so I've already managed to reduce my energy bill.	1	2	3	4	5	6	99
E. I have already done what I could to reduce my energy bill.	1	2	3	4	5	6	99
F. I feel discouraged because my neighbours are not energy-conscious.	1	2	3	4	5	6	99
G. I can control the room temperature in my house, but I often forget to turn down the heating at night or when I am away from home.	1	2	3	4	5	6	99
H. I plan to save heating costs, but always tend to postpone my saving plans.	1	2	3	4	5	6	99
I. I'm annoyed of my neighbours heating with garbage.	1	2	3	4	5	6	99

C6. How much would the following measures help you to reduce your heating and cooling energy consumption? Please indicate on a scale from 1 to 5!

One answer per row

	Not at all	Not really	Neutral	Somewhat	Very much	Don't know
A. Receiving feedback on your energy consumption comparable to previous periods or to your neighbourhood/similar households.	1	2	3	4	5	9

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B. Receiving more information on smart and easy techniques leading to lower energy consumption.	1	2	3	4	5	9
C. More frequent measuring and billing provided by your energy supplier.	1	2	3	4	5	9
D. Receiving regular energy-saving tips and reminders from your supplier to conduct energy-saving actions.	1	2	3	4	5	9

C7. How much would the following help you to reduce your heating and cooling energy consumption? Please indicate on a scale from 1 to 5!

One answer per row

	Not at all	Not really	Neutral	Somewhat	Very much	Don't know
a. "Energy saving counsellor" program, getting targeted advice on energy savings possibilities from independent experts.	1	2	3	4	5	9
b. "Household energy saving" advices in the media including information on energy-saving options (information about best practices, subsidies, technological options, financial constructs (loan etc.))	1	2	3	4	5	9
c. Opportunity for refurbishing dwellings with the help of an energy service company or the energy supplier in a way that the resulting energy-savings finance the investment.	1	2	3	4	5	9
d. Refurbishing houses with the help of the local community or organisations in the construction works, at an affordable price.	1	2	3	4	5	9
e. Information on the availability of national energy efficiency grants and assistance with the applications.	1	2	3	4	5	9
f. Expanding the energy subsidies' program (e.g. financial aid for covering your heating bills, or providing free firewood for the deprived)	1	2	3	4	5	9

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