HARP

Heating Appliances Retrofit Planning

Deliverable 2.4: Technology analysis beyond the economics: co-benefits November 2020

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ABBREVIATIONS AND DEFINITIONS

ABBREVIATION	DESCRIPTION
EU	European Union
WTP	Willingness to Pay
CV	Contingent valuation method

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PROJECT SUMMARY

The HARP project, Heating Appliances Retrofit Planning, aims at raising consumers' awareness to the opportunities that underlay the planned replacement of their old and inefficient heating appliances. This will be done by supporting the consumer in the identification of the energy (in)efficiency of their current heating equipment and the saving opportunities that derive from its replacement with a more energy efficient solution. The mission is to accelerate the European replacement rate for heating systems, actively contributing to the reduction of energy demand in buildings, in line with the energy efficiency targets set by the EU.

Now is the time to act and raise consumers' awareness about the opportunities of a planned replacement. Taking advantage of the energy label for space and water heating, the labelling concept to the installed heating stock can be mainstreamed, allowing to use a well-known decision support tool to communicate and motivate the consumer to replace its heating system with modern high-efficiency and renewable solutions. HARP accompanies the consumer decision process, providing an impartial message, based on the energy label and presenting the market solutions that respond to the consumers' heating needs, providing a quantified approach for economic and non-economic benefits and bridging the gap with the market providers and available national incentives. HARP is promoted by highly knowledgeable partners in the fields of consumer behaviour, energy efficiency, heating solutions and business models. These partners either work directly with consumers, or indirectly via networks of professionals who are key multiplying agents, promoting dynamic efficient heating communities, where all the stakeholders, from the supply to the demand side are committed to an efficient heating market, supporting the consumer to make smarter choices.

EXECUTIVE SUMMARY

This report summarizes the work developed within Task 2.4 – (Technology analysis beyond the economics: co-benefits). Task 2.4 aimed at the identification of the various co-benefits, assessing the set of co-benefits associated to each heating solution/technology and their relevance in the decision-making process regarding the replacement of existing heating appliances. The results will be integrated in the decision-making support online tool that will be developed in the scope of the project.

The report is compiled from the information collected with an EU perspective, focusing on participating countries. The data was collected through two online surveys, one gathering information from consumers and another to which of energy experts and professionals within the countries that are part of the project HARP (France, Germany, Italy, Portugal, Spain) contributed. The assessment

focused on: degree of relevance of co-benefits, Willingness to Pay (WTP) analysis and a qualitative evaluation of the relation between the co-benefits and available heating solutions.

The results point out to significant differences between national contexts, both in terms of the degree of relevance and the willingness to pay for co-benefits. The particularities of each country can be incorporated in the decision-making support tool in order to detail the information given to distinctive national contexts. In addition, information regarding qualitative evaluation allowed to relate specific co-benefits to different heating solutions. This information will be included in the online tool as a consumer preferences input, narrowing the heating solutions to the consumer preferred co-benefits) and as a technology information output (informing the consumer about the co-benefits associated to the different heating technologies).

1 INTRODUCTION

Household final energy consumption is very significant. Energy demand in the building sector is responsible for 40% of EU's energy consumption and 85% of this is used for heating and domestic hot water [1]. Given the European stock of installed appliances, 126 million space heaters installed, 75% of which likely performing as a C or lower energy class, there is considerable room for improvement, and it is objectively recognized that the replacement and retrofit of old equipment should be promoted.

The most common argument for the promotion of energy efficiency investments, such as the replacement of heating systems, is mainly related to the potential energy and economic savings achieved. However, there is a wide range of other known effects, at various scales, that are directly related to this type of investments. These effects are often termed as "co-benefits", "ancillary benefits" or "non-economic benefits" [2] and can be determinant in order to promote the change needed to successfully address climate change and its effects [3]. In the context of this study, co-benefits are defined as accompanying potential benefits to the consumer arising from the specific (technical and physical) characteristics of the heating (production) system.

There are basically two perspectives regarding the co-benefits for energy efficiency improvements, which are strongly related to the scale of effects influenced by these improvements. While a private perspective concerns primarily the building users and/or energy consumers and indicates, as possible co-benefits, improved thermal comfort and air quality, for example, the second perspective is associated with macro-economic or societal co-benefits. When societal co-benefits are addressed, the discussion is generally centred in the quantification of direct and indirect benefits for the economy and the environment, such as effects on climate change, health and productivity. This perspective is centred in policy formulation and decision-making (e.g. [4]).

From the private perspective, making the decision to adopt energy efficient technologies is known to be strongly interdependent with the economic investment needed [5], as well as socio-economic characteristics, such as age [6] and income [7], and differences in cultural contexts [6]. These factors are believed to also influence the relevance of co-benefits for the decision-making of such investments. Moreover, being of subjective nature, co-benefits are more difficult to quantify than objective indicators, such as savings, but are believed to be key to understand the decision-making process for energy efficiency improvements in the residential sector [8]. However, the majority of the approaches designed to inform the consumer are engineering-based and co-benefits are frequently ignored and rarely measured, quantified, or monetized. Energy efficiency improvements at the consumer or household level are normally evaluated by a trade-off between savings resulting from operational energy use and the investment cost of such improvements. In fact, relevant work has been conducted in order to demonstrate the cost-effectiveness of energy renovation interventions in buildings, for example [9]. Although this can be considered to be the traditional approach, this kind of assessment can disregard other potential benefits originating from interventions to improve energy efficiency and underestimate the real value of such improvements [2]. In addition, several studies point out that often energy savings are not the main motivation in the decision process. For example, improving the "indoor climate" is a known decision-making trigger for interventions to promote energy efficiency, such as replacing a heating appliance or improving the insulation of the house (e.g. [10]). In this context, identifying and quantifying the relevance of co-benefits regarding energy efficiency investments can support decision-making of building users and energy consumers, as seen in other studies addressing different contexts (e.g. [2], [11], [12]).

The work presented in this report was developed under Task 2.4 – Technology analysis beyond the economics: co-benefits. In the scope of the HARP project, and concerning the replacement of heating appliances in particular, it aims at identifying the relevance of the distinctive co-benefits for decision-making of consumers, as well as to distinguish the most relevant added value through the determination of a co-benefits economic valuation. In addition, the work in Task 2.4 also aims at determining a qualitative assessment of the co-benefits associated to each heating solution/technology. The results will be integrated in the online tool, aiming to support the consumer decision-making process.

The report presents the following organization: section 2 gives an overview on the objectives of the study, as well as the methods used for data collection, section 3 presents the results of the assessment regarding degree of relevance, economic valuation and qualitative assessment of co-benefits per heating technology and section 4 details and compares the most significant country highlights. The conclusions section reports the most important findings and their potential usefulness for the project.

2 METHODS AND DATA COLLECTION

The investigation promoted in Task 2.4 - Technology analysis beyond the economics: co-benefits – has two main objectives: assess the relevance of the co-benefits associated with the replacement of the heating system and quantify the potential added value provided by the co-benefits through an economic valuation. In addition, the work aims at providing a qualitative assessment between co-benefits and specific heating solutions.

In particular, the objectives of Task 2.4 are:

1. to identify the relevance of the distinctive co-benefits in consumers decision-making process regarding the replacement of heating appliances;

2. to determine an economic valuation of co-benefits based on a contingent valuation method in order to identify the most relevant added value for the consumers;

3. to determine a matrix concerning a qualitative assessment of the co-benefits associated to each heating solution/technology.

The work performed consisted of the following methodological steps:

- Literature review regarding the identification of co-benefits;
- Literature review on economic valuation methods;
- Assessment of the co-benefits relevance and economic valuation through the integration of questions in the consumer survey developed under Task 2.1 – Consumer Behaviour Model (Survey 1);
- Design and development of a survey regarding the qualitative assessment of the relation between co-benefits and heating technologies (Survey 2).
- Discussion and harmonization of the results from Survey 2 among HARP non industry technical partners.

Following the literature review, the co-benefits that are significant for consumers when considering the replacement of heating appliances were chosen and discussed within the project consortium. Table 1 presents the typology of the co-benefits considered in this study, as well as a brief description of each co-benefit.

Questions regarding co-benefits relevance were integrated in the survey that was developed for the definition of the Consumer Behaviour Model in Task 2.1. (Survey1), which is shown in Appendix 1. In this survey, for the assessment of the co-benefits, respondents were asked to fill an ascending 7-point numerical scale rating, which is interpreted as its relevance in the decision-making process of choosing a heating solution. Since the questions were integrated into a pre-existing online survey, which had

consumers as the target group, the numerical scale rating method adopted the same range as the existing questions, for consistency reasons.

Table 1 – Typology of the co-benefits for heating equipment replacement. Source: adapted from [13]

Co-benefits	Description
Thermal comfort	Higher thermal comfort due to more adequate room temperatures and relative humidity.
Air quality	Improved indoor air quality, meaning reducing harmful gases, particulates, microbial contaminants (which can cause mould), or other stressor that induce adverse health conditions
Aesthetics	Aesthetic improvement of the building after implementation of the heating solution
Ease of use /Control by user	Ease of use and control of the heating solution by the users (e.g. automatic thermostat controls, easier filter changes, faster hot water delivery, etc.)
Added value into the market	Improvement of the market value of the property after implementation of the heating solution
Impact on useful area	Increase or reduction of useful area of the dwelling after implementation of the heating solution
Independence from energy prices	Reduction of exposure to energy price fluctuations in order to maintain the desired level of thermal comfort
Reduction of environmental impact	Improved environmental performance regarding energy and associated carbon emissions (e.g. avoidance of use of fossil fuel as energy source)

In the same survey, questions regarding the economic valuation of the same co-benefits were also asked. These questions were designed according to a contingent valuation method (CV) in order to investigate consumers´ Willingness to Pay (WTP) (Figure 1).

WTP is used to measure the total economic and direct value of non-market goods by asking for respondents' stated preference to place a monetary value based on a hypothetical scenario [14]. In this case, the scenario is posed in the following question: "Were you willing to invest an additional value for an energy efficient heating solution, if it allows obtaining co-benefits?

After a pilot survey, the final Survey 1, available in six languages (Portuguese, French, German, Italian, Spanish and English) was disseminated online and promoted using the partner's social media channels between November 2019 and February 2020. The objective was to obtain a representative sample of the population in the countries where the survey was disseminated (France, Germany, Italy, Portugal and Spain).

	No	Up to 100€	Between 100€ and 500€	More than 500€
Achieve a comfortable indoor temperature during the heating season more easily				
Have better air quality				
Operate the equipment more easily				
Be more independent to energy prices				
Have a more aesthetically pleasant equipment				
Have more useful living area				
Value the dwelling in the real-estate market				
Have a reduced environmental impact				

Figure 1 – Matrix used in Survey 1 for data collection regarding Willingness to Pay for co-benefits

In order to calculate the amount of the necessary responses, a random sampling methodology representative by country was considered, based on the assumption of an infinite population size, since the exact number of consumers owning an inefficient heating equipment is unknown. The sample size was therefore calculated based on the following equation[1]:

$$n = \frac{Z^2 p*q}{d^2} = \frac{1.96^2 * 0.5 * 0.5}{0.05^2} = 385$$

where Z is the standard normal distribution for the (1-α/2) level, d is the precision, p is the prevalence, and q=(1-p).

For a comprehensive explanation of the assumptions regarding sampling methodology and detailed descriptive statistics, Deliverable 2.1 - Consumer behaviour change model regarding the adoption of efficient heating systems – should be consulted. The resulting representative survey sample is composed of 6044 complete responses (Table 2). The sample consists of 73% male respondents and 26% female respondents. Most of the respondents have a bachelor (42%) or a master's degree (29%). Although there is a variation in response rate for each country, the results were analysed taking into account weighted average values for subsamples of age, gender and country. Therefore, all completed responses were considered.

[1] Source: Deliverable 2.1 - Consumer behaviour change model regarding the adoption of efficient heating systems (April 2020) - https://heating-retrofit.eu/wp-content/uploads/2020/05/HARP-D2.1-Consumer-behaviour-change-model-EEHA-V1.1.pdf

For the qualitative assessment of the relation between co-benefits and heating technologies, a second survey (Survey 2) was designed. The complete survey is shown in Appendix 2. Because of the specificity of the information to be collected, it was decided that this survey would have energy specialists and professionals as the main target group.

Table 2 - Survey 1 - representative sample size per country. Source: adapted from D2.1 - Consumer behaviour change model regarding the adoption of efficient heating systems (Tiago Oliveira; Catarina Neves; Joana Neves)

Country	Number of complete responses
France	411
Germany	179
Italy	387
Portugal	331
Spain	4736
All	**6044**

Survey 2 was disseminated to the energy professionals present in the National Experts Forum in each country[2] and, complementarily, disseminated online through professional networks from each partner in the project focusing on the same target group, including the technical personnel from the Portuguese Energy agency (ADENE). This consultation was made in two phases. The first version was sent in December 2019. Results were analysed and a need for increased detail in the definition of water heaters technologies was realized. Therefore, a second version of the survey was launched in February 2020 and closed in May 2020. This step was crucial to collect additional, country specific information. Concerning the composition of the survey, in addition to the basic characterization of the respondent, the survey consisted of a matrix in which the respondents had to qualitatively evaluate the relation between a co-benefit and a heating solution, using a scale from 3 (positive relationship) to - 3 (negative relationship) (Figure 2).

The sample size of Survey 2 is reduced, mainly because of the specificity of its target audience, and consists of 91 complete responses. From these, 72% were from Portugal, 13% from Germany, 8% from Italy and 4% from Spain. France and Belgium respondents represent 2% each of the survey sample. Figure 3 presents an overview of the survey sample for the energy professionals, per country. Results also indicate that 53% of respondents were men, 38% were women, and the majority of the respondents have a significantly high level of education, with 70% having a master's or higher degree.

[2] At the time this report was written, due to constraints related to the COVID 19 outbreak, it was only possible to complete one National Experts Forum in Portugal.

What co-benefits would you associate to a specific heating solution? Please rate the co-benefits according their importance

Please only enter numbers. (+3 very positive; +2 positive; +1 slightly positive or -3 very negative; -2 negative; -1 slightly negative)

	THERMAL COMFORT	AIR QUALITY	AESTHETICS	EASE OF USE	USEFUL AREA	ADDED VALUE IN MARKET	INDEPENDENCE ENERGY PRICES	REDUCTION IN ENVIROMENTAL IMPACT
Gas condensing boilers								
Oil condensing boilers								
Electric heat pumps								
Ground / Water heat pumps								
Hybrid heat pumps								
Gas heat pumps								
Solar thermal systems								
Biomass boilers								
Combined heat and power								
Electric resistance boilers								
Gas water heaters								

Figure 2 – Matrix used in Survey 2 for data collection for qualitative assessment of co-benefits per heating technology

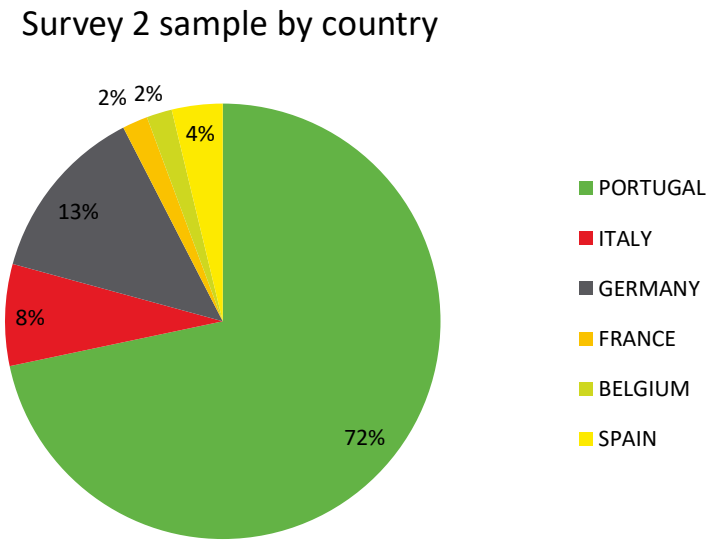


Figure 3 – Qualitative assessment survey sample descriminated by country

3 CO-BENEFITS ASSESSMENT AND WILLINGNESS TO PAY

This section presents the results of the assessment regarding degree of relevance, economic valuation and qualitative assessment of co-benefits per heating technology.

3.1 Degree of relevance of the co-benefits

The *degree of relevance* of the co-benefits was defined according to the answers of the respondents in a 7-points scale question, where 1 means no relevance at all and 7 means the maximum degree possible. The *degree of relevance* (Figure 4) is not related to any specific heating solution and is intended to collect information regarding consumers´ perceptions and preferences. The results indicate that there are significant differences in the relevance of different co-benefits, according to the geographical context.

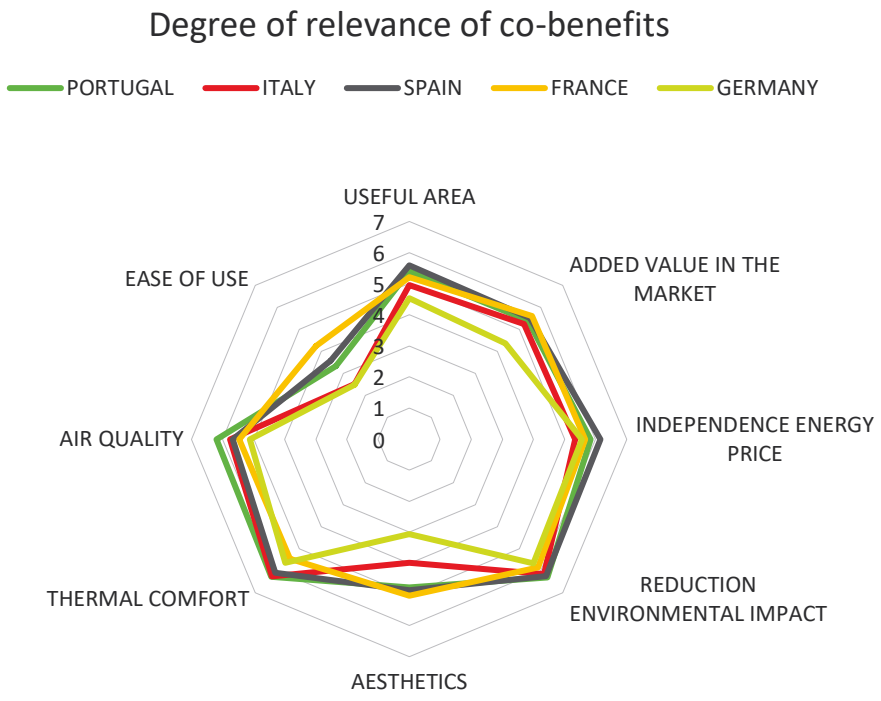


Figure 4 - Degree of relevance per country

The diagram in Figure 4 highlights the significant differences in terms of national contexts in relation to what is considered relevant in terms of co-benefits. For Portugal, for example, the most relevant co-benefits were *thermal comfort*, *air quality* and *reduction of environmental impact.* Although these

co-benefits were highly valued in several national contexts (such as in Italy or Spain), results from France indicated that the most relevant co-benefit was the *added value in the market.* For Spain, alongside *with thermal comfort,* there is strong evidence that the *independence from energy prices* is highly relevant. According to results from Survey 1, the *independence from energy prices* was also the most relevant co-benefit in Germany.

Results from Survey 1 indicated that Italy and Germany presented the lowest value regarding relevance of *ease of use* as a co-benefit. However, Italy had the highest responses in terms of *thermal comfort*, indicating that respondents attributed a high relevance to this co-benefit. *Aesthetics* was the co-benefit that presented the lowest values in terms of relevance consistently for every national context analysed, with average values ranging from 3 to 5. France presented the highest value and Germany the lowest, regarding *aesthetics*.

3.2 Willingness to pay

Responses obtained in Survey 1 in relation to the Willingness to Pay (WTP) for the identified co-benefits, for all countries, suggest that, for every co-benefit, there is at least 15% of the respondents that are not willing to pay any amount of money. In addition, there is a significant share of respondents (34% in average) who is willing to pay only an additional of 100 euros for the co-benefits. In particular, co-benefits such as *air quality, ease of use, independence from energy prices, thermal comfort* and *reduction of environmental impact* were the most valued in this tier. In the tier corresponding to willingness to pay between 100 and 500 euros, the most valued co-benefit was *independence from energy prices* (30%), closely followed by *thermal comfort* and *air quality.* Importantly, as expected, there are less respondents willing to pay more than 500 euros for co-benefits. The *reduction of environmental impact* and *independence from energy prices* were indicated as the most valued co-benefits in this tier. In opposition, *aesthetics* and *useful area* were the less valued. Consistently, most respondents (49%) indicated that they were not willing to invest any additional value in these two co-benefits (*aesthetics* and *useful area)* when associated with a heating solution. On the other hand, only 15% of the respondents indicated that they were not willing to invest in the *reduction of the environmental impact (*Figure 5*).*

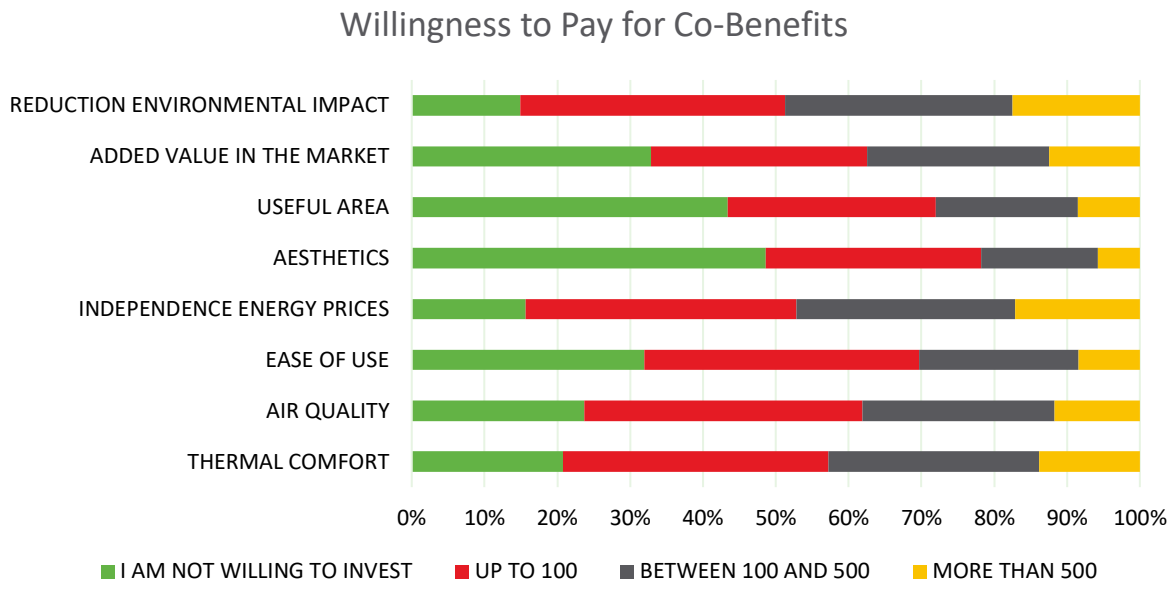


Figure 5 - Willingness to Pay for all countries

3.3 Relation between degree of relevance and WTP

Assuming that the relevance of co-benefits for the user/consumer is directly connected with the willingness to pay for these additional benefits, there is a potential dynamic between these two factors that is worth analysing. In Figure 6 , results from Survey 1 were used for demonstrating the relation between degree of relevance (X axis) and the Willingness to Pay (Y axis). The size of the circles is indicative of the amount of responses that corresponded to the relation of these two distinctive factors.

Generally, results from the survey indicate that, although there is a clear relationship between the degree of relevance and the willingness to pay for a co-benefit when purchasing a new heating solution, this relationship varied significantly depending on the co-benefits (see detailed results in Appendix 3). Results from the relation between *Degree of relevance* and *Willingness to Pay* were mostly concentrated in the co-benefits rated as being the most relevant (values between 5, 6 and 7 in the X axis) and middle level in terms of value invested (investments lower than 500EUR in the Y axis). Notably, there was quite a significant number of responses indicating that although some co-benefits were relevant for some respondents, there is no willingness to pay an additional value for it. Clear examples of this relationship could be found in the *added value in the market*, where 406 respondents indicated a degree of relevance 7 but no willingness to invest an additional value for this co-benefit. This disparity has been observed in research and is commonly referred in literature as asymmetric behaviour [15]. It is normally explained by contextual effects such as economic and phycological factors, as well as for the familiarity of the respondents to the concepts presented in the survey.

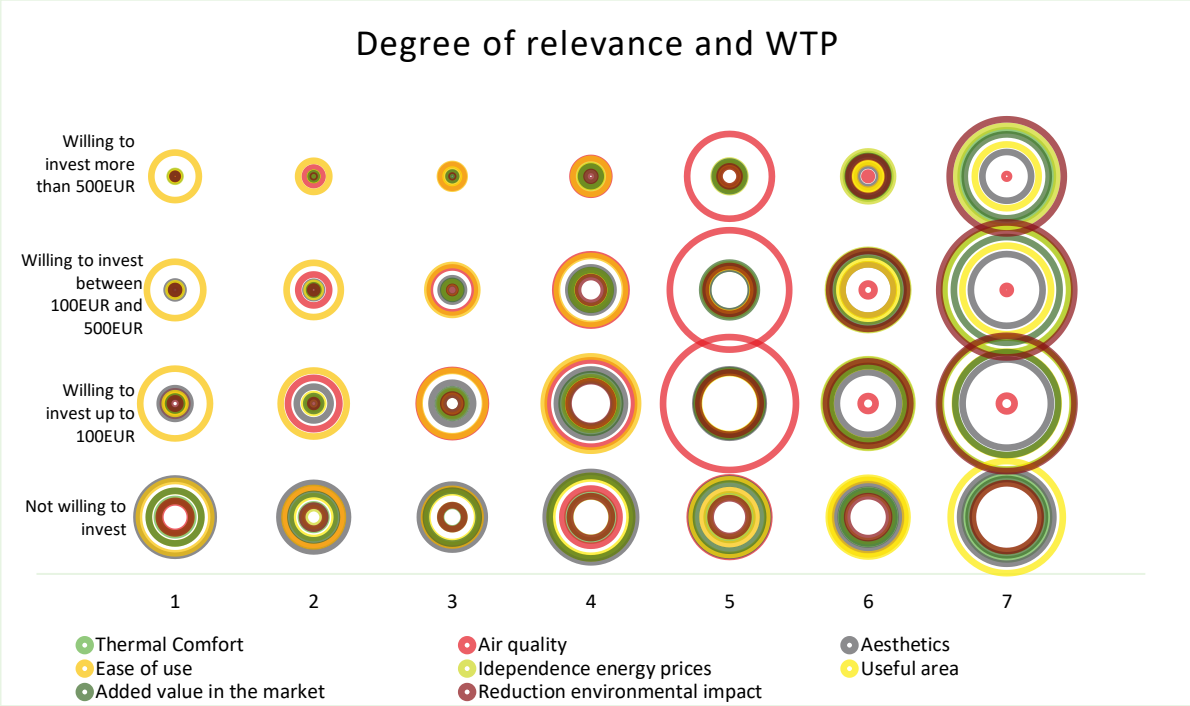


Figure 6 - Relation between degree of relevance and WTP, for all national contexts

In opposition, there is a significant relationship between the degree of relevance and WTP concerning the *reduction of environmental impact* co-benefit. The majority of responses regarding this co-benefit indicated a high relevance (degree of 7) and a significant willingness to pay. In particular a large set of responses were on the tier willing to invest up to 100 euros (1206 responses) and between 100 and 500 euros (1198 responses), although there were also some responses indicating the highest willingness to pay (more than 500 euros (868 responses)). The relations that aggregated a higher number of responses are summarized in Table 3.

Table 3 - Summary of higher aggregated responses regarding the relation between Degree of Relevance and WTP

	CO-BENEFITS							
	THERMAL COMFORT	AIR QUALITY	AESTHETICS	EASE OF USE	USEFUL AREA	ADDED VALUE IN MARKET	INDEPENDENCE ENERGY PRICES	REDUCTION IN ENVIROMENTAL IMPACT
Relation Relevance/ WTP	7/ <100€	7/<100€	7/0€	4/ <100€	7/<100€	7/100 < 500€	7/ <100€	7/<100€

The higher aggregation of responses indicates that co-benefits are considered to be of high relevance (7 in most cases), but respondents are not willing to pay more than 100 euros for the co-benefit when purchasing a new heating system. Exceptions are observed in *aesthetics* that, although considered relevant, the majority of responses indicated that users are not willing to invest in it. Another

exception was observed in *added value in the market*, where the respondents indicated that they were willing to invest a value between 100 and 500 euros.

3.4 Qualitative assessment of the co-benefits in relation to specific heating solutions

Regarding the results of the qualitative assessment collected in Survey 2, from energy experts and professionals, it was possible to obtain a comprehensive matrix (Table 4). This qualitative assessment is important in the sense that reflects the knowledge and experience of the experts and professionals in the energy sector. The matrix highlights and qualitatively assess the relation between heating solution and distinctive co-benefits that can be associated with that heating solution.

Table 4 - Matrix of the relation between heating solutions and co-benefits

	CO-BENEFITS							
	THERMAL COMFORT	AIR QUALITY	AESTHETICS	EASE OF USE	USEFUL AREA	ADDED VALUE IN MARKET	INDEPENDENCE ENERGY PRICES	REDUCTION IN ENVIROMENTAL IMPACT
Gas condensing boilers	OOO	X	X	O	OO	X	O	O
Oil condensing boilers	OOO	XX	X	X	O	X	XX	O
Electric heat pumps	OOO	OO	OOO	O	OOO	XX	OO	OO
Ground / Water heat pumps	OOO	OO	O	O	X	XX	OO	OO
Hybrid heat pumps	OOO	OO	X	O	OOO	XX	OO	OO
Gas heat pumps	O	OO	X	X	O	X	O	O
Solar thermal systems	OOO	OOO	OOO	XX	X	OOO	OOO	OOO
Biomass boilers	OOO	XX	X	XX	OO	XX	O	OO
Combined heat and power	OOO	OO	XX	XX	O	XX	OOO	OOO
Electric resistance boilers	OOO	O	OOO	O	OOO	O	XXX	X
Gas water heaters	OOO	X	O	O	OOO	O	X	O
Electric water heaters	OOO	O	OOO	X	OOO	X	X	X
Heat pumps water heater	OOO	OO	OO	O	O	X	OO	OO
Solar thermal water heaters (electric resistance as backup)	OOO	OOO	OOO	X	X	X	OOO	OO
Solar thermal water heaters (gas water heater as backup)	OOO	OOO	OOO	X	X	OOO	OOO	O
Solar thermal water heaters (heat pump as backup)	OOO	OOO	OO	X	OOO	OOO	OOO	OOO

OOO – very positive; OO – positive; O – slightly positive; X – slightly negative; XX – negative; XXX – very negative

It is worth highlighting for example, that every solution was recognized as very positive in terms of providing *thermal comfort*. In opposition, boilers based on fossil fuels energy sources were related to less positive impact in terms of *reduction of environmental impact*, in particular oil and gas condensing boilers.

Significantly, ground and water heat pumps, as well as solar thermal systems, were pointed out as being very positive regarding *thermal comfort, added value in market* and *independence from energy prices*, as well as *reduction of environmental impact.* On the other hand, biomass boilers had a significantly high assessment value for *thermal comfort,* but it was considered to present a slightly negative relationship in terms of *air quality* and are not considered to add value of the property in the market.

4 COUNTRY HIGHLIGHTS

This section presents the most important aspects found after the analysis of the 1st survey results by country, with the objective of highlighting the particularities of each national context.

4.1 PORTUGAL

Data collected in Portugal concerns 46% male respondents and 54% female respondents. The larger share of respondents has more than 40 years old (45%) and the smaller being 25 years or less (23%). The majority indicated having a degree in higher education (47%). Regarding income, the majority of the respondents indicated as having 2000 euros or less (59%), 23% responded that their income was between 2000 and 4000 euros and 19% that their income was 4000 euros or above.

Detailed results from Portugal (Figure 7) point out to the fact that, in general, female respondents valued co-benefits as being more relevant than male respondents, although the responses were aligned in terms of importance.

In Portugal, independently of the perspective under analysis, the most relevant co-benefits were *thermal comfort, air quality* and *reduction of environmental impact.* It is also noticeable that differences in income present only slight distinctions in how co-benefits were considered relevant. For example, there was a subtle decrease concerning *ease of use* for respondents with higher level of income. Respondents which reported the highest level of monthly income considered in the survey (>4000EUR) also attributed a higher relevance to *aesthetics.* Lower tier in age (<25) indicated *thermal comfort* as being less relevant than other ages tiers. In opposition, the middle tier (between 25 and 40 years old) indicated *independence from energy prices* and *added value in the market* as being less relevant. However, these are subtle differences between these two co-benefits (an average difference of 0,57 in the 7 point scale range). In terms of the economic valuation, 40% and 44% of the

respondents from Portugal respectively indicated that they were not willing to invest an additional value in *aesthetics and useful area*. At the level of willingness to pay up to 100 euros, the highest percentage of responses were *on air quality* (40%) and *independence from energy prices* (39%). Respondents also indicated that they were willing to invest an additional value between 100 and 500 in *reduction of environmental impact* (40%) and *thermal comfort* (38%), as well as *air quality* (33%). When it comes to the highest level of WTP (>500EUR), the highest percentages corresponded to *reduction of environmental impacts* (13%), *thermal comfort* (12%) and *added value in the market* (12%).

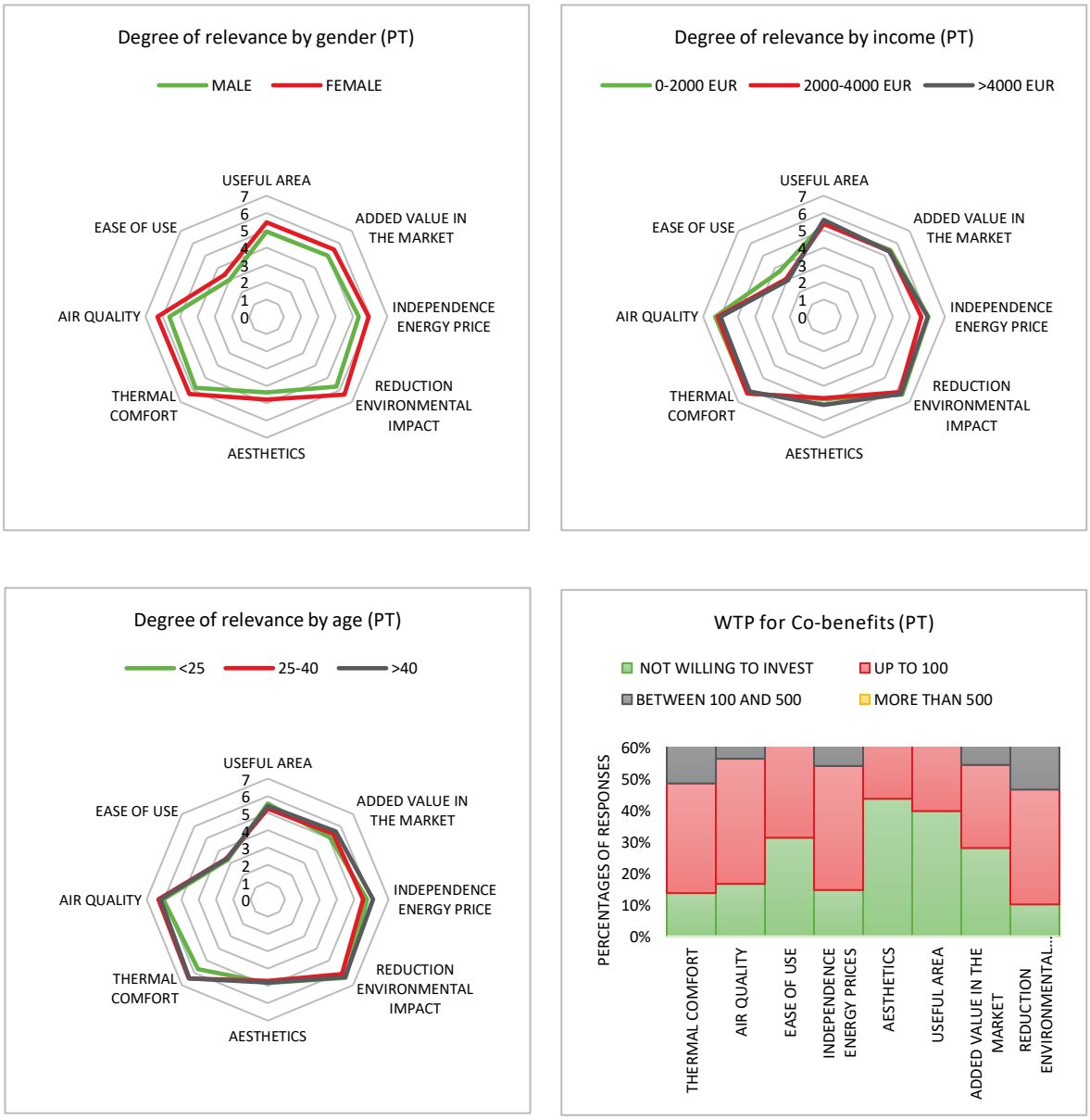


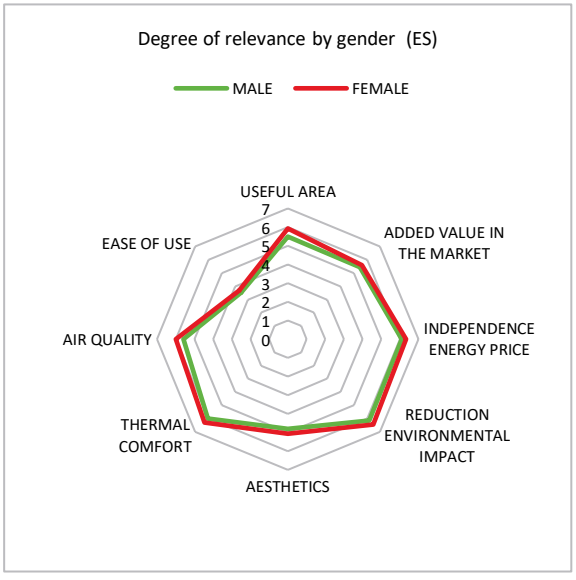
Figure 7 - Country highlights from Portugal

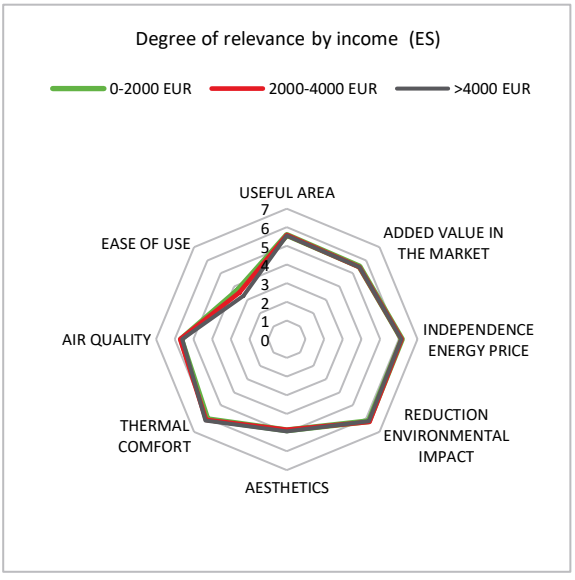
4.2 SPAIN

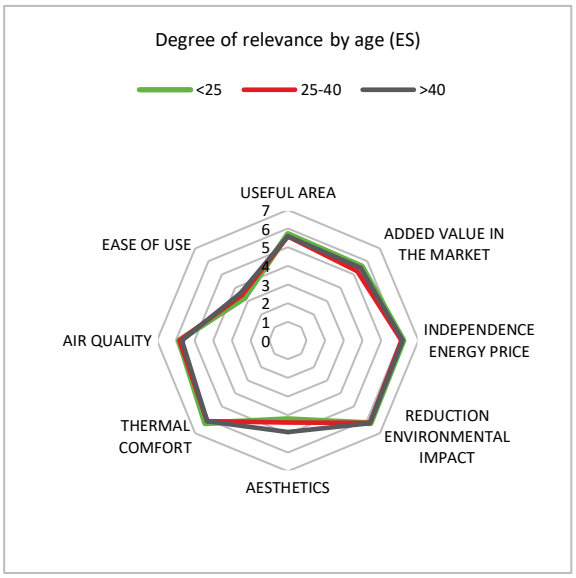
The majority of the data collected in Spain came from male respondents (76%). The larger share of respondents has more than 40 years old (93 %). 46% of the respondents indicated having a bachelor's degree and 25% a master's degree. Regarding income, the majority of the respondents indicated as having 2000 euros or less (48%), 25% responded that their income was between 2000 and 4000 euros and 26% that their income was 4000 euros or above.

Results concerning responses from Spain (Figure 8) indicated that the most relevant co-benefits at the country level were *reduction of environmental impacts* (average value of 6,15), *independence from energy prices* (average value of 6,1) and *thermal comfort* (average value of 6,0). In terms of gender, male respondents attribute less relevance to co-benefits, in particular to *useful area* (average difference of -0,43), *air quality* (average difference of -0,40) and *aesthetics* (average difference of -0,26). When income levels were considered, a coincidence in almost every co-benefit for all income levels was noticeable. However, results concerning *ease of use* (which is the less relevant co-benefit in this context) presented differences, with the first level of income (<2000EUR) attributing more relevance to this co-benefit than the second (average difference of -0,14) and the third (average difference of -0,43)levels of monthly income.

When age is analysed for this national context, results indicated that *ease of use* and *aesthetics* were considered as having a higher relevance for respondents over 40 years old (average value of 4,89) than for the respondents under 25 years old (average value of 4,22). Younger respondents (<25) from Spain indicated i*ndependence from energy prices, reduction of environmental impacts, air quality* and *thermal comfort.* as the most relevant co-benefits.







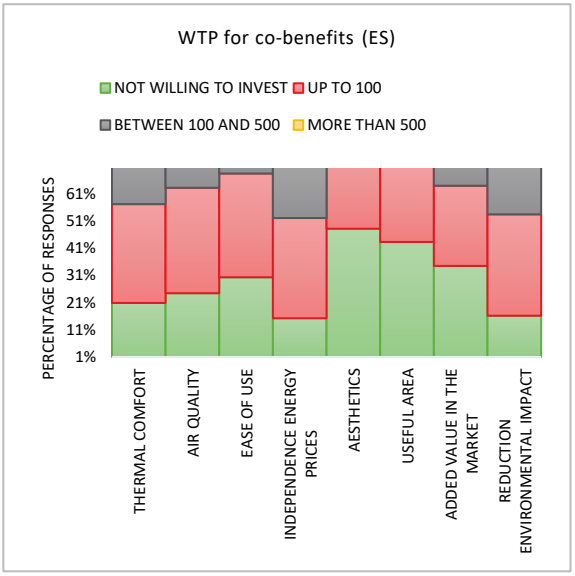


Figure 8 - Country highlights for Spain

Regarding willingness to pay, Spanish respondents indicated that they were not willing to invest an additional value in co-benefits providing improved *aesthetics* (48%) and more *useful area* (43%). A willingness to pay up to 100 euros was evidenced for *air quality* (39%) *ease of use* (38%), *independence from energy prices* (37%) and *reduction of environmental impacts* (37%). *Independence from energy prices* (31%) and *reduction of environmental impacts* (30%) were also indicated as the most significant amongst respondents willing to pay between 100 and 500 euros, as well as in highest level of willingness to pay (>500EUR).

4.3 ITALY

The majority of the data collected in Italy came from male respondents (75%). The larger share of respondents has more than 40 years old (65 %) with only 3% being 25 years or less. 9% of the respondents indicated having a bachelor's degree and 46% a master's degree. In addition, 9% reported having a doctorate degree. Regarding income, the majority of the respondents indicated as having 2000 euros or less (46%), 27% responded that their income was between 2000 and 4000 euros and 27% that their income was 4000 euros or above.

In Italy (Figure 9), similarly to Spain, *ease of use* (average value of 2,5) and *aesthetics (*average value of 3,9) were considered to be the less relevant co-benefits. On the other hand, in this national context, *thermal comfort* (average value of 6,2) and *reduction of environmental impacts* (average value of 6,1) were indicated as the most relevant. As in other national contexts, female respondents give a slightly higher relevance to co-benefits, with exception to *added value in the market.*

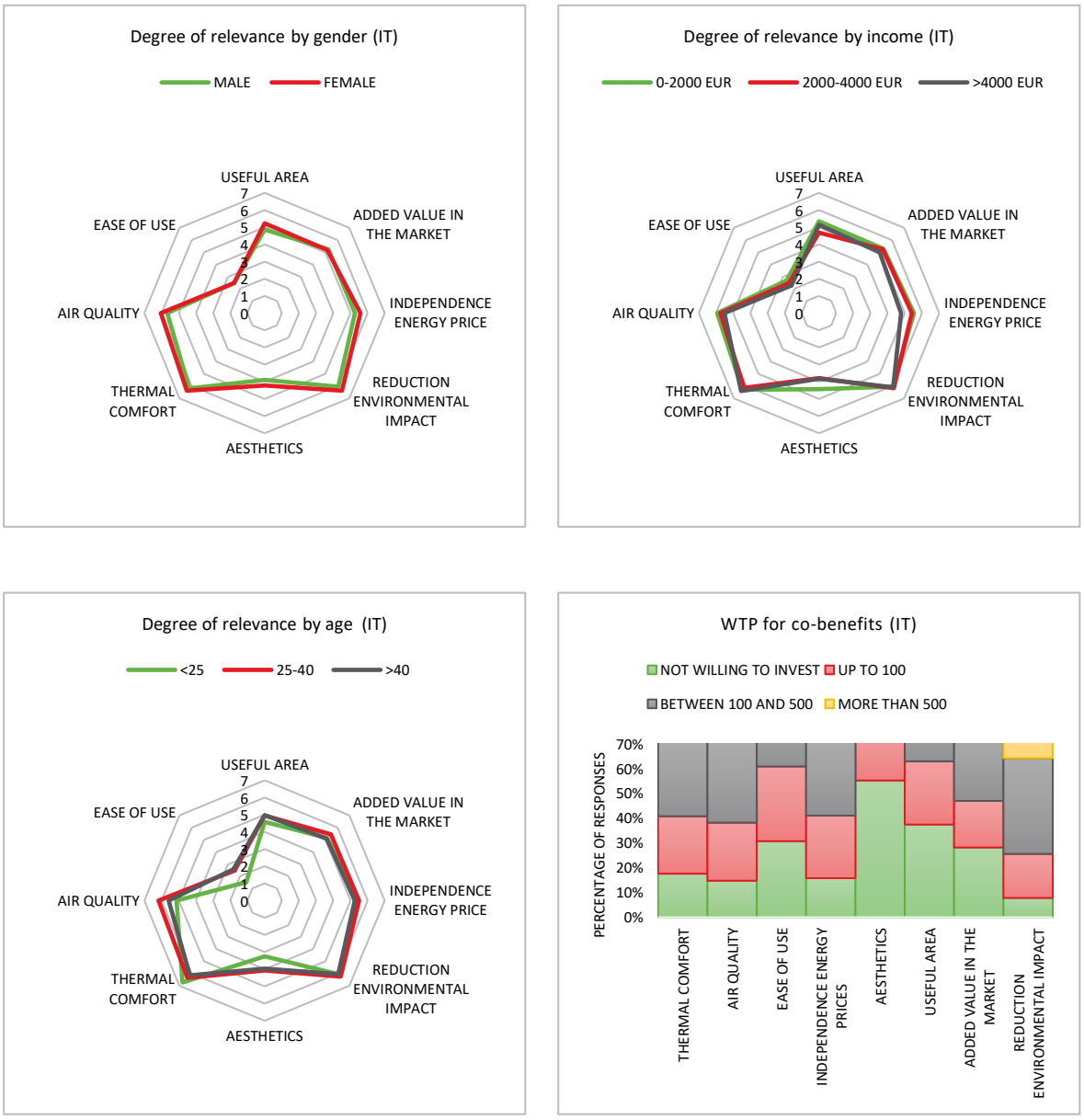


Figure 9 - Country highlights for Italy

Results regarding the level of income presented interesting differences for this national context. Respondents within the first level of monthly income (<2000EUR) were the ones indicating *thermal comfort* (average value of 6,3) and *reduction of environmental impact* (average value of 6,1) as the most relevant co-benefits. In opposition, at this level of income, respondents also indicated that *ease of use* (average value of 2,6) and *aesthetics* (average value of 4,4) were the less relevant. At the level of income between 2000 and 4000 euros, as well as for the highest level of income (>4000EUR), results consistently point in the same direction, with small differences regarding the indicated degree of relevance, in particular regarding *aesthetics*. Concerning this co-benefit, respondents in the two highest levels of income reported it as being even less relevant than for the respondents in the first level of income (<2000 euros per month).

Respondents with ages under 25 years old in Italy indicated *thermal comfort* as being the most relevant co-benefit (average value of 6,8) and *ease of use* as being the less relevant (average value of 1,5). On the other hand, respondents within 25 and 40 years old reported *air quality* as the most relevant (average value of 6,1). *Thermal comfort* was considered the most relevant co-benefit for respondents over 40 years old in Italy (average value of 6,2).

In terms of willingness to pay, there was a significant high percentage of responses (55%) indicating no willingness to invest an additional value in *aesthetics,* when acquiring a new heating solution in Italy. Respondents were willing to pay an additional value up to 100 euros primarily for *ease of use* (30%) and *added value in the market* (26%). Responses indicated that *thermal comfort* is the co-benefit most people are willing to pay an additional value between 100 and 500 euros (30%) alongside with *independence from energy prices.* Most of the respondents willing to invest more than 500 euros indicated *reduction of environmental impacts* (36%) and *thermal comfort* (29%) as the prefered co-benefits.

4.4 FRANCE

57% male respondents and 43% female respondents answered the survey in France. The larger share of respondents has more than 40 years old (62 %) with only 3% being 25 years or less. 10% of the respondents indicated as having a secondary education while 35% has a bachelor´s degree. 52% has a master´s degree and only 3% reported having a doctorate degree. Regarding income, the majority of the respondents indicated as earning more than 4000 euros (50%), 21% responded that their income was between 2000 and 4000 euros and 29% that their income under 2000 euros.

In France (Figure 10), *reduction of environmental impact* was the most relevant co-benefit (average value of 5,8) and *ease of use* the less relevant (average value of 4,2). Results indicated that, in terms of gender, male respondents valued *ease of use* more than female respondents (a difference of 0,5 in average).

Interesting results regarding income indicated a coincidence in responses in relation to the levels of monthly income between 2000 and 4000EUR and more than 4000EUR. However, for respondents with a level of income inferior to 2000EUR/month, the relevance of co-benefits was consistently lower (average of 0,9 difference in responses), with the exception of *ease of use,* which was identified as more relevant for the lower income level respondents (average of 0,8 difference) than for the respondents with higher levels of income.

Although, generally, results were consistent for all the age tiers considered in the analysis, younger respondents indicated the highest value for *thermal comfort* (average value of 5,9) and the lowest value for *ease of use* (average value of 3,58).

In terms of willingness to pay, responses pointed out to a high percentage of people not willing to invest in *aesthetics* (45%) and *useful area* (44%). In France, most of the respondents indicated that they were willing to pay an additional value of up to 100 euros for co-benefits. In this context, *thermal comfort (*58%), *independence from energy prices* (57%) and *air quality* (52%) gathered the majority of responses. Regarding responses reporting a willingness to pay between 100 and 500 euros, most of the respondents indicated *reduction of environmental impact* (30%). The same answer can be extracted from the results in the upper level of willingness to pay (>500EUR) although there are very few responses in this national context.

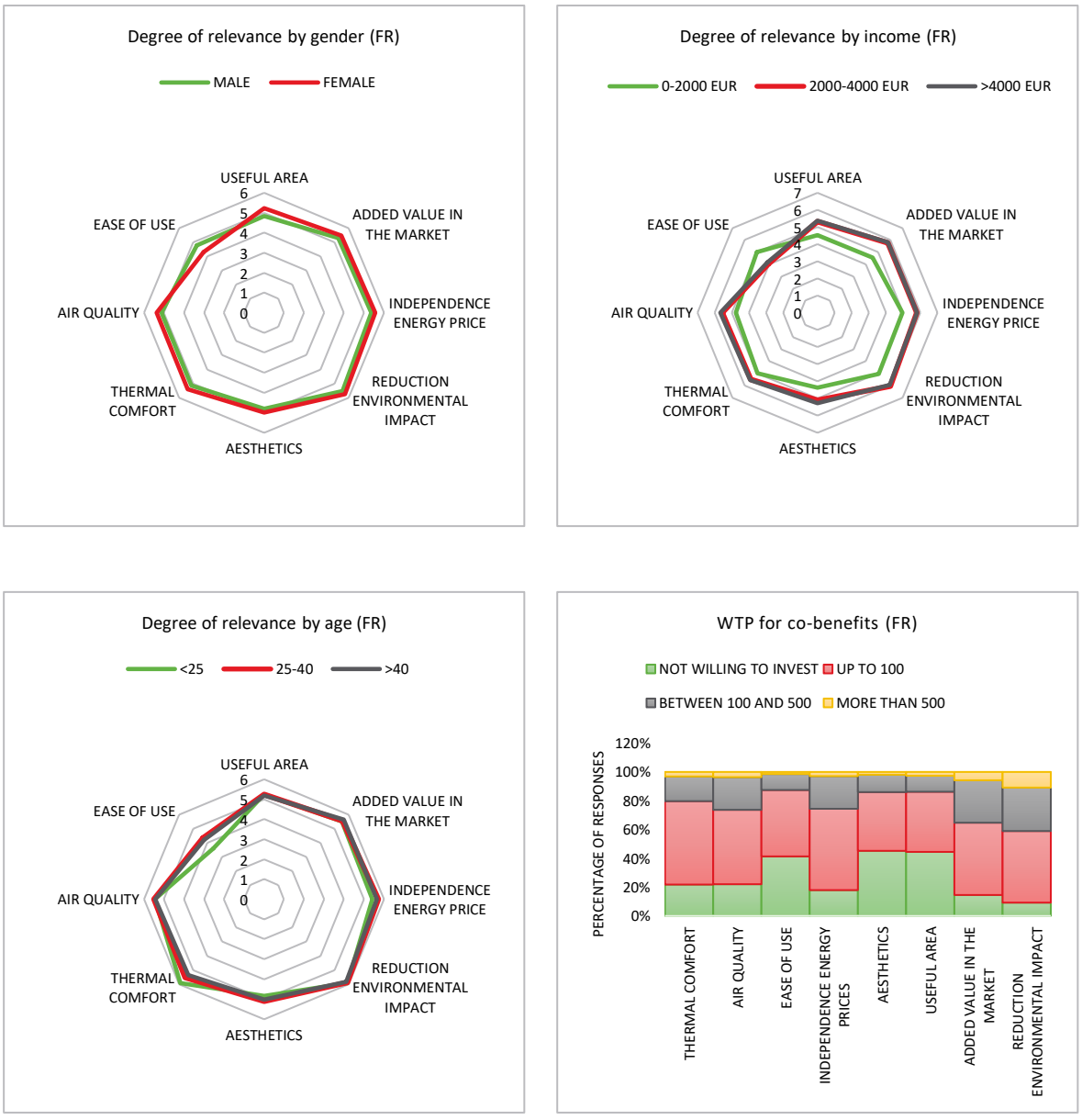


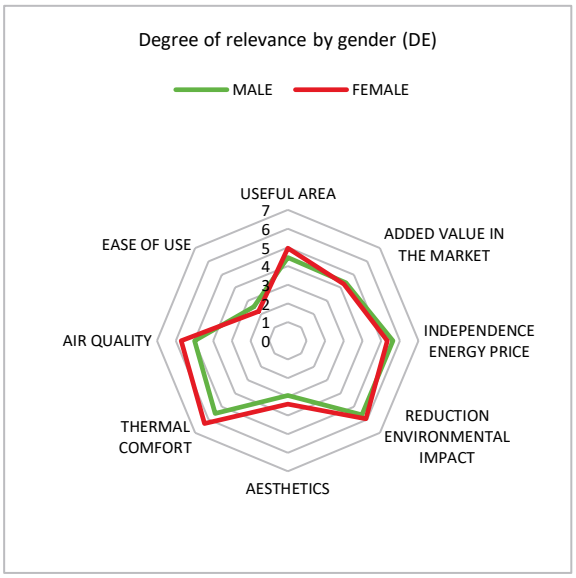
Figure 10 - Country highlights for France

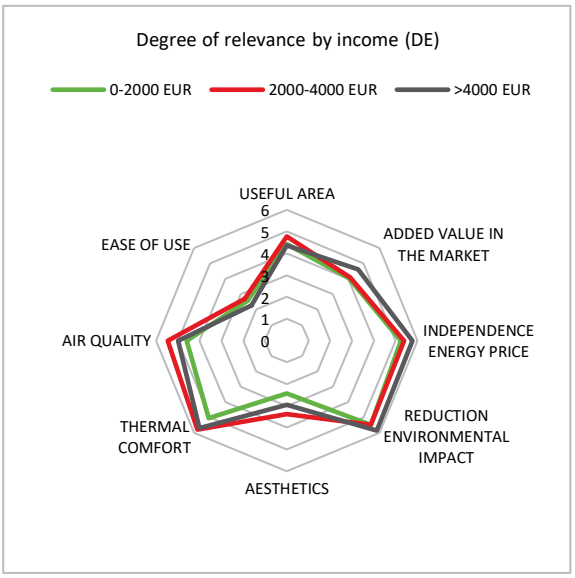
4.5 GERMANY

The majority of the data collected in Germany came from male respondents (77%). The larger share of respondents has more than 40 years old (68 %) with only 2% being 25 years or less. The majority of the respondents in Germany indicated a master´s degree as the highest education level (55%). In addition, 8% has a PhD. Contrary to other national contexts where there were virtually no answers indicating that the respondents had only primary education, 13% of the respondents in Germany responded as having this level of education. Regarding income, the majority of the respondents indicated as having an income of more than 4000 euros per month (65%), 16% responded that their income was between 2000 and 4000 euros and 18% that their income was less than 2000 euros.

In Germany (Figure 11), both *reduction of environmental impacts* and *thermal comfort* presented an average value of 5.6 in the degree of relevance, which is the highest value given by the respondents. In this national context, the less relevant co-benefit was *ease of use* (average value of 2,4).

The most significant differences in responses regarding degree of relevance by gender were on *air quality* and *thermal comfort*. In both of these co-benefits, male respondents indicated these co-benefits as being of lower relevance (an average difference of 0,7 and 0,8, respectively), when compared with the responses from the female respondents. However, male respondents considered *independence from energy prices* as being more relevant than female respondents (an average difference of 0,3 in the degree).





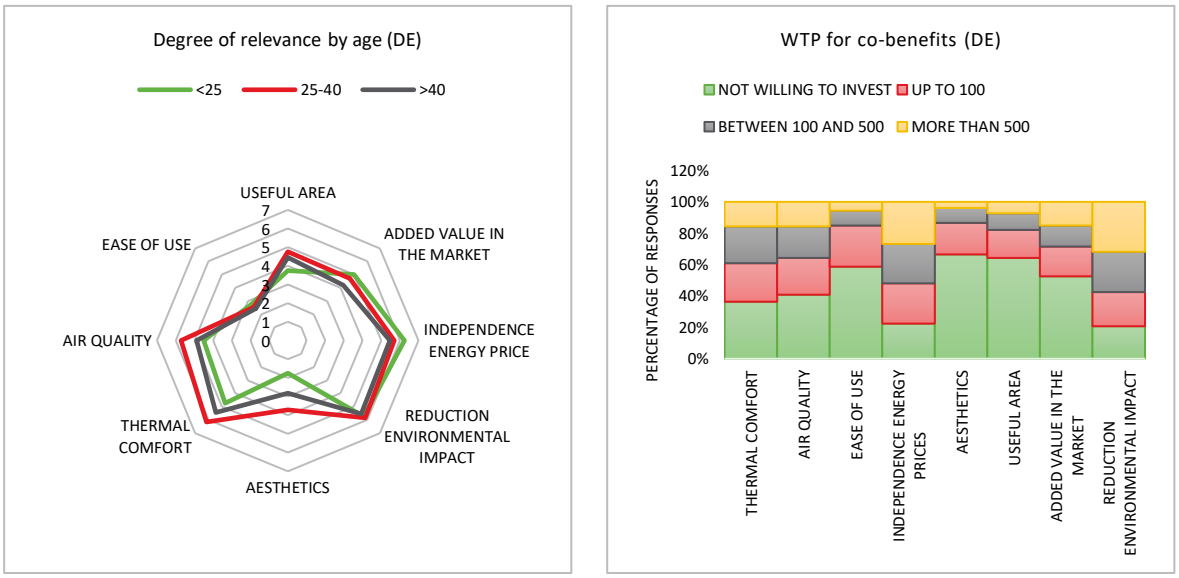


Figure 11 - Country highlights for Germany

In terms of income levels, respondents within the lower level of income (<2000EUR) indicated, in general, a lower level of relevance for every co-benefit. Respondents within the middle level of monthly income (between 2000 and 4000EUR) indicated *air quality* (average value of 5,5) and *useful area* (average value of 4,8), as well as *aesthetics* (average value of 3,4) to be the most relevant co-benefits. For respondents in Germany earning more than 4000EUR/monthly, the most relevant co-benefits were *reduction of environmental impact* (average value of 5,8), *independence from energy prices* (average value of 5,7) and *added value in the market* (average value of 4,6).

Responses also varied significantly in terms of the respondents age. For the youngest (<25 years old) German respondents, the most relevant co-benefits are *independence from energy prices* (average value of 6,2) and *reduction of environmental impact* (average value of 5,7).In opposition, the youngest respondents from Germany attributed the lowest relevance to aesthetics (average of 1,7). Respondents in the middle tier regarding age (between 25 and 40 years old), indicated that the most relevant co-benefits were *reduction of environmental impact* (average value of 5,8), *thermal comfort* (average value of 6,1) and *air quality* (average value of 5,7*)*. Despite an average difference of 0,4 in the degree, these are also the co-benefits indicated as most relevant for respondents over 40.

In terms of willingness to pay, responses indicated *aesthetics* (66%) and *useful area* (64%) as the co-benefits with the highest percentage of people not willing to invest any value in Germany. Responses regarding other levels of WTP are lower when compared with the other national contexts in terms of percentage. However, 26% of respondents indicated that they were willing to invest an additional value up to 100 euros in *reduction of environmental impact, independence from energy prices* and *ease of use.* Respondents also indicated they were willing to pay between 100 and 500 euros for *reduction of environmental impact* (26%), *independence from energy prices* (25%) and *thermal comfort*

(23%). *Reduction of environmental impact* was the co-benefit indicated by the higher percentage of respondents (32%) willing to pay more than 500 euros.

5 CONCLUSIONS

The work in Task 2.4 aimed at identifying the relevance of the distinctive co-benefits for decision-making of consumers, as well as to determine the Willingness to Pay for the additional benefits that the replacement of a heating appliance can bring. This can bring a better understanding of what consumers identify as having the most added value. It also aimed at reporting a qualitative assessment of the co-benefits associated with each heating solution/technology collected from energy professionals and experts.

Data collected allowed a better understanding of the difference in relevance of determined co-benefits in distinctive national contexts, as well as a more detailed analysis of the specificities in each country.

The co-benefits most commonly indicated as being the most relevant were *thermal comfort, air quality and reduction of environmental impact*. However, there are particularities for each context. Results from France indicated that the most relevant co-benefit is the *added value in the market* (for the building). For Spain, results indicated that, alongside with *thermal comfort*, the *independence to energy prices* is a highly relevant potential co-benefit of replacing a heating appliance. The *independence from energy prices* is also the most relevant co-benefit in Germany, as indicated by responses in this study.

Results from this analysis point out in the direction that, although there is a clear relationship between the degree of relevance and willingness to pay an additional value in the purchase of a heating solution, this relationship varies significantly depending on the co-benefits. Notably, there is a significant number of responses indicating that, although some co-benefits were reported as being relevant, there is no willingness to pay an additional value for them. Clear examples of this relationship were found concerning *added value in the market*, for example. In opposition, there is a significant relationship between the degree of relevance and WTP concerning the *reduction of environmental impact* co-benefit. The majority of responses regarding this co-benefit indicated a high relevance, as well as a significant willingness to invest an additional value for it.

In conclusion, results highlighted the potential importance of relevant economic, social and cultural differences between the five analysed countries. These differences are to be considered in the online application to further support consumers decision in the replacement of the heating solution process.

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APPENDIX 1 – Survey 1 (English version)

Drivers to change to an Energy Efficient Heating Appliance

This questionnaire is part of the European HARP (Heating Appliances Retrofit Planning) project which aims to study changes in consumer behavior regarding the adoption of energy-efficient heating solutions, addressing both space and water heating appliances.

Energy Efficient Heating Appliances (EEHA) is an appliance that performs with an energy class superior to C (for example heat pumps).

Your cooperation will greatly contribute to accomplish the goal of this project and help to understand the factors that influence the replacement of inefficient heating solutions with more efficient ones.

All the data collected is covered by a strict confidentiality and anonymity criterion. You just need less than 10 minutes to fill in the questionnaire. Thank you for your cooperation.

Drivers to change to an Energy Efficient Heating Appliance

* 1. Answer the following questions selecting one option.

	Yes	No
Do you have a (space or water) heating appliance installed in your home?	○	○
Is your heating system centralized?	○	○
Do you have an individual space heating appliance installed in your home?	○	○
Do you have an individual water heating appliance installed in your home?	○	○
Do you have an individual combined space and water heating appliance installed in your home?	○	○
Is your space heating system centralized for the whole building?	○	○
Is your water heating system centralized for the whole building?	○	○

* 2. Are you responsible for the decision of installing or replacing the heating solution in your home?

○ Yes ○ No

Drivers to change to an Energy Efficient Heating Appliance

* 3. I would be more likely to change to an **EEHA (Energy Efficient Heating Appliance)** if:

	1 - Completely disagree	2	3	4	5	6	7 - Completely agree
It will increase my house's energy efficiency	○	○	○	○	○	○	○
It will require less maintenance than my current system	○	○	○	○	○	○	○
It will work better than my current system	○	○	○	○	○	○	○
It is compatible with my home in terms of the building aesthetics	○	○	○	○	○	○	○
Condensation, humidity and mould related problems are avoided	○	○	○	○	○	○	○
It will not reduce my house's useful floor area	○	○	○	○	○	○	○
It will allow me to have a comfortable indoor temperature during the heating season	○	○	○	○	○	○	○
It will improve the indoor air quality in my house	○	○	○	○	○	○	○
I think it will be easy to operate	○	○	○	○	○	○	○
It is offered at a discounted price or with other promotional incentives	○	○	○	○	○	○	○
It is easily available in the market	○	○	○	○	○	○	○
My current heating appliance is damaged	○	○	○	○	○	○	○
It is reasonably priced	○	○	○	○	○	○	○
It is a good value for the money	○	○	○	○	○	○	○
It provides a good value	○	○	○	○	○	○	○
I receive a subsidy to finance the replacement	○	○	○	○	○	○	○
I am aware of total energy savings over the EEHA lifetime	○	○	○	○	○	○	○
I am aware of total monetary savings over the EEHA lifetime	○	○	○	○	○	○	○
It values the dwelling in the real-estate market (I will sell the house for a higher price if it is equipped with an EEHA)	○	○	○	○	○	○	○
It allows me to be independent from energy price fluctuations	○	○	○	○	○	○	○
It allows me to have a reduced environmental impact	○	○	○	○	○	○	○

* 4. Evaluate the following sentences about **energy labels.**

	1 - Completely disagree	2	3	4	5	6	7 - Completely agree
The energy label is important in the decision of buying a heating appliance	○	○	○	○	○	○	○
When I buy a heating appliance, I pay attention to the energy label	○	○	○	○	○	○	○
I am more willing to buy a heating appliance with an efficient energy class (above C, i.e., A or B)	○	○	○	○	○	○	○

Drivers to change to an Energy Efficient Heating Appliance

* 5. I will not purchase an **EEHA (Energy Efficient Heating Appliance)** because:

	1 - Completely disagree	2	3	4	5	6	7 - Completely agree
I believe that EEHA would cost more than I can afford	○	○	○	○	○	○	○
I believe the initial investment in an EEHA is not affordable	○	○	○	○	○	○	○
I believe that the maintenance costs of an EEHA are not affordable	○	○	○	○	○	○	○
I believe that the operation of an EEHA is more complicated than my current heating solution	○	○	○	○	○	○	○
I believe that an EEHA needs the user to perform maintenance work by himself	○	○	○	○	○	○	○
I believe that the maintenance of an EEHA requires too much work	○	○	○	○	○	○	○

Drivers to change to an Energy Efficient Heating Appliance

* 6. Evaluate the following sentences about **engagement.**

	1 - Completely disagree	2	3	4	5	6	7 - Completely agree
I consider myself concerned about environmental problems	○	○	○	○	○	○	○
I consider myself a "green consumer"	○	○	○	○	○	○	○
I worry about the effects of heating appliances on the environment and climate	○	○	○	○	○	○	○
I worry about the pollution caused by the use of heating appliances.	○	○	○	○	○	○	○
I pay a lot of attention to anything about EEHA	○	○	○	○	○	○	○
I keep up with things related to EEHA	○	○	○	○	○	○	○
People who are important to me think that I should adopt EEHA	○	○	○	○	○	○	○
People who influence my behavior think that I should adopt EEHA	○	○	○	○	○	○	○
People whose opinions that I value prefer that I adopt EEHA	○	○	○	○	○	○	○

* 7. Evaluate the importance of the following **sources to search for information about EEHA (Energy Efficient Heating Appliance).**

	1 - No Important	2	3	4	5	6	7 - Very Important
People I know who own an EEHA							
Internet Websites							
Mobile Applications							
Newspapers							
Radio							
Television							
Organizations (local associations, energy agencies)							
Installers and/or related professionals							
EEHA shops							
I don´t search for information about EEHA							

Drivers to change to an Energy Efficient Heating Appliance

* 8. Evaluate the following sentences about **changing to an EEHA (Energy Efficient Heating Appliance).**

	1 - Completely disagree	2	3	4	5	6	7 - Completely agree
I intend to change to EEHA in the future							
I will try to change to EEHA in my future							
I am ready to change to EEHA							
I intend to discontinue the use of my current heating systems to EEHA							
If I could, I would like to switch from my actual heating system to an EEHA							
I intend to discontinue the use of my current heating system rather than continue its use							
I usually track my energy consumption based on my billing							
I am willing to change my heating appliance(s)							
I am planning to buy an EEHA							

* 9. Please choose your **usage frequency** for each of the following:

	1 - Never	2	3	4	5	6	7 - Every time I need
Domestic Hot Water (DHW) System	○	○	○	○	○	○	○
Space heating system	○	○	○	○	○	○	○
Combined heating system (water and space)	○	○	○	○	○	○	○

* 10. Evaluate the following sentence about **the use of your heating system.**

On average, what is the monthly energy consumption of your household (in monetary units)?

* 11. Evaluate the following sentences about **changing to an EEHA (Energy Efficient Heating Appliance).**

	Yes	No
I prefer a cheap inefficient system instead of a more expensive efficient system	○	○
I am willing to adopt renewable energy sources in my residence	○	○

Drivers to change to an Energy Efficient Heating Appliance

* 12. In which country do you live in?

* 13. Please answer the following questions.

	Yes	No	I don´t know
Has your house been renovated since its construction?	○	○	○
Do your home space/construction characteristics limit the choice set for a heating system (e.g. lack of suitable space for certain EEHA)?	○	○	○

* 14. Please answer the following questions.

	0	1	2	3	4	5	>= 6
How many people live in your household?	○	○	○	○	○	○	○
How many children (up to 12 years old) live in your home?	○	○	○	○	○	○	○

* 15. If known, what is the energy class of your house (based on the Energy Performance of Building Certificate)?

A+ A B B- C D E F I don´t know

* 16. What type of area do you live in?

Rural Urban

* 17. Are you the owner of your dwelling?

Yes No

* 18. What is the size of your dwelling (in m2)?

< 50 m2 [50, 100[m2 [100, 150[m2 [150, 200[m2 [200, 250[m2 [250, 300[m2 >= 300 m2

* 19. How old is your dwelling since your last renovation (in years)? If it was not renovated, answer with the years since its construction.

< 1 [1, 5[[5, 10[[10, 15[[15, 20[[20, 25[[25, 30[>=30

* 20. What is your dwelling type?

Apartment House

* 21. What is the energy source of your main space heating system?

Gas Oiled-fired Electricity Biomass Solar Other I don't have one

* 22. What is the energy source of your main domestic hot water system is:

Gas Oiled-fired Electricity Biomass Solar Other I don´t have one

* 23. How old are you (in years)?

* 24. What is your gender?

Female ◯ Male ◯ Other

* 25. What is your level of education?

Primary ◯ Secondary ◯ Bachelor ◯ Master ◯ PhD

* 26. What do you think about the price of heating solutions?

low ◯ right price ◯ little high but acceptable ◯ too high ◯ no idea

* 27. What is the monthly income of your household?

[0, 500[◯ [500, 1000[◯ [1000, 1500[◯ [1500, 2000[◯ [2000, 2500[◯ [2500, 3000[◯ [3000, 3500[◯ [3500, 4000[◯ [4000, 4500[◯ [4500, 5000[◯ [5000, 5500[◯ [5500, 6000[◯ >= 6000

* 28. Are you willing to invest an extra value for your EEHA if it allows you to:

	No	Up to 100 €	Between 100 and 500 €	More than 500 €
Achieve a comfortable indoor temperature during the heating season more easily	◯	◯	◯	◯
Have better indoor air quality	◯	◯	◯	◯
Lower indoor noise level	◯	◯	◯	◯
Lower external noise level	◯	◯	◯	◯
Operate the EEHA more easily	◯	◯	◯	◯
Be more independent to energy prices	◯	◯	◯	◯
Have a more aesthetically pleasing EEHA	◯	◯	◯	◯
Have more useful living area	◯	◯	◯	◯
Value the dwelling in the real-estate market	◯	◯	◯	◯
Have a reduced environmental impact	◯	◯	◯	◯

29. What is your level of knowledge regarding:

	1 - Very limited	2	3	4	5	6	7 - Very good
The subject of this survey (EEHA)?	○	○	○	○	○	○	○
NOVA IMS?	○	○	○	○	○	○	○

Know more about energy efficient heating and the HARP project at:https://heating-retrofit.eu/

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Energy Efficient Heating Appliances and Co-Benefits

The main objective of this 5-minute survey is to provide insights regarding a qualitative assessment of the co-benefits associated with heating equipment. As an energy specialist, your informed opinion is valuable and appreciated.

This questionnaire is part of the European HARP (Heating Appliances Retrofit Planning) project which aims to study changes in consumer behavior regarding the adoption of energy-efficient heating solutions, addressing both space and water heating appliances.

Thank you for your contribution!

The survey is anonymous and data processing will be solely used for HARP purposes. Do you agree to take part in this survey sent by University of Minho?
Data collected will be used to gather knowledge on co-benefits of heating appliances. *

- ○ Yes

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APPENDIX 2 – Survey 2

What co-benefits would you associate with a specific heating solution? Please rate the co-benefits according to their importance

Please only enter numbers. (+3 very positive; +2 positive; +1 slightly positive or -3 very negative; -2 negative; -1 slightly negative)

	Thermal comfort	Air quality	Noise	Aesthetics	Ease of use / Control by user	Impact on useful living area	Added value to the property	Energetic autonomy	Reduced enviromental impact
Biomass boilers									
Combined heat and power									
Electric heat pumps									
Electric resistance boilers									
Gas condensing boilers									
Gas heat pumps									
Ground / Water heat pumps									
Hybrid heat pumps									
Oil condensing boilers									
Solar thermal systems									
Water heaters (up to XXL)									

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APPENDIX 3 – Results from the relation between Degree of Relevance and WTP

Co-Benefit	DR	WTP	Responses	Co-Benefit	DR	WTP	Responses
TC	1	NO	106	AE	1	NO	415
TC	2	NO	58	AE	2	NO	332
TC	3	NO	47	AE	3	NO	300
TC	4	NO	166	AE	4	NO	557
TC	5	NO	158	AE	5	NO	416
TC	6	NO	222	AE	6	NO	313
TC	7	NO	491	AE	7	NO	591
TC	1	<100	25	AE	1	<100	79
TC	2	<100	14	AE	2	<100	93
TC	3	<100	33	AE	3	<100	134
TC	4	<100	163	AE	4	<100	328
TC	5	<100	279	AE	5	<100	331
TC	6	<100	521	AE	6	<100	280
TC	7	<100	1159	AE	7	<100	533
TC	1	100 to 500	14	AE	1	100 to 500	30
TC	2	100 to 500	12	AE	2	100 to 500	29
TC	3	100 to 500	21	AE	3	100 to 500	50
TC	4	100 to 500	84	AE	4	100 to 500	155
TC	5	100 to 500	140	AE	5	100 to 500	141
TC	6	100 to 500	429	AE	6	100 to 500	195
TC	7	100 to 500	1039	AE	7	100 to 500	361
TC	1	>500	14	AE	1	>500	12
TC	2	>500	3	AE	2	>500	10
TC	3	>500	2	AE	3	>500	12
TC	4	>500	21	AE	4	>500	43
TC	5	>500	61	AE	5	>500	48
TC	6	>500	151	AE	6	>500	45
TC	7	>500	578	AE	7	>500	178
AQ	1	NO	127	EU	1	NO	367
AQ	2	NO	72	EU	2	NO	247
AQ	3	NO	74	EU	3	NO	233
AQ	4	NO	245	EU	4	NO	467
AQ	5	NO	229	EU	5	NO	217
AQ	6	NO	238	EU	6	NO	388
AQ	7	NO	439	EU	7	NO	0
AQ	1	<100	25	EU	1	<100	343
AQ	2	<100	27	EU	2	<100	310
AQ	3	<100	54	EU	3	<100	304
AQ	4	<100	196	EU	4	<100	604
AQ	5	<100	320	EU	5	<100	297
AQ	6	<100	511	EU	6	<100	410

Co-Benefit	DR	WTP	Responses	Co-Benefit	DR	WTP	Responses
AQ	7	<100	1163	EU	7	<100	0
AQ	1	100 to 500	20	EU	1	100 to 500	232
AQ	2	100 to 500	11	EU	2	100 to 500	216
AQ	3	100 to 500	16	EU	3	100 to 500	186
AQ	4	100 to 500	80	EU	4	100 to 500	327
AQ	5	100 to 500	154	EU	5	100 to 500	161
AQ	6	100 to 500	357	EU	6	100 to 500	195
AQ	7	100 to 500	946	EU	7	100 to 500	0
AQ	1	>500	10	EU	1	>500	170
AQ	2	>500	6	EU	2	>500	81
AQ	3	>500	9	EU	3	>500	55
AQ	4	>500	32	EU	4	>500	99
AQ	5	>500	48	EU	5	>500	40
AQ	6	>500	108	EU	6	>500	62
AQ	7	>500	494	EU	7	>500	0
IEP	1	NO	88	AVM	1	NO	204
IEP	2	NO	33	AVM	2	NO	163
IEP	3	NO	53	AVM	3	NO	206
IEP	4	NO	132	AVM	4	NO	470
IEP	5	NO	127	AVM	5	NO	320
IEP	6	NO	174	AVM	6	NO	205
IEP	7	NO	331	AVM	7	NO	406
IEP	1	<100	27	AVM	1	<100	23
IEP	2	<100	18	AVM	2	<100	25
IEP	3	<100	48	AVM	3	<100	70
IEP	4	<100	178	AVM	4	<100	248
IEP	5	<100	285	AVM	5	<100	314
IEP	6	<100	537	AVM	6	<100	395
IEP	7	<100	1143	AVM	7	<100	711
IEP	1	100 to 500	13	AVM	1	100 to 500	10
IEP	2	100 to 500	13	AVM	2	100 to 500	13
IEP	3	100 to 500	26	AVM	3	100 to 500	33
IEP	4	100 to 500	89	AVM	4	100 to 500	123
IEP	5	100 to 500	194	AVM	5	100 to 500	219
IEP	6	100 to 500	446	AVM	6	100 to 500	353
IEP	7	100 to 500	1027	AVM	7	100 to 500	750
IEP	1	>500	16	AVM	1	>500	6
IEP	2	>500	9	AVM	2	>500	8
IEP	3	>500	5	AVM	3	>500	10
IEP	4	>500	47	AVM	4	>500	38
IEP	5	>500	83	AVM	5	>500	74
IEP	6	>500	185	AVM	6	>500	129
IEP	7	>500	684	AVM	7	>500	485
UA	1	NO	203	REI	1	NO	87

Co-Benefit	DR	WTP	Responses	Co-Benefit	DR	WTP	Responses
UA	2	NO	135	REI	2	NO	49
UA	3	NO	185	REI	3	NO	52
UA	4	NO	416	REI	4	NO	136
UA	5	NO	398	REI	5	NO	113
UA	6	NO	430	REI	6	NO	136
UA	7	NO	839	REI	7	NO	325
UA	1	<100	41	REI	1	<100	15
UA	2	<100	36	REI	2	<100	9
UA	3	<100	57	REI	3	<100	33
UA	4	<100	203	REI	4	<100	153
UA	5	<100	267	REI	5	<100	278
UA	6	<100	391	REI	6	<100	489
UA	7	<100	723	REI	7	<100	1206
UA	1	100 to 500	21	REI	1	100 to 500	11
UA	2	100 to 500	23	REI	2	100 to 500	9
UA	3	100 to 500	27	REI	3	100 to 500	8
UA	4	100 to 500	118	REI	4	100 to 500	59
UA	5	100 to 500	170	REI	5	100 to 500	172
UA	6	100 to 500	281	REI	6	100 to 500	421
UA	7	100 to 500	537	REI	7	100 to 500	1198
UA	1	>500	10	REI	1	>500	7
UA	2	>500	10	REI	2	>500	3
UA	3	>500	21	REI	3	>500	3
UA	4	>500	42	REI	4	>500	12
UA	5	>500	63	REI	5	>500	39
UA	6	>500	73	REI	6	>500	120
UA	7	>500	291	REI	7	>500	868