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Executive summary

Among the alternative technologies to generate low-carbon heat and electricity and to replace fossil-fuel based powertrains, residential stationary fuel cells and hydrogen fuel cell electric vehicles (FCEVs) are receiving support towards commercialization. Residential fuel cells offer some important benefits over other low-carbon heating technologies, and cost reductions and financing mechanisms for the purchase or installation are bringing the technology close to commercialisation in several countries (Dodds et al., 2014; Ammermann et al., 2015). Although the technology will likely remain comparatively expensive, it is assumed that residential fuel cells have mass-market potential and will have a significant impact on reducing emissions and primary energy consumption where they are deployed (Ammermann et al., 2015). The deployment of FCEVs, although still facing several challenges, is advancing worldwide; fuelling infrastructures are being deployed in several countries and auto manufacturer actions seem to confirm their commitment to keeping fuel cell technology as an option (Eberle, Müller, & von Helmolt, 2012; Air Resources Board, 2015).

Public and consumer acceptance will likely play a role in the successful adoption of hydrogen and fuel cell applications, both in the residential and the transportation sector. The future is uncertain: FCH applications might benefit from a public willingness to take up more efficient heating and transport systems, or the public may prefer other alternatives or even incumbent, fossil fuel or combustion-based technologies that might be perceived as safer, cheaper, more effective and easier to control (Dodds et al., 2014). As markets for hydrogen and fuel cell technologies develop, citizens will react in different ways to energy policies and local infrastructures deployed in their countries, regions and cities, and end-users will decide whether fuel cells fit their particular circumstances.

In this context, the Hyacinth Project, funded by the Fuel Cells and Hydrogen Joint Undertaking (FCH-JU), has worked to increase the understanding of cross-country differences and similarities in public and stakeholder awareness and attitudes in relation to FCH applications. The primary aim of Hyacinth has been to assess levels of awareness, understanding and acceptance of FCH technologies in the general public in various EU countries with different levels of market penetration and government support. Specifically, the project has aimed at examining public attitudes towards residential fuel cell units and hydrogen fuel cell electric vehicles in Belgium, France, Germany, Norway, Spain, Slovenia, and United Kingdom.

The study

A specific multi country questionnaire-survey was designed and implemented during 2015 and 2016 to assess the levels of public awareness, understanding and acceptance of hydrogen and fuel cell technologies and applications. The design of the questionnaire also aimed at building a predictive model for the acceptance of FCH technologies based on segmented responses to FCH technologies, including factors known to be relevant in this context. The questionnaire included items specifically developed by the research team and drawing partly on a technology acceptance model describing the causal links among the attitudinal elements that directly and

indirectly affect technology acceptance (Huijts, Molin and Steg, 2012). It also included selection of items from previous studies on public acceptance of hydrogen and fuel cell technologies and other energy technologies in different countries (Achterberg, Houtman, van Bohemen, & Manevska, 2010; de Best-waldhober and Daamen, 2006; Huijts, De Groot, Molin, and van Wee, 2013; Huijts, Molin, and Steg, 2012; Midden & Huijts, 2009; Truett & Schmoyer, 2008).

Given that hydrogen fuel cell technologies are generally unknown to the general public, special attention was given to the type of information provided to respondents about the technology prior to answering the questionnaire. Participants received neutral information regarding: a) hydrogen and fuel cells in general and; b) fuel cells for residential use (half of the sample in each country) or hydrogen fuel cell electric vehicles (the other half of the sample), depending on the type of application the respondent was evaluating. Participants also received information regarding the potential consequences of the implementation of the two FCH applications. Each of the consequences was related to one potential benefit/cost of the application. Participants were then asked to rate each of the consequences. The main objective of this exercise was to allow for an informed evaluation of the application by the participants. The exercise was inspired by the Information Choice Questionnaire method (Best-Waldhober and Daamen, 2006).

Nationally-representative samples of approximately 1000 adults from each country took part in the online survey. The sample consisted of panel members who had agreed to participate in online market and social research. The samples were representative for the age and gender groups in each country and had an approximate distribution regarding region and education. Invitations to take part in the survey were sent to participants through the access panel system. Data was collected during April and May 2016.

Main results

Hydrogen and fuel cell technologies

- Levels of public awareness about hydrogen and fuel cell technologies in the context of energy production vary across the seven countries. More than 40% of respondents report having heard of FCH technologies in the context of energy production. Levels of public awareness are higher in Germany and Norway (50%) and lower in Spain (29%). Only around 6% of respondents consider themselves familiar with the technology.
- Despite this, the European public tends to provide a neutral to positive initial evaluation of FCH technologies as a potential solution to energy and environmental challenges. Almost 6 out of 10 respondents (57%) evaluate FCHs as a good or very good solution to energy challenges. There are small but significant differences in the initial evaluation of FCH technologies across the seven countries.

Stationary fuel cells

- The level of public awareness of residential fuel cell units is significantly lower than the level of awareness found for hydrogen and fuel cell technologies in general, in all of the countries studied. Only around 25% of respondents report having heard of residential ap-

plications. The level of awareness ranges from 32% in Germany to 20% in Norway. Fewer than 5% of respondents consider themselves knowledgeable about this specific application.

- More than 60% of participants report feeling somewhat or very much interested in the technology, 54% report feeling somewhat or very much hopeful about it (hope, anxiety and aversion relate to risk perceptions), 15% report feeling somewhat or very much worried about the technology and 11% report feeling somewhat or very much averse. There are small but significant differences across countries.
- In general, respondents perceive home fuel cells to be beneficial, that is, perceived that the benefits outweigh perceived costs. Generally, respondents believe that home FCs will have a positive effect on the environment (mean= 3.9 on a scale from 1 to 5), will be moderately user friendly (3.6), convenient (in terms of noise, vibration, specific location) (3.5), and safe (3.4). Respondents have less positive beliefs about the costs of the installation (2.9), the cost of running the installation (3.2) and maintenance (3.3).
- Regarding the evaluation of the consequences of home fuel cells, the consequences evaluated as the most positive are the propositions that fuel cell home units: "will reduce the cost of producing energy", "would reduce CO_2 emissions" and "would reduce the need to purchase electricity from the power company". The "house space requirements" and the "potential risks" are, on average, rated as not important consequences. The "initial capital costs" is rated as a negative-neutral consequence.
- All the consequences have a moderate to medium association with the overall evaluation of the application. The "reduction in the need to purchase electricity" is the most highly associated with the global attitude. However, the "initial capital cost" is the factor most highly associated with the reported likelihood of purchasing a home fuel cell. This means that the distinct consequences of residential FCHs, and their evaluation by participants, have a different effect on individuals' attitude towards the application than on individuals' self-reported likelihood of installing a home fuel cell.
- Generally, respondents provide a positive evaluation of home FCHs (average of 3.7 in a scale of 1 to 5). Around 60% respondents consider the technology a good or very good electricity and heating system. There are small but significant differences across the countries studied. The attitude towards home fuel cells is more positive in Slovenia (mean 3.84), Spain (3.79) and Germany (3.78) and more neutral in Norway (3.48) and United Kingdom (3.62).
- Respondents generally express a preference for FCHs relative to more traditional technologies such as gas boilers but also a preference for renewable systems, specifically for solar thermal, relative to FCHs.
- Regarding acceptance and support, the majority of participants (64%) in the seven studied populations would be happy to have a hydrogen fuel cell unit installed in their home in the future. There is a higher level of acceptance in Germany, Spain and Slovenia (around 71%), and a lower level in France (55%), Norway (58%), Belgium (60%) and UK (60%). Support of public funding for FCHs is generally high in the seven studied countries, and higher than personal acceptance. More than 7 out of 10 respondents agree with providing subsidies to stationary residential FCHs.

- Finally, only around 2 out of 10 respondents consider it likely or very likely that they would purchase a home FCH in the near future. The price the fuel cell is the most relevant reason for not installing a fuel cell at home (73% of respondents), followed by the perceived lack of maturity of the technology (45%). Other issues raised include not being the owner of the residence, already having other electricity and heating system installed, the suitability for various types of homes, potential installation problems, safety and lack of information.
- The majority of respondents in all seven countries would support the installation of a fuel cell power plant in their town. In the full sample, around 6 out of 10 respondents would vote in favour of the siting of the power plant, 3 out of 10 are undecided and 1 out of 10 would vote against it.

Hydrogen fuel cell electric vehicles (FCEVs)

- Public awareness of hydrogen fuel cell electric vehicles (FCEV) is higher than that for residential fuel cell units. Around 45% of respondents have heard a little bit about FCEV and 15% report knowing a little about fuel cell cars. There are significant differences across the countries. Norway and Germany are the countries with higher levels of awareness of FCEVs. Respondents' experience with FCH electric vehicles is low across the studied countries. Fewer than 10% of respondents have had some experience with FCEVs (passenger cars or buses).
- The majority of respondents in the seven studied populations report feelings of interest and hope regarding FCEVs. Specifically, 60% of respondents in the total sample report feeling interest and hope 56% "somewhat" or "very much". Only around 13% report feeling "somewhat" or "very much" worry, and 9% report feeling aversion.
- In general, respondents perceive hydrogen vehicles as slightly beneficial, that is, perceived benefits slightly outweigh perceived costs. However, respondents seem to be somewhat unsure about the potential benefits of FCEVs. There are weak but significant differences across countries.
- Regarding the evaluation of the consequences of FCEVs, the three consequences evaluated in the total sample as the most positive are the propositions that: "they will reduce the need for petroleum", it "would produce lower CO_2 emissions than convention al cars" and the "price of hydrogen" (79%, M= 4.06). The "range" and "safety issues" were, on average, rated as unimportant consequences. The "need for new infrastructure" and the "price of fuel cell material" were rated as negative consequences.
- The evaluation of the consequence "reduction in the need for petroleum" is the best predictor of respondent's global attitude towards FCEVs, followed by "the reduction in CO2 emissions" and "the price of hydrogen" (rho= 0.38). However, the "price for fuel cell material" and the "need for new infrastructure" are the most predictive factors in the self-reported likelihood of purchasing a hydrogen car.
- Generally, respondents in the seven countries provide a positive evaluation of FCEVs (average of 3.7 in a scale from 1 to 5). Around 6 out of 10 respondents consider the technology a good or very good option. There are small but significant differences among the countries studied.

- Respondents generally express a preference for FCHs over conventional cars and compressed or liquefied natural gas cars. However, battery electric cars and hybrid (battery and fossil fuel combined) cars are preferred options compared to hydrogen fuel cell electric cars. There are significant differences across countries in their preference for alternative cars. Germany is the only country where the percentage of respondents who consider electric cars a worse option than FCEV cars is higher than the percentage that considers electric cars a better option.
- Regarding acceptance and support for FCEVs, the majority of participants in the seven countries would be happy to have a hydrogen fuel cell car in the future (assuming all things being equal, including price equivalence with contemporary cars and refuelling availability). Specifically, more than 60% in the full sample would like to buy an FCH electric car in the future, again under conditions of equivalence.
- Almost 80% of respondents are in favour of the substitution of conventional buses for hydrogen fuel cell buses, though with significant differences across countries.
- Without the condition of equivalence, only a minority of respondents consider it likely or very likely that they would purchase an FCEV if they need to purchase a car in the near future. The price is reported as the most relevant factor for not purchasing a FCEV, followed by lack the maturity of the technology. Other reasons for not purchasing a FCEV include the lack of refuelling stations, having other necessities or not wanting to have a car, safety and other perceived disadvantages.
- Finally, less than 5% of respondents are aware of the existence of a hydrogen refuelling facility in their city. Generally, a hydrogen refuelling station is considered by the average respondent to have more benefits than costs. Respondents generally support the siting of hydrogen refuelling stations. Around 7 out of 10 respondents would vote in favour of the siting of the hydrogen refuelling station. Differences across countries are not significant.

Differences in awareness and acceptance per country-grouping

When the data is examined according to the country grouping developed in deliverable 2.1 (countries were classified in advanced, medium and low policy support to hydrogen), the following patterns are observed:

- Norway and Germany have a similar position in terms of public awareness and initial uninformed evaluation of FCHs. As initially expected given its level of hydrogen and fuel cell implementation, Germany is the country with the highest levels of public awareness, acceptance and support to hydrogen and fuel cell applications. The levels of awareness and acceptance of FCHs are also high in Norway, but interestingly, the public in Norway is more positive about FCEVs than they are about residential fuel cells. In the United Kingdom, the general public is significantly more sceptic or neutral towards FCH applications than in Germany and Norway. Public awareness about the technology is also lower in the UK than initially expected, given the level of implementation of these technologies. Interestingly, the UK shares a similar level of awareness of FCHs and uninformed evaluation to France.

- Public acceptance and support to hydrogen and fuel cell technologies is relatively high in Belgium. In France, the public is slightly less positive about these technologies than in other countries, but the level of support to public funding for these technologies is high. The public in France seems to express a relatively higher preference for alternative technologies such as hybrid and full electric cars. In Spain, despite the low levels of awareness about the technology, the general attitude of the public towards hydrogen and fuel cell applications is very positive. Levels of public acceptance in Spain are significantly higher than in France and Belgium.
- Despite the low level of implementation of FCH technologies in Slovenia, the level of public awareness and the general attitude of the public towards hydrogen and fuel cell applications is very positive. Levels of public acceptance of hydrogen fuel cell applications in Slovenia are significantly higher than in countries such as France, Belgium or the UK.
- In general, while some of the results of the study seem to indicate that countries with higher levels of policy support and technological implementation tend to have higher levels of public awareness and acceptance (this seems to be true for Germany and Norway, although not necessarily in a similar way for stationary and mobile applications), overall, public reactions to hydrogen and fuel cell applications seem to be, to a large extent, independent from the country's level of technological implementation and policy support.
- According to the data, and focusing only on the level of public awareness about hydrogen fuel cell technologies in general and the initial uninformed evaluation of these technologies, Norway and Germany have a similar position in terms of public awareness and initial evaluation. Belgium and Spain have a similar uninformed evaluation but a lower level of public awareness than Germany and Norway. France and UK share a similar level of public awareness and uninformed evaluation. Both are lower in France and the UK relative to Norway and Germany. Slovenia shows a particular pattern, with a higher level of uninformed evaluation.

Supporters and opponents

Overall, based on the level of acceptance and support for the two FCH applications studied, respondents can be categorized into three groups: supporters, neutrals and opponents. In the full sample, 6 out of 10 respondents can be considered supporters of FCHs applications, 3 out of 10 as neutral and fewer than 1 out of 10 respondents as opponents to FCH applications. There are significant differences across the seven countries. The highest percentage of supporters is found in Slovenia, Spain and Germany, and the lowest is found in United Kingdom, France and Belgium.

Supporters and opponents differ significantly in their affects, beliefs and reactions towards home FCHs and FCEVs. Both categories of respondent evaluate both hydrogen fuel cell applications in significantly different ways. Although the groups share most sociodemographic characteristics, male and younger respondents are significantly overrepresented among supporters.

Sociodemographic correlates of public attitudes towards FCH applications

The data show the existence of small but significant socio-demographic differences in public attitudes towards FCH applications. Gender and age were the sociodemographic variables associated to more dependent variables. The pattern of association was very clear for sex: male respondents reported, on average, higher levels of awareness, interest, acceptance and support relative to female respondents. The patter of association was unclear for age. Younger participants reported higher values in some of the variables, whilst older participants reported higher values for other variables. Educational level, size of residence and income were positively associated to almost half of the studied variables. Briefly, male respondents with university degrees living in cities with more than one million inhabitants and living comfortably with current income had, on average, the most favourable profile of acceptability.

The effect of information and prior attitudinal orientations

Regarding the effect of providing information on respondents' evaluation of FCEV, the data show an average non-significant increase in favourable attitude (after comparing the differences between the uninformed evaluation of FCHs and the informed evaluation of domestic FCH units and FCEV). Interestingly, the effect seems to differ between opponents and supporters: as opponents become more informed about FCH applications, their evaluation of the technology gets worse, and this variation is significantly higher than for supporters or neutrals.

Considering the previous attitudinal orientations of respondents, we find that those reporting a positive orientation towards both environment *and* towards technology tend to report a more positive evaluation of both applications, a higher level of interest and a higher self-reported likelihood of installing a home FCH or purchasing an FCEV. On the contrary, those without an orientation towards technology and the environment report a more negative attitude towards both applications, a lower level of interest and a lower self-reported likelihood of installing a home FCH or purchasing an FCEV. Those with a positive orientation to the environment *or* to technology report an intermediate attitude to both applications.

A model of public acceptance of FCH applications

Finally, a number of independent variables have an indirect effect on acceptance of home FCH and FCEV. The acceptance of both applications is influenced by the global attitude towards the applications, which in turns, is influenced by familiarity, positive affect, negative affect, the perception of benefits and costs and the preference for alternative technologies. Positive affect is the variable most strongly associated with acceptance, for both the acceptance of home fuel cell units and for the acceptance of FCEVs. Perceived benefits play a more relevant role in the acceptance of home fuel cells, whilst the preference for alternative technologies (conventional cars) plays a more relevant (though negative) role in the acceptance of hydrogen fuel cell cars. Trust, having a pro-technology belief and environmental self-identity have a positive but small effect on acceptance of both residential FCHs and FCEVs.

Discussion

Europe needs to decarbonize its economy and this requires action within the domestic and transportation sectors. Among the alternative technologies for generating low-carbon heat and electricity and to replace fossil-fuel based powertrains, residential stationary fuel cells and hydrogen fuel cell electric vehicles (FCEV) are receiving support towards commercialization. Consumer preferences and choice will likely play a role in the degree in which these applications will impact on reducing emissions and primary energy consumption. Existing public preferences may become a hurdle to a hydrogen future. Understanding attitudes and behaviours provide insights into the factors that influence how individuals and households take decisions on technologies for electricity and heat and transportation. Together with other measures, European carbon targets should be underpinned by an evaluation of the likely role of public and customer preference and choice.

Abbreviations

CSA	Coordination and Supporting Action
CHP	Combined Heat and Power
EC	European Commission
DOE	US Department of Energy
DX.Y	Deliverable X.Y
FCH	Fuel Cell and Hydrogen
FCH-JU	Fuel Cell and Hydrogen – Joint Undertaking
FCEV	Hydrogen Fuel Cell Electric Vehicle
IPR	Intellectual Property Rights
M	Mean
p	*p*-value
SD	Standard Deviation
TC	Technical Committee
WP	Work Package
WPL	Work Package Leader

1. Introduction

The public acceptance of energy policies, infrastructures and applications has become a matter of importance for governments, the energy industry and academics alike. In the energy field, although traditionally perceived as a residual question (Wüstenhagen, Wolsink, and Bürer 2007), social acceptance, and the broader process of interactions between technologies and their social environments, has increasingly come to be regarded as a one issue among others that shape the successful implementation of new developments and policies. Issues such as the lack of support among key stakeholders, reluctance among policy makers to promote effective policies, or the lack of public support can hinder the development of energy technologies. Understanding the factors that influence technology acceptance may help to improve the design of public engagement strategies that may benefit the implementation of the technology.

Among the alternative technologies to generate low-carbon heat and electricity and to replace fossil-fuel based powertrains, residential stationary fuel cells and hydrogen fuel cell electric vehicles (FCEVs) are receiving support towards commercialization. Residential fuel cells offer some important benefits over other low-carbon heating technologies, and cost reductions and financing mechanisms for the purchase or installation are bringing the technology close to commercialisation in several countries (Dodds et al., 2014; Ammermann et al., 2015). Although the technology will likely remain comparatively expensive, it is assumed that home fuel cells have mass-market potential and will have a significant impact on reducing emissions and primary energy consumption where they are deployed (Ammermann et al., 2015). The deployment of FCEVs, although still facing several challenges, is advancing worldwide; fuelling infrastructures are being deployed in several countries and auto manufacturer actions seem to confirm their commitment to keeping fuel cell technology as an option (Eberle, Müller, & von Helmolt, 2012; Air Resources Board, 2015).

Public and consumer acceptance will likely play a role in the successful adoption of hydrogen and fuel cell applications, both in the residential and the transportation sector. The future is uncertain: FCH applications might benefit from a public willingness to take up more efficient heating and transport systems, or the public may prefer other alternatives or even incumbent, fossil fuel or combustion-based technologies that might be perceived as safer, cheaper, more effective and easier to control (Dodds et al., 2014). As markets for hydrogen and fuel cell technologies develop, citizens will react in different ways to energy policies and local infrastructures deployed in their countries, regions and cities, and end-users will decide whether fuel cells fit their particular circumstances. Although these technologies are not yet present in peoples' lives, they have the potential to influence peoples' daily life and routines in the future and so will face a range of challenges in terms of social and public acceptance.

Public attitudes towards hydrogen and fuel cell technologies have received significant attention from the social sciences in the last 20 years. Available studies in different countries have examined public awareness, understanding and acceptance of hydrogen and fuel cell technologies as well as the factors that predict support and opposition. This research includes different research designs and studied populations (general public, users, population affected by hydrogen infra-

structures, selected age groups, students, and workers) and hydrogen and fuel cell applications. Generally, the available studies indicate that low levels of knowledge of - and interest in – FCH technologies coexist with relatively high levels of acceptance and support. An overview of the various conceptual frameworks and methodologies used in this research has been provided in deliverable 2.3 of Hyacinth Project as well as on various review articles (Ricci, Bellaby, and Flynn 2008; Truett and Schmoyer 2008; Yetano Roche et al. 2010).

A major challenge in research on public acceptance of FCH applications involves reliable measurement of attitudes, behavioural intentions and actual behaviours that may predict actual public reactions to these technologies. Emerging energy technologies are often not well known yet by the general public, which often produces the so-called problem of "pseudo opinions" and "non-attitude" (de Best-Waldhober and Daamen, 2006). This problem is particularly relevant in the case of some public opinion surveys. For instance, it is common that despite the fact that respondents know little or do not have a stable belief about some energy technology (like CCS, Hydrogen or nuclear fusion), they express an opinion. Consequently, their views tend to be unstable and very responsive to contextual change (de Best-Waldhober and Daamen, 2006; Fleishman et al. 2010). In recent years, a number of studies on public attitudes towards FCH technologies (P. Achterberg, 2012; N. M. A. Huijts, De Groot, Molin, & van Wee, 2013) have tried to minimize this problem by providing to respondents information (e.g. aimed to resemble information that could also be found in a newspaper article on hydrogen technology).

As part of this greater effort, the Hyacinth Project has worked to increase the understanding of cross-country differences in public awareness and attitudes about FCH applications. The vast majority of research on public acceptance of FCH applications has focused on specific countries and very few multi-country social research studies have been carried out in this area. Therefore, the primary aim of this study is to assess levels of awareness, understanding and acceptance of FCH technologies in the general public in various EU countries with different levels of market penetration and government support. Specifically, this report uses survey data to examine public attitudes towards residential fuel cell and hydrogen fuel cell electric vehicles in seven European countries: Belgium, France, Germany, Norway, Spain, Slovenia, and United Kingdom. The specific objectives of the study are:

a) To estimate in the general population indicators for: awareness, familiarity, perception of benefits and costs, global attitude, acceptance and related attitudinal dimensions regarding (1) fuel cell residential applications; (2) hydrogen fuel cell transport applications and related infrastructures
b) To identify key individual and social determinants of public awareness and acceptance of these FCH applications;
c) To report on cross-country comparisons in public awareness, attitudes and acceptance about FCH applications.

The report starts with a brief review of the available studies on public acceptance of FCH technologies. The next section provides information about the design of the research. The report then presents the findings from the study in two main sections: home hydrogen fuel cell and

hydrogen fuel cell electric vehicles. The analysis focuses on comparisons across all seven countries. The main variables are examined for the distinct dimensions included in the study: awareness, initial evaluation of FCH technologies, affects, perception of benefits and costs, evaluation of consequences, global attitude, preference over other technologies, acceptance and support. The variables are also cross-examined by age, sex, and urban/rural residence and income. Additional analyses are carried out in order to examine the determinants of public awareness and acceptance of these FCH applications. The summary and discussion section provides conclusions and implications from the study.

Social research on public acceptance of hydrogen and fuel cell technologies

In order to facilitate the discussion of the results, we classify the studies reviewed in this section according to the type of application under study: hydrogen and fuel cells technologies in general, vehicles and home applications. A broader review of the research on the social acceptance of hydrogen has been provided in deliverable 2.3.

Hydrogen and fuel cell technologies

A significant proportion of the studies on public attitudes and acceptance of hydrogen and fuel cell technologies have examined the levels of public awareness, familiarity and understanding of FCH technologies in general, as well as support to investments in hydrogen in specific countries. Survey studies at the country level with representative samples of members of the general public have been carried out by Zimmer & Welke (2012) in Germany; Zachariah-Wolff & Hemmes (2006) or Achterberg, (2014) in the Netherlands; R. Schmoyer & Cooper (2008) in USA.

The majority of studies conclude that whilst the level of knowledge about hydrogen technology is generally low, the level of support for hydrogen technology is high. Zachariah-Wolff & Hemmes, (2006), based on a sample of the Belgian population, found a low level of public knowledge about hydrogen. They also found that hydrogen was perceived as environmentally friendly and the willingness to use hydrogen was rather high. Overall, the results of this study suggest that respondents have a positive attitude towards hydrogen investments and hydrogen applications. The surveys carried out within the US Department of Energy's Hydrogen Program in 2004 and 2008 (Schmoyer, Truett, Cooper, & Chew, 2010), showed that only around 35% of the sample was able to provide a correct answer to eight questions about hydrogen technologies. The study by the DOE also found a low level of reported familiarity with hydrogen technologies. Specifically, almost 9 out of 10 individuals considered themselves "not at all familiar" or "slightly familiar" with hydrogen and fuel cell technologies. More recently, the study by Achterberg (2012), based on a representative sample of the Belgian population, found a high level of public support for investments in hydrogen technologies and for the use of hydrogen technologies in public transportation. Support to hydrogen differed based on individuals' knowledge regarding hydrogen technologies and cultural predispositions.

FCEVs

A significant part of the studies on public acceptance of hydrogen and fuel cell technologies have focused on the public reactions to fuel cell hydrogen vehicles (mainly buses and passenger cars) (see for a review Altmann, Schmidt, Mourato, & O'Garra (2003) and Yetano Roche, Mourato, Fischedick, Pietzner, & Viebahn (2010)).

Schulte, Hart, & Van der Vorst (2004), for instance, found that the response towards hydrogen vehicles was generally positive and levels of acceptance were high. Altmann et al., 2004), in a study of public perception of hydrogen buses in different locations, found that the support for hydrogen and fuel cells was generally high, that there was practically no opposition to the introduction of hydrogen fuel and hydrogen vehicles, that many people were undecided and need more information, and that hydrogen was connected to positive (environment), negative (bomb, explosive) as well as neutral associations (physical properties). Heinz & Erdmann (2008), based on a survey in eight European cities, found that a majority of citizens (68%) would support a substitution of conventional buses by hydrogen buses and only 1% would object to this, but also that a significant 31% of the sample reported being indifferent or needing more information to come to a decision concerning the substitution of conventional buses by hydrogen buses. Zachariah-Wolff & Hemmes, (2006) found that 92% of respondents would prefer to drive a hydrogen-powered fuel cell vehicle rather than a conventional car (all else being equal). The study by O'Garra, Mourato, & Pearson (2008) on the attitudes towards the introduction of H2 vehicles in London found that one third (32%) of respondents supported the introduction of H2 vehicles, and less than 1% opposed them. Reasons for opposition were all related to risk. The majority (62%) of respondents, however, said that they would 'need more information'.

More recently, Zimmer & Welke (2012) found that 79% of respondents gave a clear vote for the introduction of hydrogen powered cars. Only 4% of respondents opposed the introduction of hydrogen powered-cars. Similar results were shown in the study by Tarigan, Bayer, Langhelle, & Thesen (2012), where most part of the residents in one Norwegian region supported the introduction of hydrogen vehicles, but also that the number of supporters decreased from 2006 to 2009. Heo & Yoo (2013) measured the public's willingness to pay (WTP) for a large-scale introduction of H2FC buses in Korea and found that the majority of respondents wanted to introduce H2FC buses in a large scale regardless of their income, age, and education level. Achterberg (2014) found a strong support (77%) for the application of hydrogen technology in public transportation such as buses, as well as a generalized perception that the use of hydrogen as a fuel is good for the environment. The study also found that support to hydrogen had declined between 2008 and 2013.

Hydrogen refuelling stations

Studies in various countries have also investigated the public reactions to hydrogen fuelling stations. O'Garra, Mourato, & Pearson (2008) investigated local attitudes towards the proposed installation of hydrogen storage facilities at existing refuelling stations throughout London. Confronted with the hypothetical construction of a hydrogen refuelling facility in their local petrol station, the majority of respondents (60%) indicated that they 'needed more information'. Sup-

port levels were moderate, with a 25% of respondents supporting such a development. Only around 10% of respondents said they would oppose a proposed H2 storage development taking place at their local refuelling station. They also found that residents living very close to a proposed H2 facility were less likely to be opposed than residents living 200 to 500m away. Opposition was influenced by a lack of trust in safety regulations, non-environmental attitudes, and concerns about the existing local refuelling station.

Schmoyer, Truett, Cooper, & Chew, (2010) asked respondents about their feelings in the situation that their local gas station also sold hydrogen. A significant part (40%) of the sample that had a low level of knowledge regarding hydrogen reported not having a clear response to this. Around 50% of respondents reported feeling pleased or at ease about this scenario. Only 10% reported feeling uneasy.

The study by Thesen and Langhelle (2008) and by Tarigan, Bayer, Langhelle, & Thesen (2012) investigated acceptability of hydrogen vehicles and filling stations among residents in the Greater Stavanger area (Norway) and compared the results with the findings from a London case study. The study also compared acceptance levels among Norwegian residents living very close to the refuelling stations and those living beyond the stations' site (one sample was drawn from residents living within a 1-km circle of the location of the filling station, and one control sample was drawn from the Greater Stavanger area). The study first showed that although only just over one third were clearly in favour of the introduction of hydrogen vehicles in London, the number in Greater Stavanger was close to 60%. The key determinants of acceptability were prior knowledge and awareness of hydrogen, sociodemographic background variables and environmental knowledge. The study also showed that support for the introduction of hydrogen vehicles was greater among people living closer to the filling station than in the region as such.

Huijts, De Groot, Molin, & van Wee (2013) investigated public support to a local hydrogen refuelling facility in The Netherlands. The study found that among respondents that received information about hydrogen as a fuel, hydrogen technology, and the opinion of stakeholders, around 62% supported the installation of the infrastructure, 27% expressed a neutral attitude and 11% opposed the installation. Respondents receiving no information about hydrogen were generally more neutral (the % of neutral voters was 45%) towards the installation of a hydrogen fuelling installation. The three strongest determinants of intention to act in favor of the technology were personal norm, positive affect and the perceived effects of the technology. For intention to act against the technology these were personal norm, negative affect, and trust in the industry. In a more recent study, Huijts and van Wee (2015) found that psychological variables explained public acceptability better than the socio-demographic and spatial variables. The strongest predictors were positive affect, negative affect, expected local effects and expected societal and environmental effects.

Home fuel cells

Very few studies have investigated public or consumer acceptance of home fuel cells. In the study by Zachariah-Wolff & Hemmes (2006), respondents (a sample of the general population)

were asked to what degree they were willing to use hydrogen applications in the domestic context, including the use of hydrogen as a mixture with natural gas and domestic fuel cells as micro-CHP "all else being equal." Respondents were presented with different scenarios for the use of micro-CHP in their homes. As the authors conclude, "the general willingness to use hydrogen-fuelled micro-CHP in homes was quite high: 94% if all things remain equal with conventional boilers". Increased risk of failure was the most important factor in the evaluation. The study also found that an increase of 10% on the capital cost of installation reduced significantly willing to use (to 61%). Bellaby & Clark (2014), in a study among students visiting a "Hydrogen Research and Demonstration Centre" in the UK, also found evidences of public support to the use of hydrogen fuel cells in combined heat and power units. Students thought that, as the technology developed, people would switch to hydrogen from fossil fuel.

In the next section are detailed the main results of the present survey study.

2. Method

2.1. Design

The current study is based on survey data collected in seven European countries (Belgium, France, Germany, Norway, Slovenia, Spain and United Kingdom). A specific questionnaire to measure public attitudes towards hydrogen fuel cell technologies was developed by the research team. Participants, members of the general population aged 16 and over, were recruited from online panels in the seven countries.

2.2. Questionnaire

Following the research design established in Deliverable 3.1, a specific questionnaire was developed by the research team to assess the levels of public awareness, understanding and acceptance of hydrogen and fuel cell technologies and applications. The design of the questionnaire also aimed at building a predictive model for the acceptance of FCH technologies based on segmented responses to FCH technologies, including factors known to be relevant in this context. The perspective is social-psychological, drawing partly on a technology acceptance model (Huijts, Molin, & Steg, 2012), a model describing the causal links among the attitudinal elements that directly and indirectly affect technology acceptance (cf. Figure 1). Given the assumed unfamiliarity of the technologies and a modest questionnaire completion period of 20 minutes, in order to secure similar multi-country study response rates, the questionnaire implemented in the study mainly refers to the attitudinal path in the model. Attitude formation is here considered the most important process for influencing intention to accept and finally acceptance.

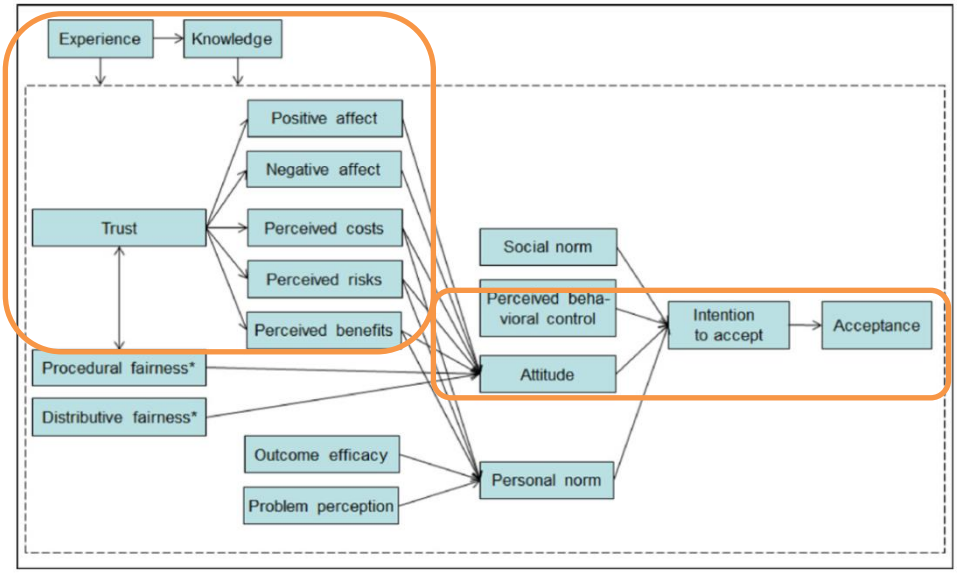


Figure 1. *Acceptance model (adapted from Huijts et al., 2012). In orange, the constructs included in the questionnaire are displayed*

Accordingly, normative concepts, behavioural control and fairness aspects were not added to the questionnaire. The fairness issues from the model are mainly relevant for acceptance of siting decisions (passive acceptance) and less for the applications under study. Normative issues were neglected as we assumed that no (accessible) norms on FCH technologies have been formed so far, thus, hence measuring these would not be a priority. Perceived behavioural control was replaced by perceived consequences, following the rationale of an informed questionnaire approach, i.e. that the first priority was to support respondents in their understanding of the broad nature of the technology.

The final questionnaire included items specifically developed by the research team to measure the various dimensions of the public acceptance of energy technologies (Huijts, Molin and Steg, 2012) as well as a selection of items from previous studies on public acceptance of hydrogen and fuel cell technologies and other energy technologies in different countries (Achterberg, Houtman, van Bohemen, & Manevska, 2010; de Best-waldhober and Daamen, 2006; Huijts, De Groot, Molin, and van Wee, 2013; Huijts, Molin, and Steg, 2012; Midden & Huijts, 2009; Truett & Schmoyer, 2008). Table 2 gives an overview of the dimensions considered in the study.

Table 2. *Dimensions included in the study and illustrative studies*

Dimension	Definition	Studies
Awareness	Degree to which individuals are conscious, know, have heard of specific technologies or developments	Zimmer and Welke (2012)
Familiarity	Subjective knowledge and familiarity with the technology	DOE survey
Experience	Direct personal contact with hydrogen applications	Zimmer and Welke (2012)
Affect	Degree in which the technology generates various emotions in participants	Midden and Huijts, 2009
Evaluation of consequences	Degree in which individuals consider potential consequences an advantage or a disadvantage	De Best-Waldhober et al., 2006
Global attitude	Personal evaluation of the technology	De Best-Waldhober et al., 2006
Acceptance and Support	Degree in which the individual accepts and supports (attitudinal and behavioural acceptance) further developments in the technology. Support for local infrastructures	Achterberg, 2014 Huijts et al. (2012)
Trust	Trust in industry and governments to make good decisions and to succeed	Midden and Huijts, 2009
Other variables	Involvement and identity in energy and environmental issues Lifestyles	Axsen et al. (2012); Whitmarsh & O'Neill, (2010)

The questionnaire was structured in the following sections: i) baseline questions; ii) awareness, familiarity, affects and beliefs; iii) evaluation of consequences; iv) global attitude, acceptance, preference and support; v) trust; vi) other questions. Sections ii, iii and iv constituted the core of the questionnaire and included a number of items designed to measure awareness, familiarity, affects, perception of benefits and costs, evaluation of consequences, attitude, acceptance and

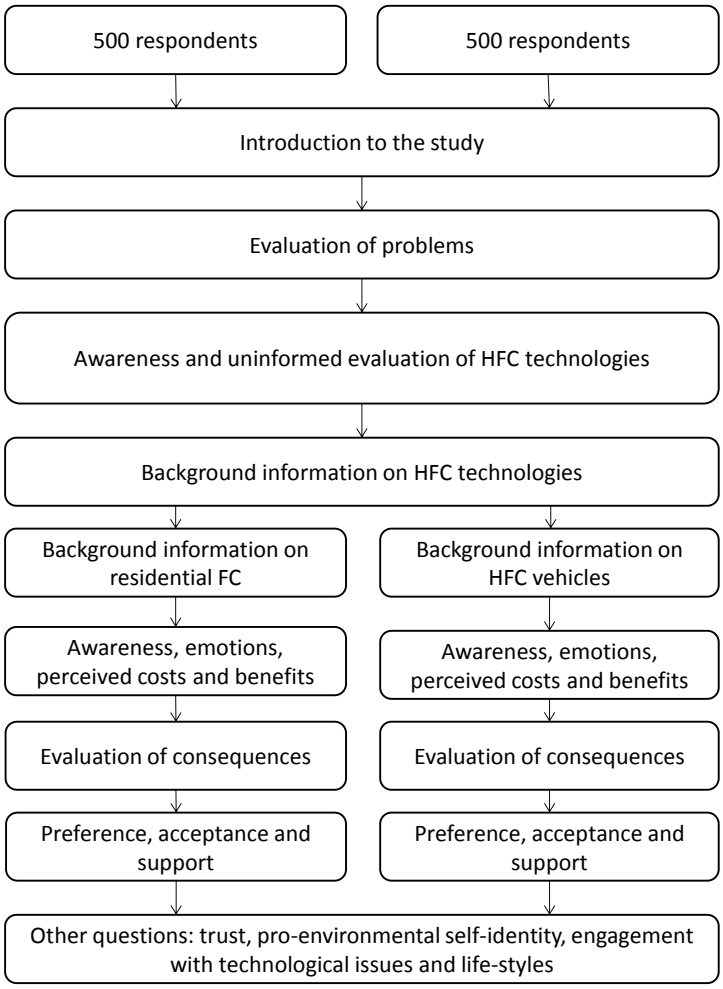
support regarding the two specific applications. More details of these analytical dimensions are provided in Table 2.

2.3. Variables

Baseline questions

All participants were first asked to evaluate a number of problems regarding energy, environmental and technological issues in terms of importance for their country. After this question, participants received a brief introduction about the study. It was explained to participants that governments and companies around the world are developing alternative methods of energy production such as hydrogen fuel cell technologies. It was also explained to them that it was therefore necessary to study the evaluation of the public regarding these applications.

Figure 2. *Questionnaire design*



After this information, participants were asked to report their level of awareness, familiarity and initial (uninformed) evaluation of hydrogen and fuel cell technologies.

Awareness, familiarity, affects and beliefs

After the baseline questions, participants in the study were randomly split into Group A and Group B. Participants in Group A (around 500 participants) evaluated stationary fuel cells for home use. Participants in Group B (around 500 participants) evaluated FCH vehicles (see Figure 2).

In each group, and before being asked the first questions, participants received neutral information regarding: a) hydrogen and fuel cells in general and; b) fuel cells for residential use or hydrogen fuel cell vehicles. This information was aimed at providing participants with the basics of hydrogen and fuel cell technologies and of the two specific applications. These informative texts were elaborated based on information collected through a number of reports and informative web-pages and reviewed by various hydrogen and fuel cell experts in the consortium.

After receiving the information about the specific application, participants were asked to answer a number of questions to measure their level of awareness and familiarity with the specific application, their affects regarding the application and the perceived costs, risks and benefits. Affects were measured by a Likert scale of response (from 1= not at all to 5= very much) using four questionnaire items. Perceived costs and benefits were measured using seven items with a differential semantic scale (from 1 to 5).

Evaluation of consequences

Participants were then provided with information regarding the potential consequences of the implementation of the specific FCH application. Each of the consequences was related to one potential benefit/cost of the application. This information was carefully designed and reviewed by experts in the consortium. Participants were then asked to rate each of the consequences in a scale from 1 to 5 (from very negative to very positive). The main objective of this exercise was to allow for an informed evaluation of the application by the participants. The exercise was inspired by the Information Choice Questionnaire method (Best-Waldhober and Daamen, 2006).

Global attitude, acceptance, preference and support

After the evaluation of the consequences, participants answered a number of questions regarding their global attitude towards the application, their level of acceptance and support (including willingness to install/buy) and their preference for the application as compared to various alternative technologies. Various specific items were included to measure acceptance and support. All items were measured on a five-point scale.

Trust

After the section on acceptance and support, four items (measured on a five-point Likert scale) were included in the questionnaire to measure levels of trust in industry and governments to (1) to make good decisions about hydrogen technologies and (2) to solve possible problems and succeed in implementing hydrogen technologies safely and in a responsible way. This measure of trust was based on Midden and Huijts (2009).

Other questions

A final section in the questionnaire included questions regarding environmental self-identity (Whitmarsh and O'Neill 2010) and involvement with issues regarding energy technologies. All items were measured on a five-point scale (1= strongly disagree to 5= strongly agree). An additional scale on lifestyles (Axsen et al. 2012) was also included.

2.4. Participants

Nationally-representative samples of approximately 1000 adults from each country took part in the online survey conducted by Norstat. The sample consisted of Norstat panel members who had agreed to participate in online market and social research. The samples were representative for the age and gender groups in each country and had an approximate distribution regarding region and education. Invitations to take part in the survey were sent to participants through the access panel system. Data was collected during April and May 2016. The socio-demographic characteristics of the sample in each country are shown in Table 1.

Table 1. *Demographic characteristics of study populations*

Sample		**BE (%)**	**FR (%)**	**DE (%)**	**NO (%)**	**SL (%)**	**ES (%)**	**UK (%)**
N (Total= 7148)		1021	1022	1011	1033	1014	1034	1013
Sex (male)		47%	48%	49%	49%	49%	49%	52%
Age group	18-34	27%	28%	23%	28%	27%	29%	28%
	35-44	18	18	18	19	19	21	18
	45-54	19	17	19	18	18	18	17
	55+	36	36	40	35	35	32	37
Education	Primary	13%	24%	0.3%	8%	5%	8%	9%
	Secondary	46	25	75	40	60	31	30
	Tertiary (or higher education)	41	51	25	52	35	61	61
Size of place of residence	<2.000	9%	21%	8%	12%	27%	6%	12%
	2.000-20.000	46	33	31	29	38	19	23
	20.001-199.999	32	27	29	35	18	31	32
	200.000-1.000.000	7	10	19	17	14	23	17
	>1.000.000	5	9	13	6	2	21	16

2.5. Analysis

The data were analysed using SPSS 19 software (SPSS, Chicago, Illinois, United States) and Excel software (Microsoft, Redmond, Washington, United States). Descriptive analyses of the relevant variables were performed for all the countries. Contingency table analyses were performed to study the relationship between responses on dependent variables and other independent variables such as age, gender, geographic region and other demographic variables. Differences in the frequencies of different survey responses were tested for significance by using a $\chi 2$ test of proportions and Anova for means, and p values below 0.01 were considered statistically significant. Multiple regression and path analyses were conducted to investigate associations among vari-

ous dependent and independent variables, with difference tests used to make cross-country comparisons.

3. Results

3.1. Hydrogen fuel cell technologies

The first section of the questionnaire was aimed at examining: a) the public perception of a set of environmental, economic and energy challenges potentially addressed by FCH technologies; b) public awareness and familiarity about FCH technologies and c) the initial or uninformed evaluation of FCH technologies. Respondents received a brief information text on the objectives of the study before answering the questions in subsections *b* and *c*. This first section of the questionnaire was presented to all participants in the study.

3.1.1. Evaluation of problems

Before introducing FCH applications to participants, we asked them to evaluate a number of challenges in terms of importance for their countries. These four problems are generally considered as challenges that the development and adoption of FCH technologies could tackle. We specifically asked for their evaluation of:

- The need to improve energy security by being less dependent on fuel imports from other countries
- The need to reduce the greenhouse gas emissions that cause climate change
- The need to reduce local air pollution in urban areas
- The need to create opportunities for national industries to increase their capability to provide innovative technologies

As shown in figure 3, the four considered challenges are rated as important or very important by the majority of participants in the seven countries. In general terms, we find significant but small differences in participants' responses across countries and across challenges. If we take into account the whole sample, the "need to reduce local air pollution" is the challenge rated as the most important (74% of the whole sample consider it an important or very important challenge, Mean= 4.0), followed by the "need to reduce the emissions of greenhouse gases" (72%, M= 3.96), the "need to improve energy security" (70%, M= 3.88) and the "need to create opportunities for national industries" (70%, M=3.87).

There are moderate differences in the evaluation of specific challenges across countries. For instance, the "need to improve energy security" produces the strongest differences across countries (Standard Deviation= 0.10), as it is rated the most important challenge in United Kingdom and the least important challenge in Germany. The "need to reduce local air pollution" is the challenge that has a more similar evaluation across countries (SD= 0.06), as it is considered the most important challenge in five of the seven countries. On average, the countries where a greater proportion of the population considers these four challenges as important or very important for their country are Slovenia (83%), France (78%) and Spain (76%). The countries where

these challenges are considered, on average, a bit less important are United Kingdom (64%) and Germany (64%).

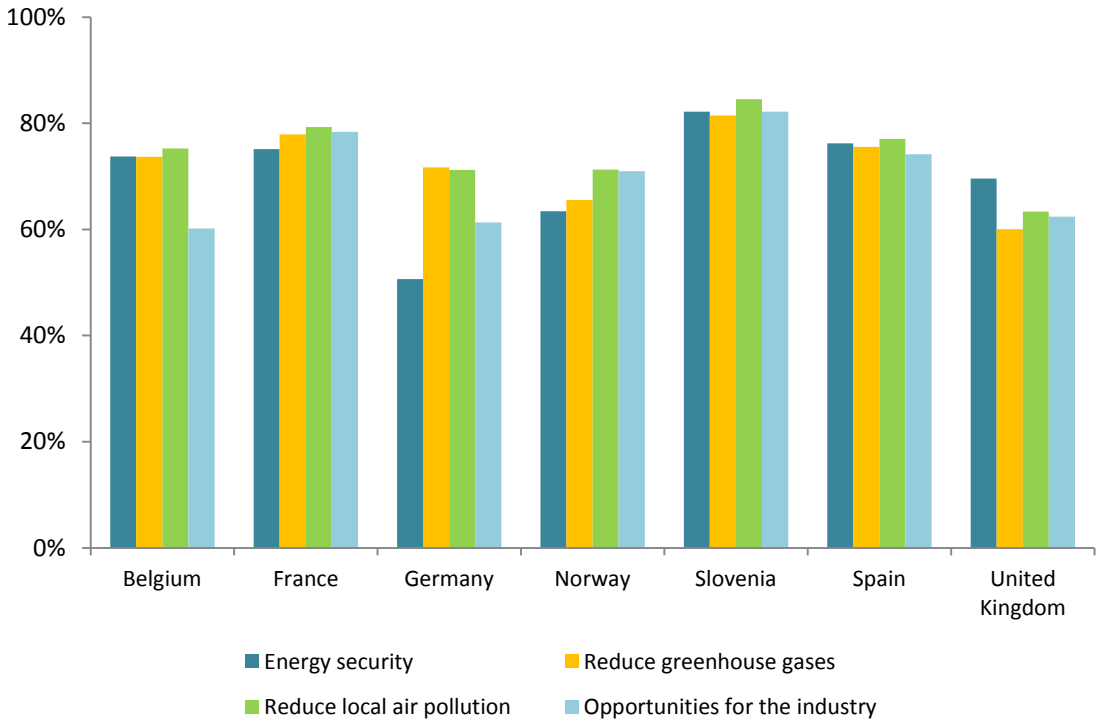


Figure 3. *Percentage of people considering the distinct challenges as important or very important*

3.1.2. Awareness

After the evaluation of problems, we provided participants with some information about the objectives of the study and introduced the concept of FCH technologies. We specifically informed respondents that: "[…] Among these potential solutions to future energy challenges, here we are focusing on hydrogen fuel cell technologies. These have various possible end-uses, such as for electricity and heat generation; automobiles, buses and other vehicles; and portable electronics". The questionnaire items following this piece of information were aimed at measuring the level of awareness and familiarity of respondents with FCH technologies.

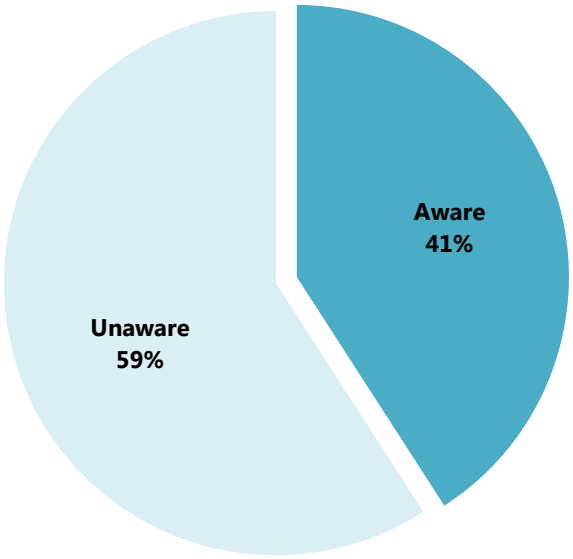


Figure 4. *Awareness of hydrogen fuel cell technologies (as % of respondents, all countries)*

Figures 4 and 5 display the level of awareness about hydrogen fuel cell technologies in the full sample and the seven studied populations. Around 40% of respondents in the full sample report having heard about FCH technologies. There are moderate but significant differences across the countries. We find the highest levels of public awareness in Germany and Norway, where almost 50% of respondents report having heard of FCH technologies in the context of energy production. Around 40% of respondents are aware of FCH technologies in Belgium, Slovenia, France and United Kingdom. Only 30% of respondents reports having heard of these technologies in Spain.

In the total sample, male respondents report significant higher levels of awareness of FCH technologies (57%) relative to females (26%). Awareness is also higher for those having a university degree (47%) relative to those not having a university degree (36%), as well as for those living comfortably with current income (51%) relative to respondents finding it difficult to live with current income (36%). There are no statistically relevant differences for age or size of residence (Table 4).

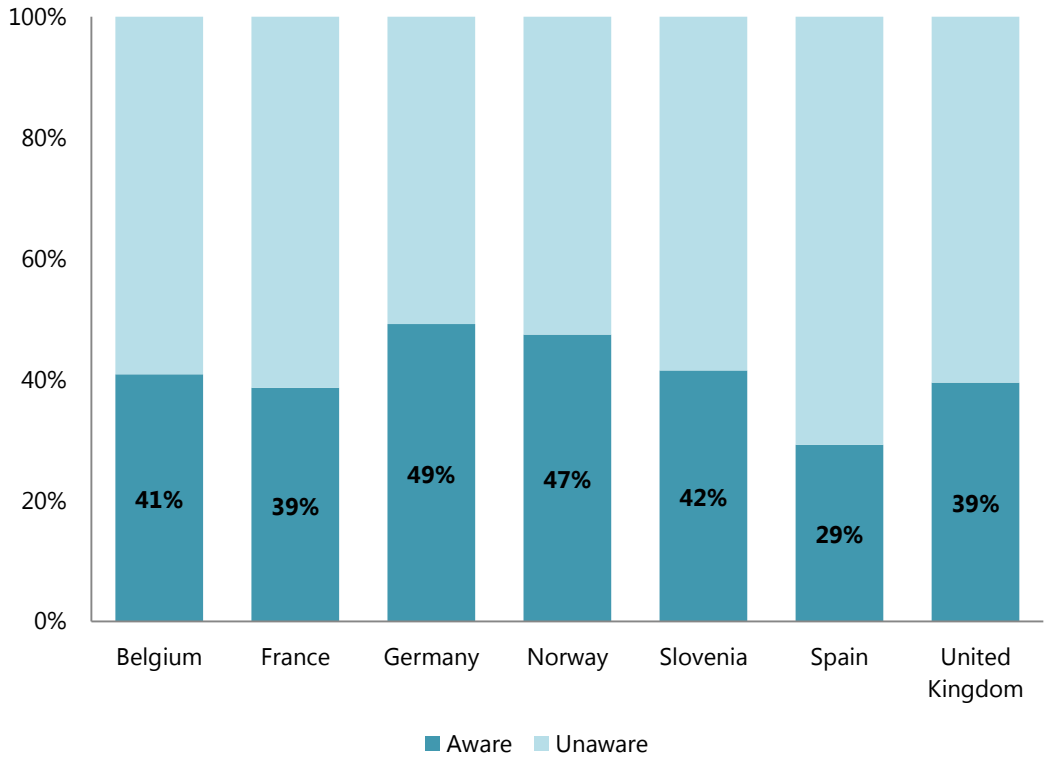


Figure 5. *Awareness of hydrogen fuel cell technologies in the seven countries (as % of respondents)*

Those having heard of FCH technologies we asked them to rate their level of familiarity with the technology. As shown in table3, the majority of participants in the seven countries (around 70%) that have heard about FCH technologies consider themselves as slightly familiar with FCHs, meaning that they have read an article or watched a television feature about the technology, or participated in a casual conversation about the technology. Only around 15% of those aware of the technology (6% of the total sample) consider themselves familiar with the technology (they had limited experience with hydrogen and fuel cell technologies, researched the subject for school, work, or personal interest, or learned about the technology in a class or workshop). The highest percentage of respondents familiarized with the technology (answers "familiar" and "very familiar") is found in United Kingdom, France and Norway (around 20% of the aware respondents, or 8% of the total sample).

Table 3. *Familiarity with FCH technologies in the seven countries (% of those that had heard before about the technology)*

	BE (%)	FR (%)	DE (%)	NO (%)	SL (%)	ES (%)	UK (%)
Not at all familiar – You know nothing about hydrogen and fuel cell technologies	16	10	18	6	9	18	12
Slightly familiar – You've heard about hydrogen and fuel cell technologies, read an article…	74	70	68	75	81	70	68
Familiar – You've had limited experience with hydrogen and fuel cell technologies, researched the subject for school…	10	17	13	17	10	10	16
Very familiar – You consider yourself an expert in hydrogen and fuel cell technologies	1	3	2	1	1	2	4
	100% (417)	100% (395)	100% (497)	100% (490)	100% (421)	100% (302)	100% (400)

When looking at the entire sample, the highest percentage of respondents familiar with FCH technologies is found in the age group 18 to 34 years (20%), among respondents living in cities with more than one million inhabitants (19%) and among those living comfortable with current income (19%) (Table 4).

Table 4. *Awareness and familiarity according to sociodemographics*

		Awareness (%)	Familiar (%)
Overall (n= 3592)		41	13
Gender	Male	57*	16*
	Female	26	8
Age	18-34	42	20*
	35-44	39	14
	45-54	42	10
	55+	41	10
Educational level	Non-university degree	36*	9*
	University degree	47	17
Size of residence	<20.000	41	11*
	20.000 – 1.000.000	43	15
	>1.000.000	40	19
Income	Finding it difficult to live with current income	36*	12*
	Coping on current income	39	11
	Living comfortably with current income	51	19

**the difference between categories is statistically significant, p<0.01*

3.1.3. Uninformed evaluation

Following the questions on awareness and familiarity, we asked participants to evaluate FCH technologies as a possible solution for energy and environmental challenges. At this stage, no information had been given about the features of FCHs. We measured respondents' evaluation of FCH technologies in a scale from 1 to 5 where 1 means a "very bad solution" and 5 a "very good solution".

Figure 6 shows the distribution of the uninformed evaluation in the total sample. The majority of respondents provide an initial neutral to positive evaluation of FCHs. Almost 6 out of 10 respondents (57%) evaluate FCHs as a good or very good solution to energy challenges. 4 out of 10 consider FCHs a neutral solution, and less than 0.1 out of 10 respondents belief that FCHs are a bad or very bad solution to energy challenges.

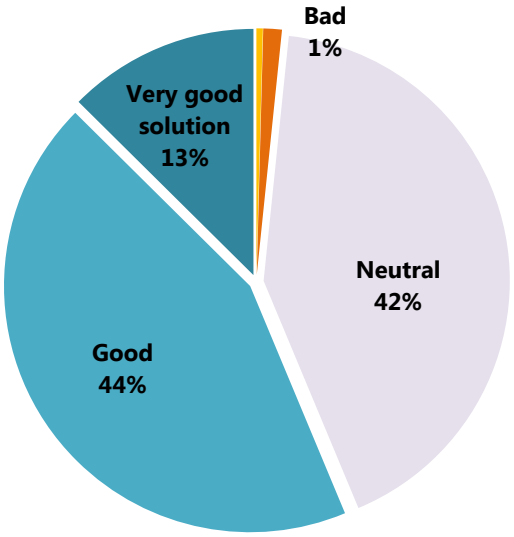


Figure 6. *Uninformed evaluation of FCHs (as %, all countries)*

In the entire sample, male respondents are slightly more positive about FCHs relative to female respondents (average evaluation of 3.80 vs. 3.54). Also respondents aged 55 years or more are more positive relative to respondents aged 18-34 (3.70 vs. 3.62) as well as those living comfortably with current income relative to those coping with current income (3.76 vs. 3.63) There are no statistically significant differences for education or size of residence (Table 5).

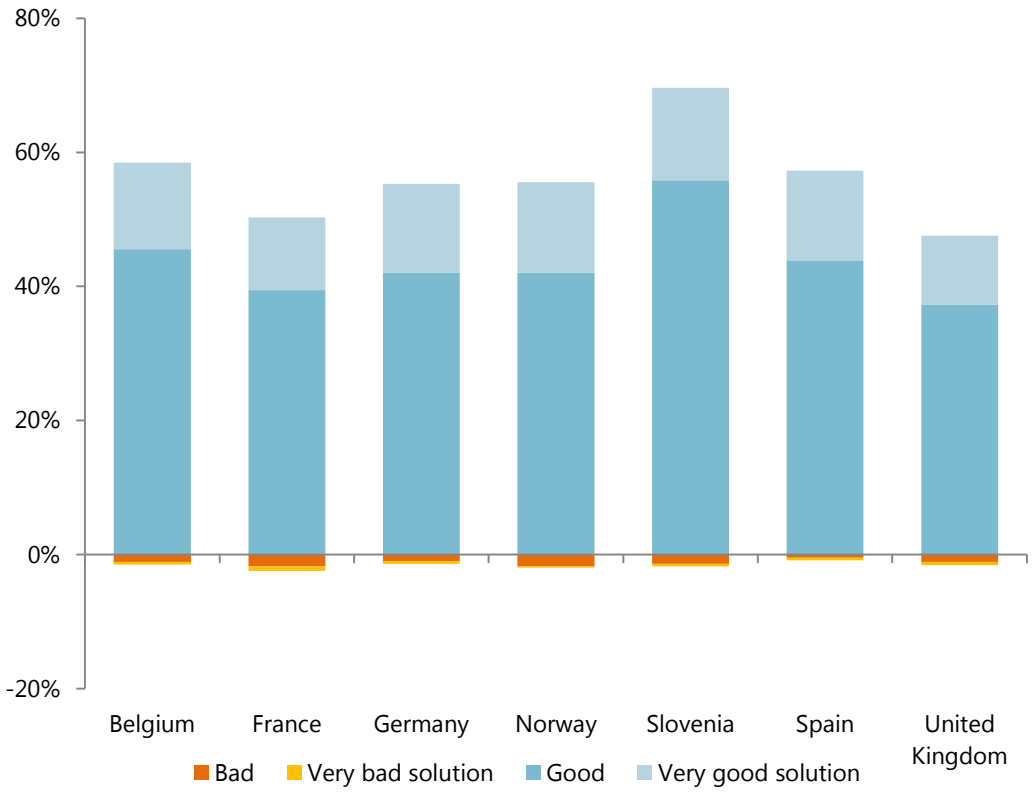


Figure 7. *Uninformed evaluation of FCH technologies in the seven studied countries (% of respondents that consider them a very bad-very good solution for energy and environmental challenges)*

There are weak but significant differences in the initial evaluation of FCH technologies across the seven countries. Figure 7 shows the distribution of the initial evaluation of FCHs in each of the seven studied populations. In order to emphasize the differences among countries, we have only graphed values 4 and 5 of (in positive) and values 1 and 2 (in negative) the scale. The average initial evaluation of FCHs ranges from 3.81 in Slovenia, where 70% of respondents consider the technology as a good or very solution and only 30% rate it as a neutral solution, to 3.56 in the United Kingdom, where 48% of respondents consider the technology a good or very good solution and 51% consider it a neutral solution.

Table 5. *Uninformed evaluation of FCH technologies according to sociodemographics*

		Uninformed evaluation (Mean)	Uninformed evaluation (% very good solution)
Overall (n=3592)		3.67	13
Gender	Male	3.80*	16*
	Female	3.54	10
Age	18-34	3.62*	10*
	35-44	3.66	12
	45-54	3.70	13
	55+	3.70	15
Educational level	Non-university degree	3.63*	12
	University degree	3.71	13
Size of residence	<20.000	3.66*	12
	20.000 – 1.000.000	3.71	14
	>1.000.000	3.69	12
Income	Finding it difficult to live with current income	3.65*	13
	Coping on current income	3.63	11
	Living comfortably with current income	3.76	15

**the difference between categories is statistically significant, p<0.01*

3.1.4. Awareness and uninformed evaluation of FCHs per country grouping

In order to examine the differences among the studied countries according to its level of hydrogen and fuel cell implementation and policy support, in this section we provide further details about the specific situation of the selected groups (as categorized in WP2 in advance, medium and low support).

Advanced policy support to hydrogen

Germany

Germany has the largest level of public awareness about FCH technologies among the seven studied countries. Almost 50% of the population reports having heard about hydrogen fuel cell technologies. Around 55% of respondents initially evaluate FCHs as a good or very good solution for energy and environmental challenges.

Norway

Norway has also a large level of public awareness of FCH technologies. Around 47% of the population reports having heard about hydrogen fuel cell technologies. 56% of respondents initially evaluate FCHs as a good or very good technological solution.

United Kingdom

Public awareness of FCH technologies is lower in the United Kingdom relative to Germany and Norway. Around 39% of the population report having heard about hydrogen fuel cell technologies in the context of energy production and transport. Uninformed evaluation of FCHs is also less positive in the UK relative to Germany and Norway, as 47% of respondents rate the technology as a good or very good option.

Medium policy support to hydrogen

Belgium

Around 41% of the population reports having heard about hydrogen fuel cell technologies in the context of energy production and transport in Belgium. The initial evaluation of the technology among the Belgian population is very positive (59% rate it as a good or very good option)

France

Around 39% of the population reports having heard about hydrogen fuel cell technologies in the context of energy production and transport in France. The uninformed evaluation of the technology is slightly less positive than in Germany and Norway, Belgium and Spain, as 50% of respondents rate it as a good or very good option.

Spain

Public awareness of hydrogen and fuel cell technologies is relatively low in Spain. Only around 29% of the population reports having heard about hydrogen fuel cell technologies in the context of energy production and transport in Spain. This level of awareness is 10 percentage points lower than in Belgium and France and almost 20 percentage points lower than Germany or Norway. Around 57% of respondents initially rate FCHs as a good or very good solution for energy and environmental challenges.

Low policy support to hydrogen

Slovenia

Public awareness of hydrogen and fuel cell technologies in Slovenia is very similar to other countries. Around 42% of the population reports having heard about hydrogen fuel cell technologies in the context of energy production and transport. The global evaluation of FCHs is very positive in Slovenia (around 70% of respondents rate the technology as a good or very good solution).

Awareness and evaluation

The figure below displays the position of the seven countries given their level of awareness and their average uninformed evaluation. The data show that Norway and Germany have a similar position in terms of public awareness and initial evaluation. Belgium and Spain have a similar uninformed evaluation but a lower level of awareness than Germany and Norway. France and UK share a similar level of awareness and uninformed evaluation. Both are relatively distant to Norway and Germany. Slovenia shows a particular pattern, with a higher level of uninformed evaluation.

Figure 8. *Representation of the seven countries according to uninformed evaluation and prior awareness*

3.2. Stationary applications

This section provides an overview of the public awareness, attitudes and acceptance of residential stationary fuel cells. Prior to answering to the questions respondents were shown two one-page factsheets providing basic information on stationary residential fuel cells (see the questionnaire in the annex). At this stage, no information on the consequences of the technology (e.g. cost, electricity consumption, etc.) had been given to respondents.

3.2.1. Awareness

The level of public awareness about stationary residential hydrogen fuel cells is very low in the seven studied populations. Only around 25% of respondents report having heard about residential stationary fuel cells (this is 15 percentage points lower than the level of awareness of FCHs in general). And less than 5% consider themselves knowledgeable about this application.

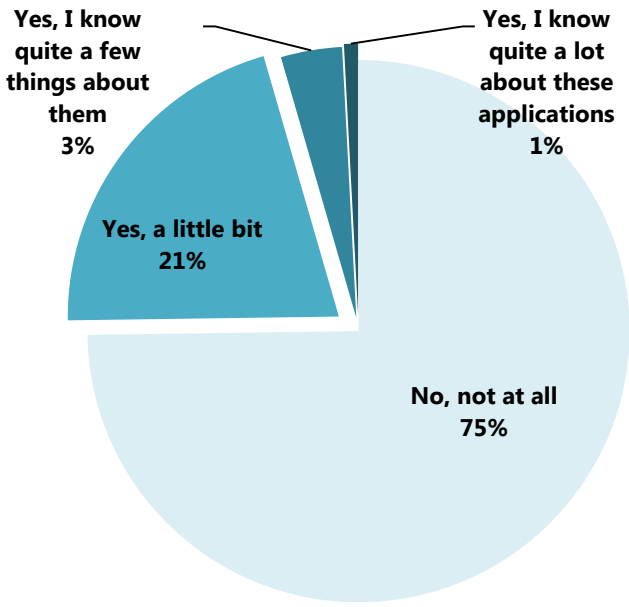


Figure 9. *Awareness of residential hydrogen fuel cells (in %, all countries)*

There are very small differences among the studied populations. The level of awareness (categories "yes, a little bit" to "yes, I know quite a lot about these applications") ranges from 32% in Germany to 20% in Norway. Generally, awareness of residential fuel cells is low in the seven countries (Figure 10).

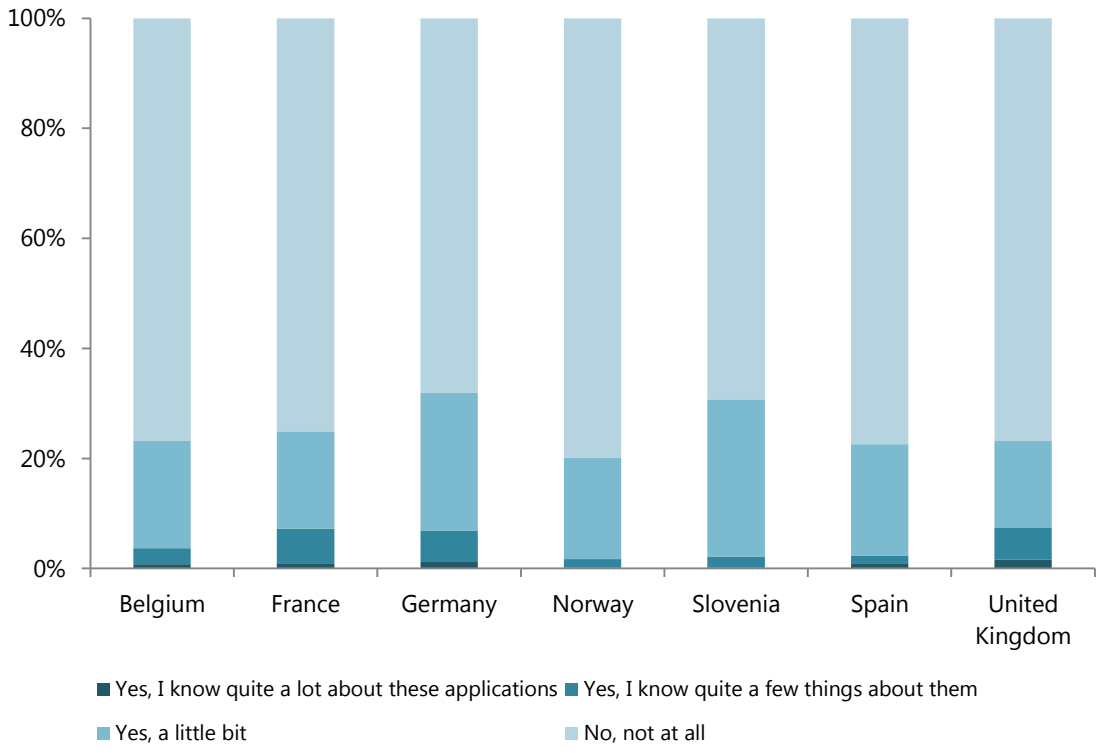


Figure 10. *Awareness of residential hydrogen fuel cells in the seven studied countries (in %)*

Male respondents report significant higher levels of awareness of residential fuel cell micro-CHP (33%) relative to females (18%). Awareness is also higher for the age group 18-34 (31%) compared to the older participants, as well as for those having a university degree (28%) and for those living comfortably with current income (29%). There are no relevant differences for size of residence (Table 6).

Table 6. *Awareness according to sociodemographics*

		Awareness (% have ever heard)
Overall (n=3592)		25
Gender	Male	33*
	Female	18
Age	18-34	31*
	35-44	25
	45-54	21
	55+	23
Educational level	Non-university degree	23*
	University degree	28
Size of residence	<20.000	25
	20.000 – 1.000.000	26
	>1.000.000	28

Income	Finding it difficult to live with current income	24*
	Coping on current income	24
	Living comfortably with current income	29

**the difference between categories is statistically significant, p<0.01*

3.2.2. Affect

In order to examine the potential emotional responses of individuals to home hydrogen fuel cells, we asked respondents to what extent the technology, as presented in the information fact-sheet, evoked the following feelings: worry, aversion, hope and interest.

In a scale from 1 to 5, where 1 means "not at all" and 5 means "very much", respondents in the seven countries report, on average, a mid-high level of interest (M= 3.73) and hope (3.57) regarding home fuel cells. Respondents also report an average level of worry of 2.42 and of aversion of 2.09. Specifically, 60% of participants report feeling somewhat or very much interest in the technology, 54% report feeling somewhat or very much hope, 15% report feeling somewhat or very much worry and 11% report feeling somewhat or very much aversion. Figure 11 presents the average score for the total sample in each of the four scales.

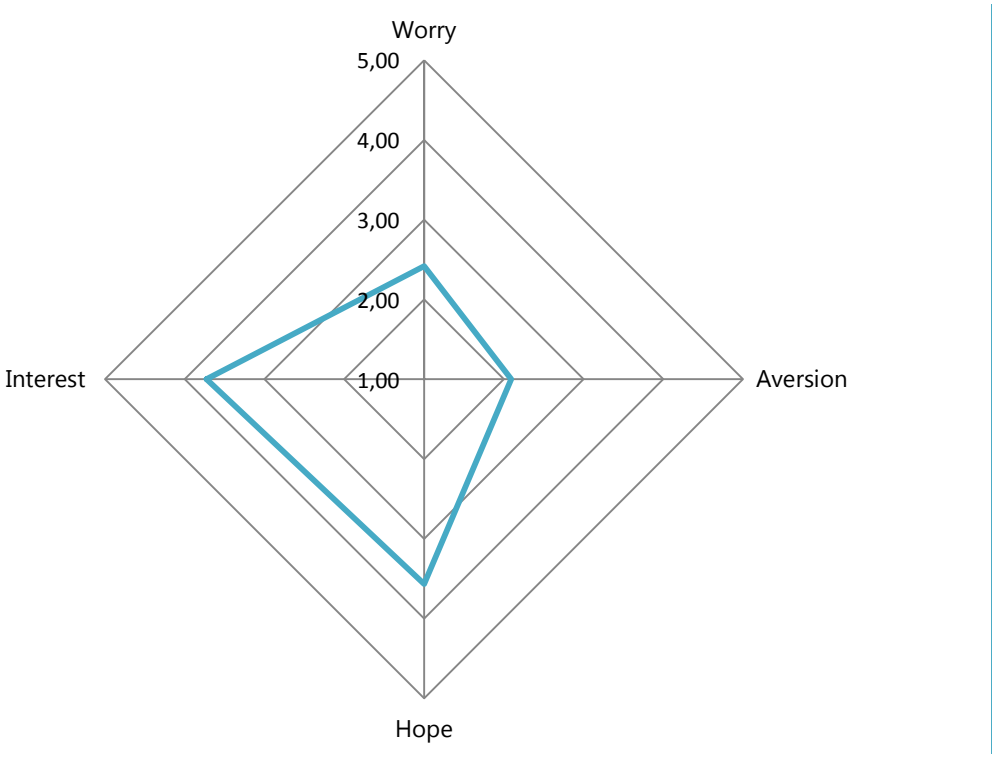


Figure 11. *Affect associated to residential hydrogen fuel cells (mean value, all countries)*

	BE (M)	FR (M)	DE (M)	NO (M)	SL (M)	ES (M)	UK (M)	Total (M)	Differences (eta)
Worry	2.5	2.5	2.3	2.2	2.4	2.6	2.4	2.42	0.14
Aversion	2.1	2.3	1.9	1.9	2.0	2.2	2.3	2.09	0.14
Hope	3.4	3.6	3.5	3.4	3.8	3.7	3.4	3.57	0.13
Interest	3.5	3.6	3.7	3.7	4.0	4.0	3.6	3.73	0.16

Male respondents (3.84), respondents aged 55 or more (3.82) and those living in cities with more than one million inhabitants (3.88) report, on average, more interest relative to the other sociodemographic categories. Feelings of worry associated to the technology are higher among participants aged 18-34 (2.53) and those finding it difficult to live with current income (2.56) (Table 7).

There are weak but significant differences across countries in the affects associated to home FCHs. For instance, self-reported interest is higher in Spain and Slovenia (4.0) and lower in Belgium (3.5). Worry is higher in Spain (2.6) and lower in Norway (2.2). As shown by the eta coefficient, differences among countries are slightly higher regarding interest relative to hope or worry.

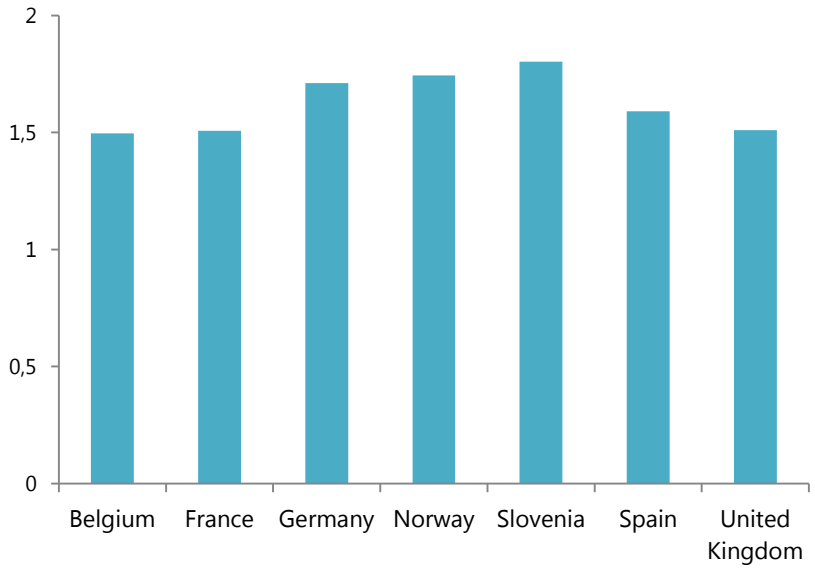


Figure 12. *Ratio between average positive and negative affect in the seven countries*

Figure 12 shows the ratio between positive (hope and interest) and negative (worry and aversion) affect in the studied populations. The ratio is higher than 1 in the seven countries, meaning that positive affect is more prevalent than negative affect. The countries with higher ratios are Slovenia, Norway and Germany. The countries with lower ratios of positive to negative affect are Belgium, United Kingdom and France.

Table 7. *Interest and worry according to sociodemographics*

		Interest (Mean)	**Worry (Mean)**
Overall (n=3592)		3.73	2.42
Gender	Male	3.84*	2.39
	Female	3.62	2.44
Age	18-34	3.63*	2.53*
	35-44	3.62	2.47
	45-54	3.80	2.42
	55+	3.82	2.30
Educational level	Non-university degree	3.66*	2.41
	University degree	3.80	2.42
Size of residence	<20.000	3.73	2.42
	20.000 – 1.000.000	3.74	2.41
	>1.000.000	3.88	2.45
Income	Finding it difficult to live with current income	3.67	2.56*
	Coping on current income	3.73	2.39
	Living comfortably with current income	3.80	2.28

**the difference between categories is statistically significant, p<0.01*

3.2.3. Beliefs about costs and benefits

Figure 13 displays the beliefs about the potential benefits and costs of a home hydrogen fuel cell unit. In general, respondents perceive home fuel cell micro-CHP to be slightly beneficial, that is, perceived benefits outweigh perceived costs. Generally, respondents belief that home FCs will have a positive effect on the environment (M= 3.9 in a scale from 1 to 5, being 1 the negative pole and 5 the positive pole), will be moderately user friendly (3.6), convenient (in terms of noise, vibration, specific location) (3.5), and safe (3.4). Respondents have less positive beliefs about the costs of the installation (2.9), the cost to run the installation (3.2) and maintenance (3.3). The most important perceived benefit is, so, that home FCHs might have a positive effect on the environment, while main perceived cost is the cost of purchasing and installing the system.

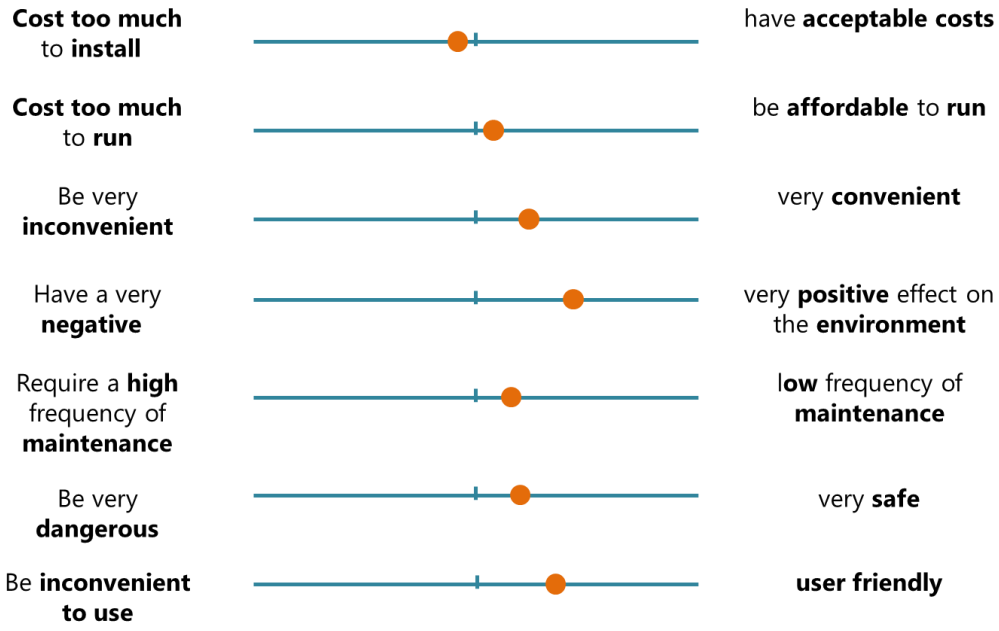


Figure 13. *Perception of benefits and costs associated to residential hydrogen fuel cells (mean value)*

	BE (M)	FR (M)	DE (M)	NO (M)	SL (M)	ES (M)	UK (M)	Total	Difference (eta)
Cost too much to install--have acceptable costs	2.7	3.0	2.9	2.9	2.9	2.8	2.8	2.9	.073
Cost too much to run-- be affordable to run	3.0	3.3	3.2	3.2	3.4	3.0	3.3	3.2	.109
Be very inconvenient (in terms of noise, vibration, specific location)--very convenient	3.4	3.6	3.6	3.2	3.7	3.4	3.5	3.5	.138
Have a very negative--very positive effect on the environment	3.8	3.9	4.1	3.8	3.9	3.7	3.9	3.9	.096
Require a high frequency	3.2	3.4	3.4	3.1	3.4	3.2	3.2	3.3	.092

of maintenance--low frequency of maintenance									
Be very dangerous--very safe	3.4	3.4	3.5	3.3	3.5	3.3	3.4	3.4	.068
Be inconvenient to use--user friendly	3.6	3.8	3.8	3.4	3.8	3.5	3.7	3.6	.122
Total	3.3	3.5	3.5	3.3	3.5	3.3	3.4	3.4	

There are weak but significant differences across countries in the perception of benefits associated to home FCH. Home FCH are perceived as having more benefits in Germany (3.5), France (3.5) and Slovenia (3.5), whilst respondents in Belgium, Norway and Spain (3.3) are, on average, more negative about the potential costs-benefits of home FCs. The seven studied populations differ somewhat in their perception of how convenient (in terms of noise, vibration, specific location) home fuel cells would be (eta= 0.14). They are very similar in their perception of how safe or dangerous FCHs could be as well as in terms of the costs associated with installing the fuel cells (eta= 0.07).

Not all participants have a stable belief about the potential benefits and costs associated with residential micro CHP hydrogen fuel cells. The figure below displays the percentage of respondents per country not providing an answer in the question about perceived benefits and costs of home FCH. The prevalence of "don't know" ranges from 12% in Germany to 25% in Norway. A significant proportion of the sample is, therefore, unsure about the potential benefits and costs of home FCH units.

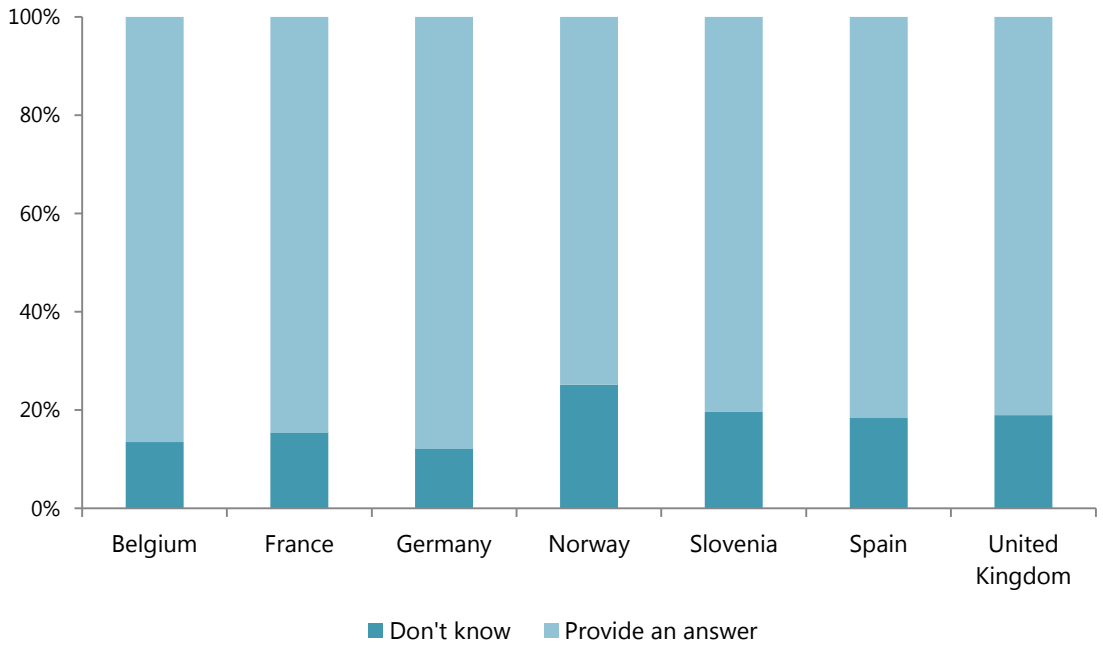


Figure 14. *Prevalence of don't know answers regarding benefits and costs of residential hydrogen fuel cells (as % of respondents per country)*

3.2.4. Evaluation of consequences

Table 8 shows respondents' evaluation of distinct consequences associated to residential FCHs. Six consequences regarding the potential impacts of installing residential FCHs were introduced to study participants by presenting them a short text for each consequence (see Figure 15). Then, respondents were asked to evaluate, in a scale from 1 to 5, where 1 means very negative and 5 means very positive, each of the consequences.

The data show that the three consequences evaluated as the most positive are the fact that "it will reduce the cost of producing energy" (86% of participants rate it as a positive or very positive consequence, M= 4.3), that it "would reduce CO_2 emissions" (86%, M= 4.3) and that they would reduce the need to purchase electricity from the power company (85%, M= 4.2). The "house space requirements" and the "potential risks" are, on average, rated as not important-positive consequences (M= 3.8 and 3.2 respectively). The initial capital costs is rated as a negative-neutral consequence (M= 2.6).

In terms of agreement between participants, we find that the three consequences rated as more positive (reduction of the need to purchase electricity, CO_2 emissions and lower cost of energy production) generate a greater degree of agreement (SD= 0.82 and SD=0.84). Participants agree less on their evaluation of the house space requirements and the risks of the installation (SD= 1.10). The initial capital costs is the consequence generating a lower degree of agreement between participants (SD= 1.26) (Table 8).

Table 8. *Evaluation of consequences for residential hydrogen fuel cells (in % and mean, all countries)*

	Very negative (1)	Negative (2)	Not important (3)	Positive (4)	Very positive (5)	M	SD
They would reduce the need to purchase electricity from a power company	1%	3%	11%	46%	39%	4.18	0.82
They would reduce CO_2 emissions	1	2	11	39	47	4.29	0.82
Initial capital costs	25	27	19	22	7	2.59	1.26
House space requirements	2	13	23	31	31	3.75	1.10
It will reduce the cost of producing energy	1	3	10	38	49	4.30	0.84
Similar risks to other fuels	6	24	24	34	12	3.21	1.11

In terms of differences between countries in the evaluation of the consequences, we find significant but small differences, with the exception of the evaluation of the consequence "house space requirements" (eta= .272), which generates higher differences between the countries.

Taking into account all the consequences evaluated, there is a more positive general evaluation of the consequences in Germany (M= 3.86) and Slovenia (3.89) and a more negative evaluation in Norway (3.61) and United Kingdom (3.63).

Table 9. *Evaluation of consequences for residential hydrogen fuel cells (mean per country and consequence)*

	BE (M)	FR (M)	DE (M)	NO (M)	SL (M)	ES (M)	UK (M)	Difference (eta)
They would reduce the need to purchase electricity from a power company	4.21	4.13	4.27	4.08	4.32	4.22	4.07	.108
They would reduce CO_2 emissions	4.26	4.20	4.41	4.23	4.44	4.28	4.19	.111
Initial capital costs	2.55	2.75	2.64	2.59	2.55	2.43	2.63	.073
House space requirements	3.67	3.69	4.19	3.57	4.22	3.48	3.43	.272
It will reduce the cost of producing energy	4.27	4.22	4.47	4.17	4.50	4.28	4.19	.144
Similar risks to other fuels	3.35	3.15	3.20	3.00	3.33	3.19	3.28	.101
Average	3.72	3.69	3.86	3.61	3.89	3.65	3.63	

Figure 15 displays the average score obtained by each consequence and the correlation between this assessment and the subsequent global attitude towards home FCHs (see next section for an analysis of the global attitude or evaluation of home FCHs) . The closer to 1 in the correlation coefficient indicates that the evaluation of the consequence is associated, to a greater extent, to the overall attitude towards the application; while values close to 0 in the coefficient indicate that the evaluation of the consequence is not related to the overall assessment of technology.

All the consequences have a moderate to medium association with the overall evaluation of the application. But there are significant differences between the consequences. The "reduction in the need to purchase electricity" is considered a positive consequence and it is the most highly associated with the global attitude (rho= .43), followed by "the reduction in CO_2 emissions" (rho= 0.42) and "the reduction in the cost of producing energy" (rho= 0.42). So the fact that a home FCH would reduce the need to purchase electricity from energy companies is the most influential factor in forming individuals' attitude towards the application. On the other hand, the consequence regarding the "initial capital costs" is more weakly associated (0.27) to the global evaluation, which means that this factor plays a less relevant role in forming the attitude towards the application, whilst the risks and the space requirements are moderately associated (0.36 and 0.39 respectively).

Interestingly, as shown in Table 10, the importance of each of the consequences changes significantly if we consider the correlation with the self-reported likelihood of installing a home FCH, relative to the correlation with the global attitude. The "initial capital cost" is the factor most

highly associated (rho= 0.37) with the reported likelihood of purchasing a home fuel cell, whilst it is the least correlated factor with global attitude (rho= 0.27). On the other hand, the "reduction in CO_2 emissions" is moderately associated (0.41) to the global attitude, but plays a weaker role in the likelihood of installing a home fuel cell (rho= 0.17). This means that the distinct consequences of residential FCHs, and their evaluation by participants, have a different effect on individuals' attitude towards the application than on individuals' self-reported likelihood of installing a home fuel cell. Individuals' evaluation of the technology is somehow independent of the price of purchase, whiles this factor plays a key role in self-reported likelihood of purchasing a home fuel cell

Table 10. *Correlation between the evaluation of the consequences, the global evaluation of residential hydrogen fuel cells and self-reported likelihood of installing a residential FCH (in Spearman Rho)*

	Global evaluation of residential FCHs	Self-reported likelihood of installing a residential FCH
They would reduce the need to purchase electricity	,430	,222
They would reduce CO_2 emissions	,416	,168
Initial capital costs	,270	,377
House space requirements	,393	,268
It will reduce the cost of producing energy	,418	,168
Similar risks to other fuels	,366	,346

	Mean evaluation (1 – 5)	Correlation (Rho) (- 1 a 1)	Global attitude towards home FCH units (1 – 5)
They would reduce the need to purchase electricity from a power company Combining the production of on-site local heat with local electricity generation to meet on-site energy needs for both can save around 25% of the primary energy needed. **They would reduce CO_2 emissions** A typical fuel cell micro combined heat and power system, using natural gas as the hydrogen source and comprising a fuel cell unit–and hot water tank, can reduce CO_2 emissions by up to 50% compared to the separate generation of heat and power. **High initial capital costs** As of December 2012, Panasonic and Tokyo Gas Co., Ltd. sold Ene-Farm units (full cell units that convert natural gas to heat and electricity) in Japan for a price of around 20.000 € before installation. **House space requirements** Installing a domestic fuel cell micro-CHP system requires around 0.65 m2 (about the size of fridge freezer). **It will reduce the cost of producing energy** Operating costs for home fuel cells can be as low as 10 cents per kWh for electricity. Residential systems are advertised by their manufacturers as reducing household bills by 450-1000 euros per year. **Similar risks to other fuels** Like any other fuel, hydrogen poses risks if not properly handled. Some of the properties of hydrogen make it potentially less hazardous than natural gas, petrol and diesel, while other characteristics make it more dangerous in particular situations. Specific precautions, such as good venting, need to be in place for hydrogen just as for many other fuels.			

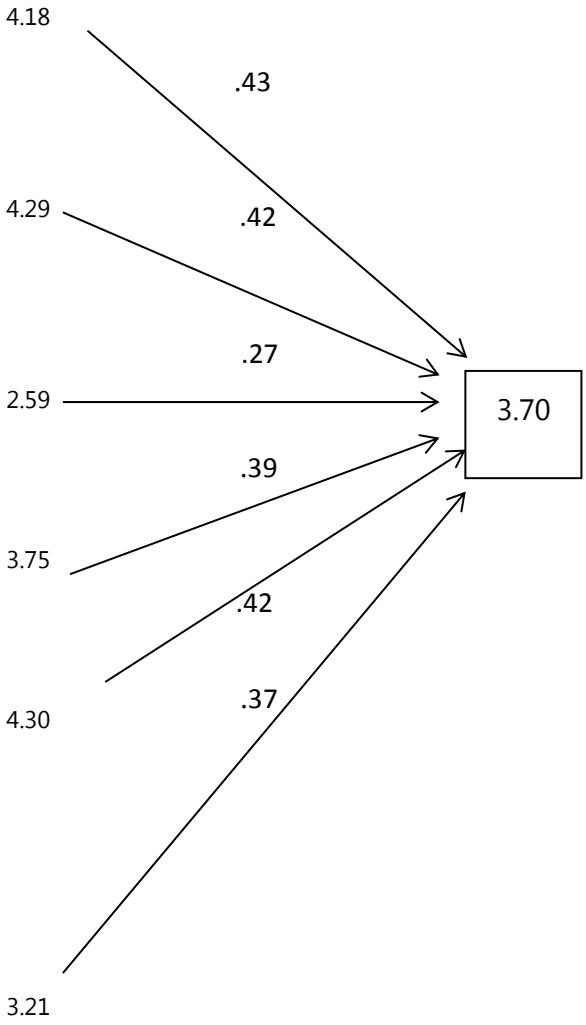


Figure 15. *Evaluation of consequences of residential fuel installations*

Figure 16 shows other potential consequences that respondents attribute to residential hydrogen fuel cells and that they consider also relevant. These potential consequences were raised by participants from an open question.

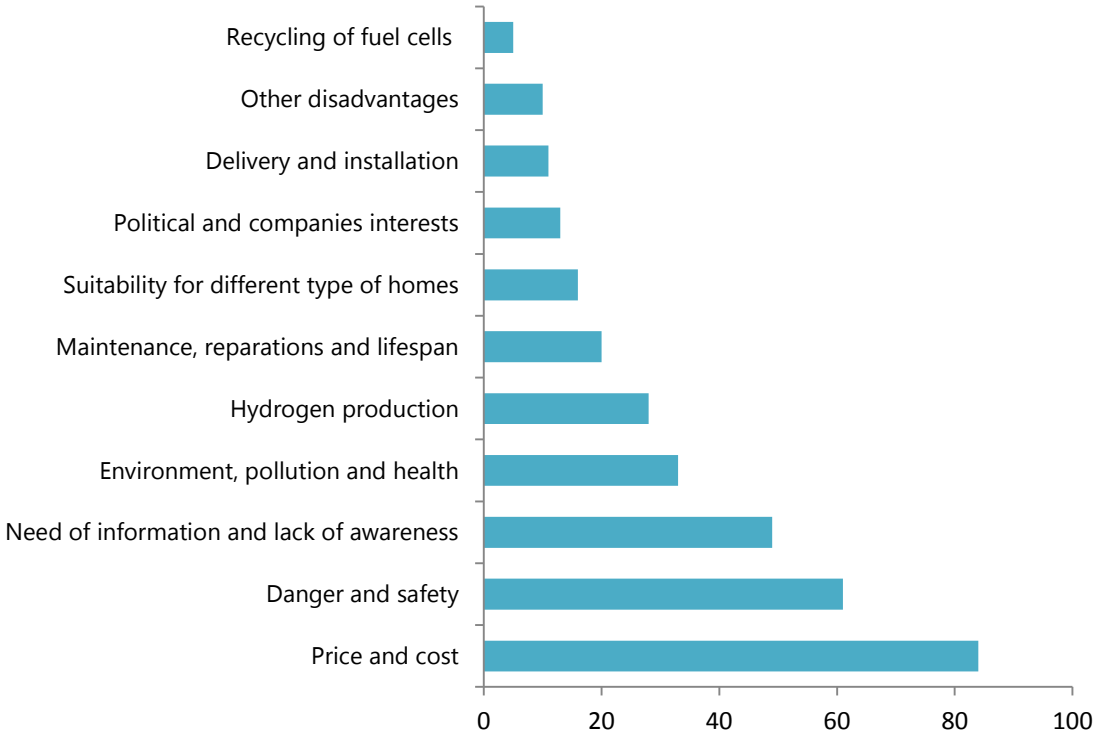


Figure 16. *Other consequences/attributes of home hydrogen fuel cells raised by respondents (in number of times mentioned)*

The majority of issues raised by respondents are related to the price of the home fuel cell unit and safety (see the Annex for details). Respondents generally consider the price of the fuel cell unit as too high for a home. The second consequence most frequently raised by respondents is related to the potential risks associated with handling the hydrogen in a residential context. The majority of respondents pointing out to this consequence tend to express worry about the risks associated with the technology. The third most mentioned consequence regarding residential fuel cells has to do with the lack of information and experience with the technology. Some respondents refer to their lack of specific knowledge and lack of experience about the application as something limiting their capacity to provide an evaluation of the technology. The fourth consequence is related to the environmental impacts, positive for the majority of respondents, of home fuel cells. The fifth most mentioned attribute is related to the production of hydrogen. Some participants are concerned about the production of hydrogen via natural gas. They perceive it as a dependence on fossil fuels and big energy companies. Other consequences mentioned by participants include the maintenance of the fuel cell units, the suitability for different types of homes, the often perceived as spurious interests of governments and companies, issues of installation and delivery and the recycling of fuel cells.

3.2.5. Global evaluation

After the evaluation of the various consequences of home fuel cells, we asked participants to provide their overall informed evaluation of home FCH units as a heating and electricity source. This can also be considered as a measure of the global attitude towards residential fuel cells.

Figure 17 displays the distribution of the informed evaluation in the whole sample. Generally, respondents have a positive attitude towards home FCHs. The average evaluation of home FCHs in the total sample is 3.7 in a scale of 1 to 5. Around 60% respondents consider the technology a good or very good solution; 30% rate it as an acceptable option; and less than 10% consider it a bad or very bad option.

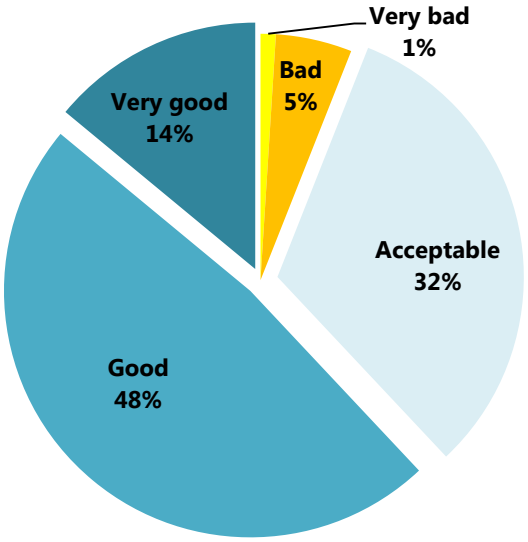


Figure 17. *Global evaluation of residential hydrogen fuel cells (as % of respondents that consider them a very bad-very good solution)*

Male respondents and those 55 ages or older report a more positive evaluation of residential FCHs, relative to female respondents (3.76 vs. 3.64) and those aged 35-44 (3.77 vs. 3.63). The informed evaluation of residential FCHs does not vary significantly by educational level, size of place of residence or income (Table 11).

There are small but significant differences across the countries studied (Figure 18). In all the countries surveyed we find that the majority of the population rates the technology as a good option (percentages range from 40% and 53%), followed by those who rate it as acceptable (from 27% to 36%; percentage not displayed in the figure). The distribution of the attitude is, in a way, very similar in the seven studied populations. But on average, the attitude towards home fuel cells is more positive in Slovenia (average in the scale of 3.84), Spain (3.79) and Germany (3.78) and more neutral in Norway (3.48) and United Kingdom (3.62).

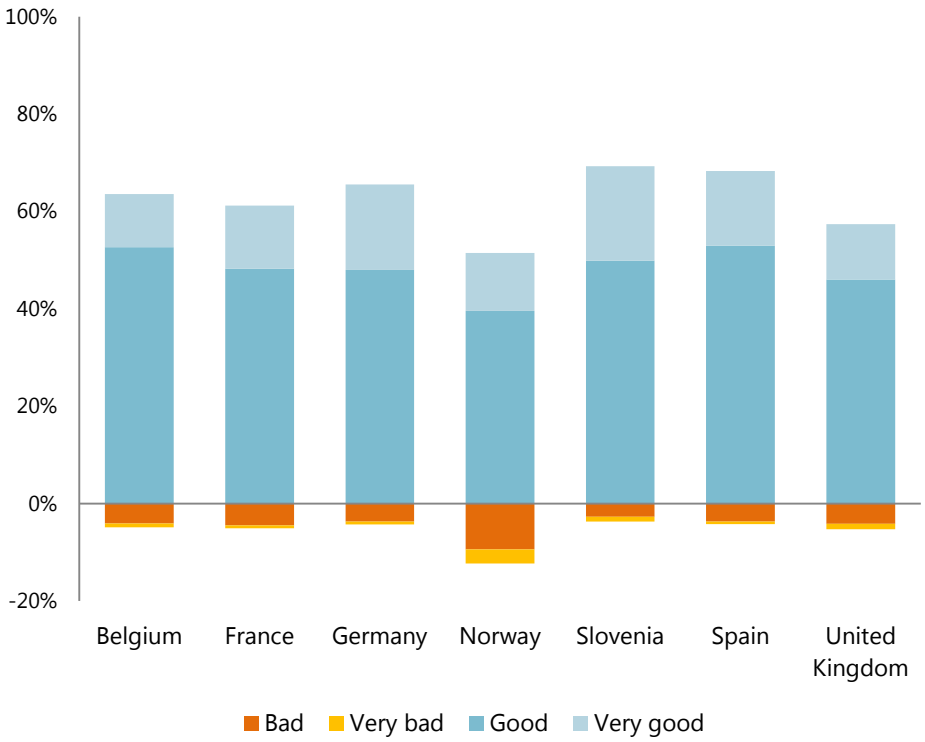


Figure 18. *Global evaluation of residential hydrogen fuel cells in the seven countries (% of respondents that consider them a very bad-very good option)*

	BE (%)	FR (%)	DE (%)	NO (%)	SL (%)	ES (%)	UK (%)	Total (%)	Difference (eta)
Very bad	1	1	1	3	1	1	1	1	
Bad	4	5	4	9	3	4	4	5	
Neutral	32	34	30	36	27	27	37	32	
Good	53	48	48	40	50	53	46	48	
Very good	11	13	18	12	19	15	11	14	
Total	100%	100%	100%	100%	100%	100%	100%	100%	
Mean	3.69	3.68	3.78	3.48	3.84	3.79	3.62	3.70	0.14

Table 11. *Informed evaluation of home FCHs according to sociodemographics*

		Informed evaluation of home FCHs (Mean)	Informed evaluation of home FCHs (% very good)
Overall (n=3592)		3.70	14
Gender	Male	3.76*	17
	Female	3.64	12
Age	18-34	3.64*	11
	35-44	3.63	12
	45-54	3.70	15
	55+	3.77	18
Educational level	Non-university degree	3.71	15
	University degree	3.69	13
Size of residence	<20.000	3.71	14
	20.000 – 1.000.000	3.70	14
	>1.000.000	3.76	17
Income	Finding it difficult to live with current income	3.69	15
	Coping on current income	3.68	12
	Living comfortably with current income	3.74	16

**the difference between categories is statistically significant, p<0.01*

3.2.6. Preference for other technologies

In order to understand the preference for FCHs applications compared to other heat and electricity systems, we asked respondents to rate a set of alternative technologies (solar thermal, biomass boilers, ground source heat pumps, electric heat pumps and gas boilers) as a worse, about the same or a better option than FCHs.

The data show that respondents generally express a preference for FCHs relative to more traditional technologies such as gas boilers but also a preference for renewable systems, specifically for solar thermal, relative to fuel cell units. As shown in the figure below, respondents in the whole sample report a preference for FCHs relative to gas boilers (ratio of those who consider it a better option versus those who consider it a worse option of 0.31) and electric heat pumps (ratio of 0.82). Biomass boilers are equally preferred by participants (ratio of 1). On the other hand, ground source heat pumps (ratio of 2.6) and solar thermal (ratio of 5.38) are preferred options, relative to micro FCHs. It is important to outline, however, that the percentage of respondents that do not have a clear opinion on this (don't know option) is significant (from 17% for the comparison between solar and FCHs to 32% for the comparison with biomass) (Figure 19).

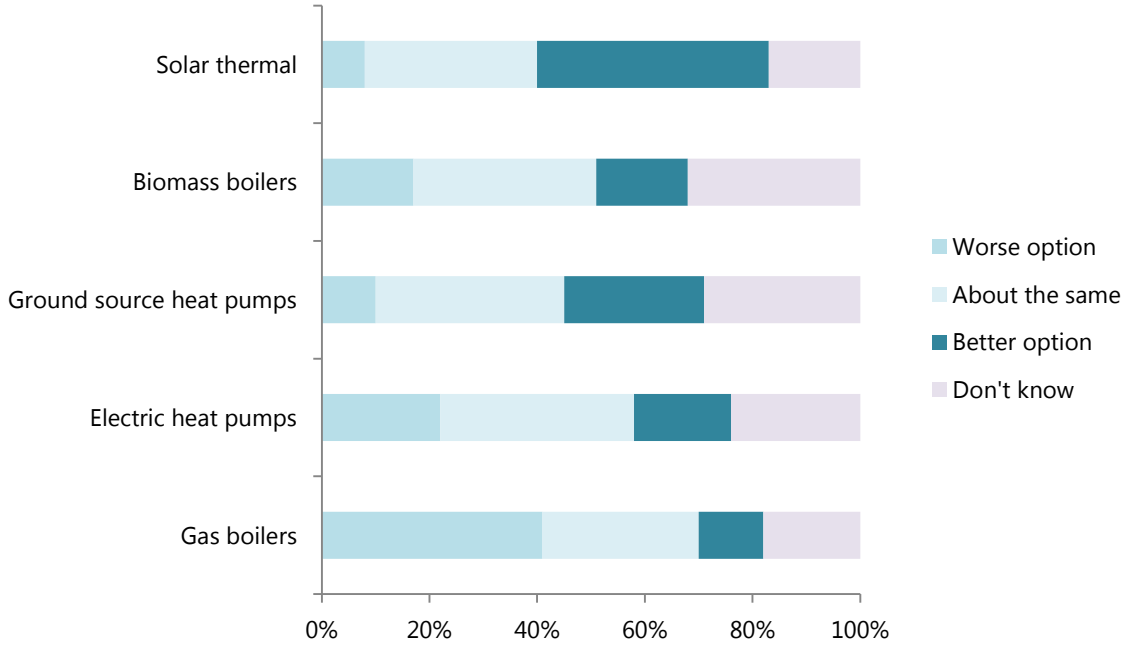


Figure 19. *Evaluation of alternative technologies as compared to residential hydrogen fuel cells (as % of respondents that consider the alternatives a worse, about the same or a better option)*

There are some marked differences between the studied populations in terms of their preference for alternative heating systems. So, although in the majority of countries home FCHs are preferred over gas boilers and solar and ground source heat are preferred over fuel cells, the average strength of the preference varies across the countries. As shown in Figure 20, respondents in Norway, for instance, have a very strong preference for solar thermal and ground source heat pumps over residential micro FCHs (a ratio bigger than 1 in the figure indicates a preference for the alternative option). In Germany, on the other hand, electric heat pumps are preferred over domestic fuel cells, but fuel cells are preferred over biomass boilers. In UK and Spain, biomass boilers are preferred over domestic FCHs. The details for the seven studied countries can be seen in the figure below.

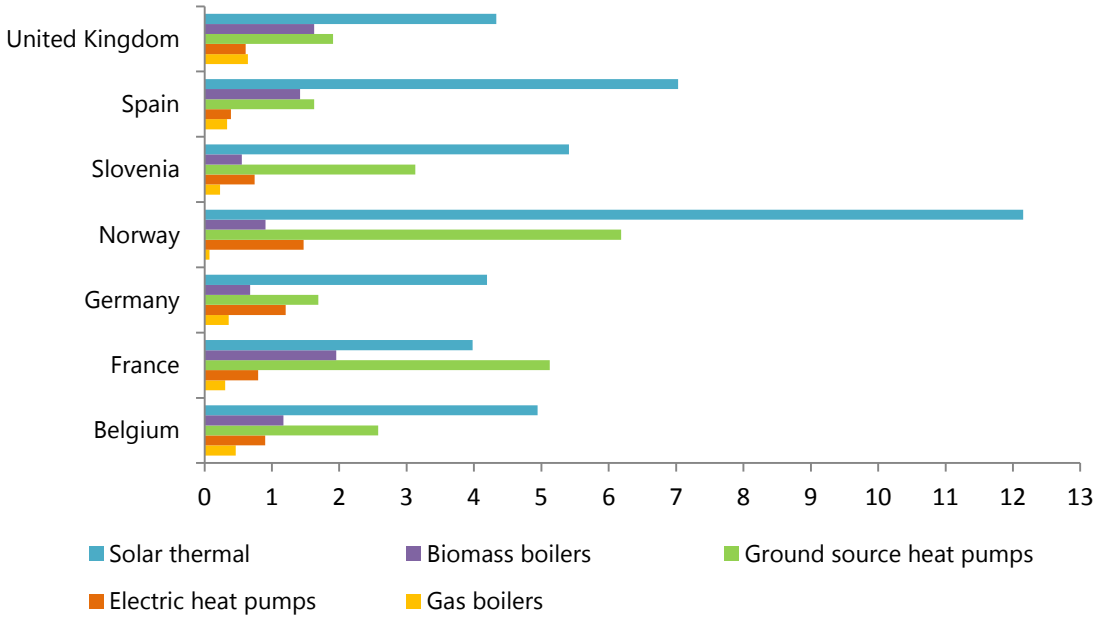


Figure 20. *Evaluation of alternative technologies as compared to residential hydrogen fuel cells in the seven countries (as ratio between the % of respondents that consider the option a better option than FCHs and the % of respondents that consider it a worst option)*

Again, we have to take into account the percentage of respondents that were unsure about their preferences. This is a relevant result as can be considered a proxy measure of the percentage of respondents that do not have a clear and stable judgement about residential fuel cell micro-CHP installations. As shown in Figure 19, between 17 and 32% of respondents is not able to evaluate FCHs over other systems.

3.2.7. Acceptance and support

After having measured respondents' beliefs, affects, global attitude and preferences regarding residential fuel cells, we introduced a number of items to measure the general acceptance and support towards this installation.

Regarding the **acceptance** of residential fuel cell micro-CHP installations, the figure below shows the distribution of the agreement with the statement "All else equal (price, comfort, maintenance cost, etc.), I would be happy to have an hydrogen fuel cell unit in my home in future". If we take into account the whole sample, around 6 out of 10 would be very happy to have a residential FCH unit at home (2 out of 10 would be very happy), 3 out of 10 are undecided about this and less than 1 out of 10 would not be happy about it at all.

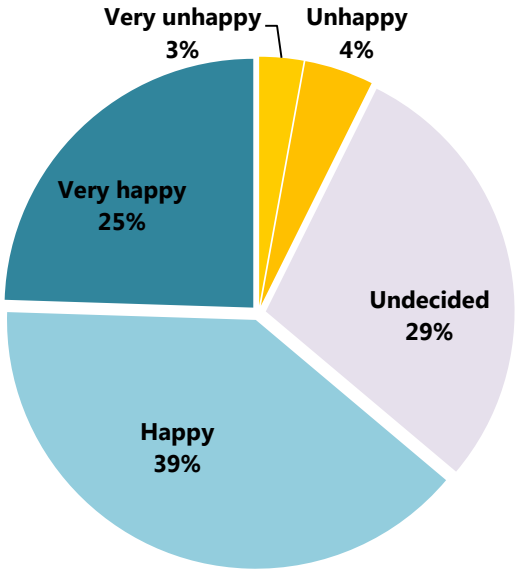


Figure 21. *Acceptance of residential hydrogen fuel cells (% of respondents in the total sample that would like to have a hydrogen fuel cell system in their home)*

Males tend to report a more positive attitude towards having a FCH home unit installed in the future relative to female respondents (68% of acceptance vs. 60%), as well as those in the age group 18-34 relative to those aged 55 or more (67% vs. 63%) and those living in bigger cities (more than one million inhabitants) relative to those living in cities with less than 20.000 inhabitants (72% vs. 63%). Willingness to install a residential FCH unit does not vary significantly by educational level or income (Table 12).

There are significant differences among the studied countries. There is a higher level of acceptance in Germany, Spain and Slovenia (71% in the three countries), and a lower level in France (55%), Norway (58%), Belgium (60%) and UK (60%). In these four countries, more than

30% of respondents are undecided about home FCHs and around 10% are not willing to have one installed in the future (Figure 22).

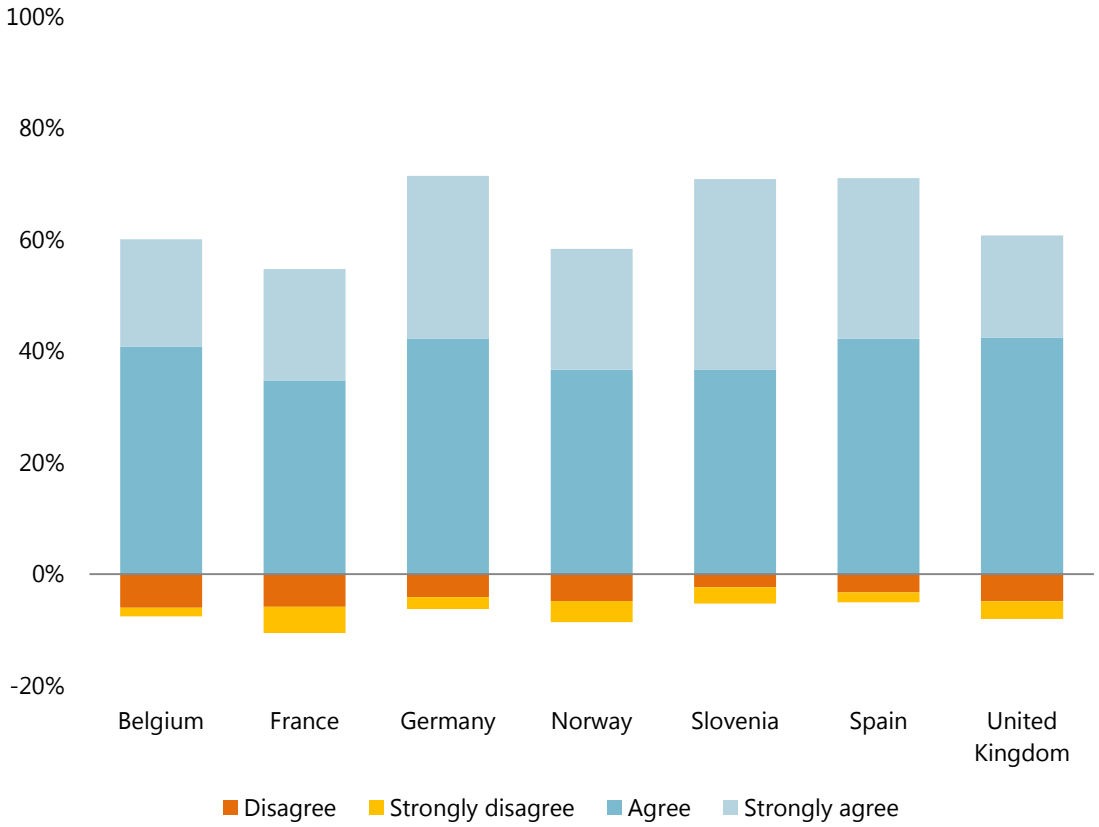


Figure 22. *Acceptance of residential hydrogen fuel cells (% of respondents in the seven countries that would like to have a hydrogen fuel cell system in their home)*

Respondents were also asked if public funding should be used to subsidize the purchase price of a fuel cell installation. This can be considered a measure of **support** to FCHs. As shown in figure 23, support to public funding to FCHs is generally high in the seven studied countries, and higher than personal acceptance. More than 7 out of 10 respondents agree with providing subsidies to home FCHs. 2 out of 10 are undecided and less than 1 out of 10 are reluctant to support FCHs. So, in general terms, some of the individuals that were undecided about having a home fuel cell installed in their home in the future, are supportive of providing public funds to this technology. This pattern is found in the seven countries. Only in the UK, the level of personal acceptance is very similar to the level of support for public funding (60%).

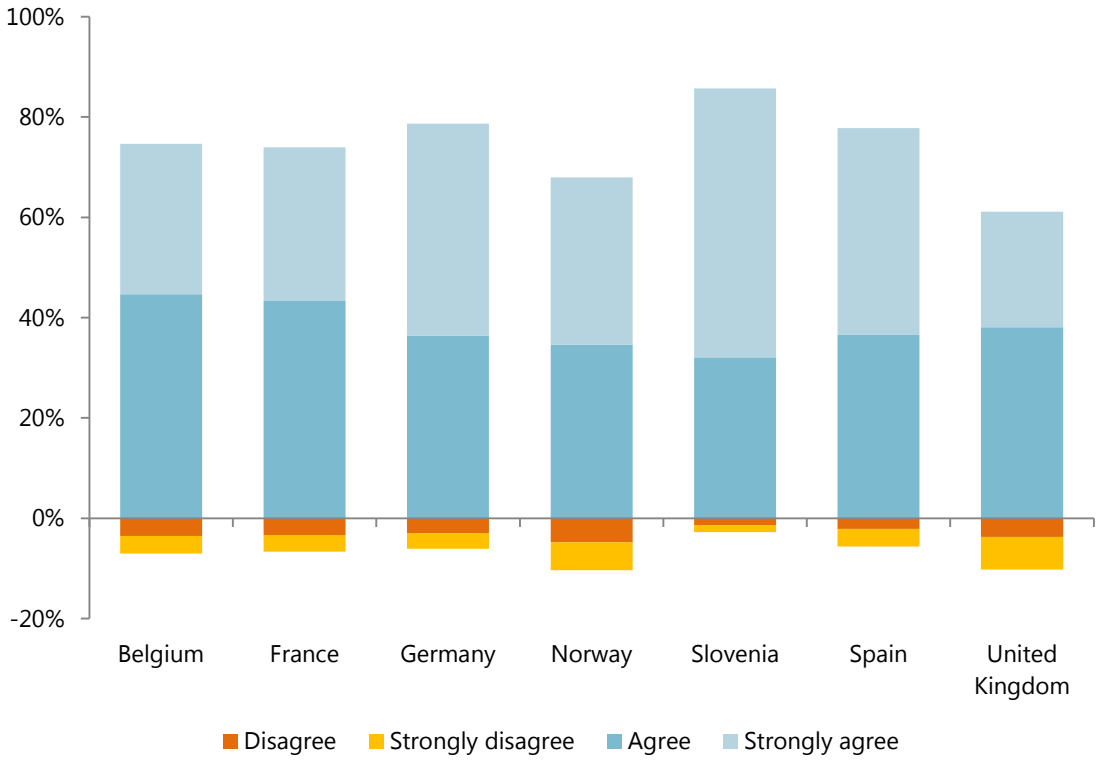


Figure 23. *Support to residential hydrogen fuel cells (% of respondents in the seven countries that agree-disagree with using public funding to subsidize the purchase price of the fuel cell)*

Table 12. *Acceptance and self-reported likelihood of installing a home fuel cell according to soci-odemographics*

		Acceptance (% agree and strongly agree)	**Self-reported likeli-hood of installing a home fuel cell (% likely or very likely)**
Overall (n=3592)			
Gender	Male	68*	24*
	Female	60	15
Age	18-34	67*	22*
	35-44	61	21
	45-54	63	18
	55+	63	17
Educational level	Non-university degree	62	19
	University degree	65	19
Size of residence	<20.000	63*	16*

	20.000 – 1.000.000	65	21
	>1.000.000	72	28
Income	Finding it difficult to live with current income	63	21
	Coping on current income	64	18
	Living comfortably with current in-come	66	20

**the difference between categories is statistically significant, p<0.01*

Self-reported likelihood of installing a home fuel cell

We also asked participants to report how likely would they be to install a residential fuel cell in the case they were considering replacing their current heating system. To those who considered it unlikely or very unlikely, we asked for the reasons for it.

In the whole sample, only around 20% of respondents consider it likely or very likely to purchase a home FCH. 45% consider it possible. And 36% consider it unlikely. Male respondents, those aged 18-34 and those living in a city with more than one million inhabitants reported being more likely to install a home FCH unit.

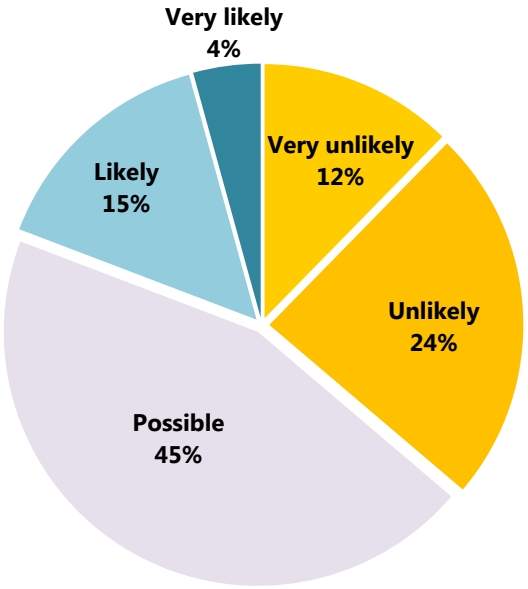


Figure 24. *Self-reported likelihood of installing a home fuel cell (% of respondents in the total sample that consider themselves very unlikely-very likely of installing a home fuel cell)*

The studied populations differ significantly in their reported likelihood of installing a residential fuel cell unit. The country with a higher level of self-reported likelihood of installing a residential FCH is Germany, where 25% of respondents consider it somehow likely. We find the lowest level of self-reported likelihood of installing a residential FCH in Norway (12% of respondents consider it likely). The percentages vary between 16 and 23% in the rest of the countries.

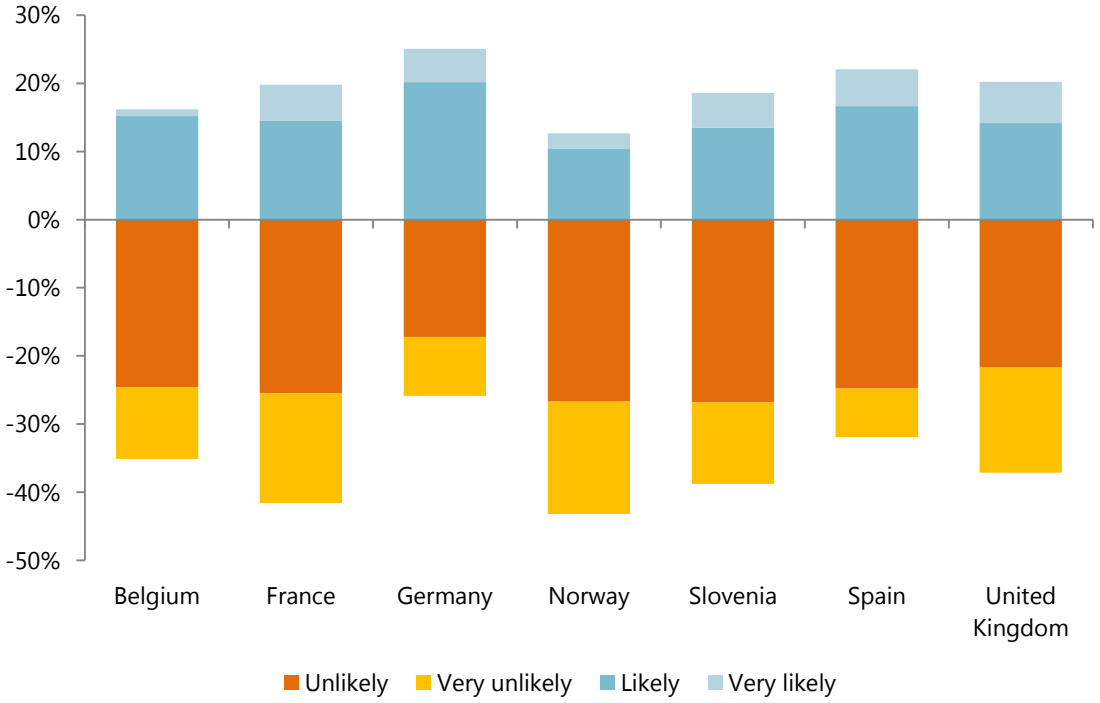


Figure 25. *Self-reported likelihood of installing a home fuel cell (% of respondents in the seven countries that consider themselves very unlikely-very likely of installing a home fuel cell)*

When respondents were asked about the reasons for not installing a fuel cell at their home, the price of installing a fuel cell appears as the most relevant factor in all the studied countries (reported as a problem by 73% of the participants considering it unlikely to install a FCH), followed by the perceived lack of maturity of the technology (subscribed by 45 % of respondents). The preference for investing in other renewable forms of heat generation is the third mentioned factor (by 28% of respondents). Less than 15% of respondents argue that the reason for not installing a fuel cell would be that they rely on fossil fuel (natural gas) or that thy prefer to invest in traditional systems (Figure 26).

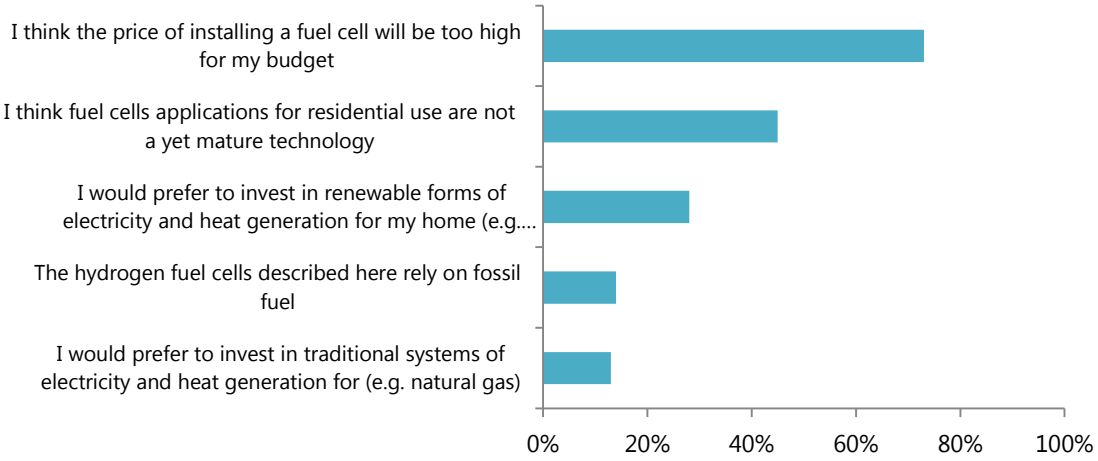


Figure 26. *Reasons for not purchasing a home fuel cell (as % of those respondents that consider themselves very unlikely to install a home fuel cell)*

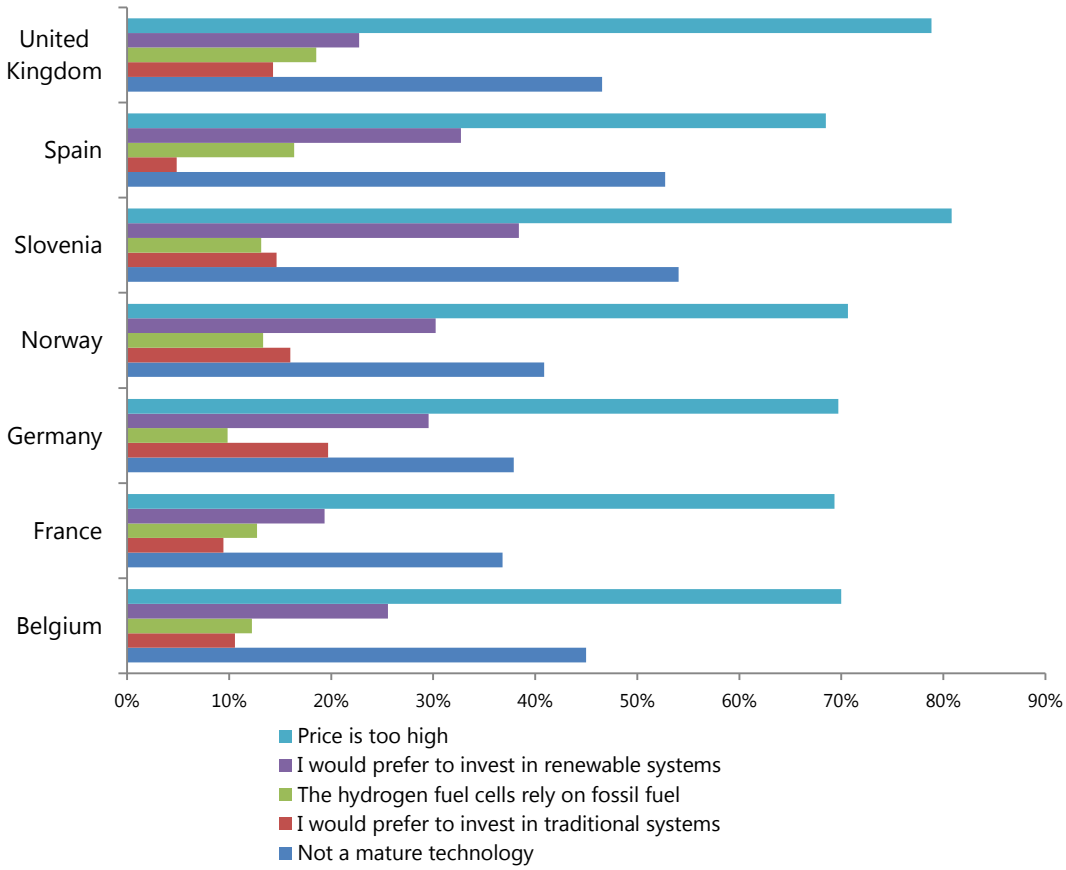


Figure 27. *Reasons for not purchasing a home fuel cell (as % per country of those respondents that consider themselves unlikely to install it)*

The same pattern is observed in all seven countries. The price of the fuel cell system is the main factor for respondents in all the countries, followed by the perceived immaturity of the technol-

ogy and the preference for investing in alternative renewable energy systems. The differences between the factors and the relative importance of the factors vary slightly among the seven countries (Figure 27).

Respondents who consider themselves unlikely to purchase a residential fuel cell if they had to replace their current heat system were asked for other reasons to not to buy a fuel cell micro-CHP. As shown in Figure 28, the majority of respondents referred to not being the owner of the flat as another reason for not purchasing a home fuel cell. Having other electricity and heating system installed was the second most frequently reason mentioned by respondents. Other reasons had to do with the suitability for various types of homes, installation problems, safety issues, lack of information, etc. (see the Annex for details on the reasons for not purchasing a home fuel cell unit).

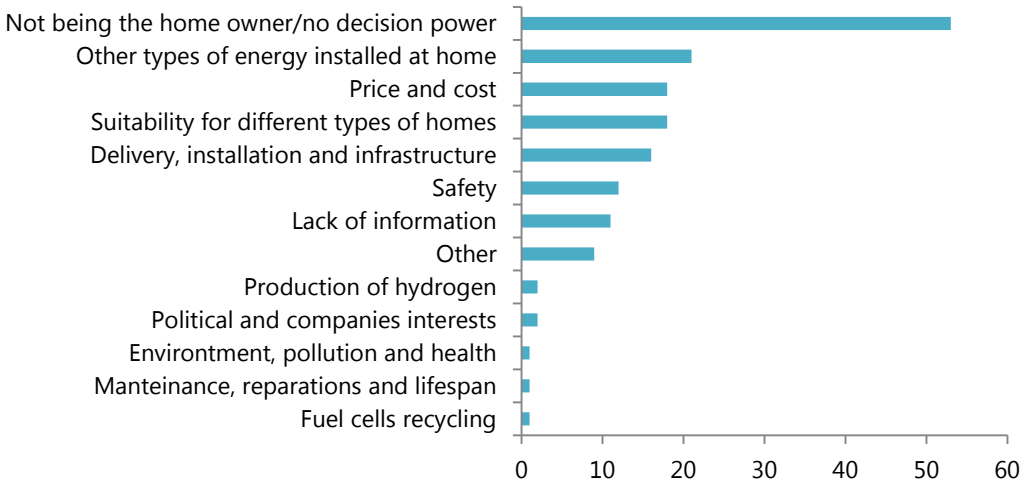


Figure 28. *Other reasons for not purchasing a residential hydrogen fuel cell unit mentioned by respondents (in total number of mentions)*

3.2.8. Attitudes towards hydrogen fuel cell power plants

In order to explore the potential public acceptance of a large stationary FCH installation, participants received information about a potential fuel cell power plant of a combined capacity of 15 megawatts to generate power and heat for about 15.000 homes that could be located in their town. Participants were first asked about their beliefs regarding the potential impacts of a large hydrogen fuel cell power plant.

Figure 29 displays the beliefs about the potential benefits and costs of a fuel cell power plant. Generally, a large hydrogen fuel cell power plant is associated, by the average respondent, to more benefits than costs. In a scale from 1 to 5, being 1 a very negative impact and 5 a very positive impact, respondents rate FCHs power plants as having a general neutral-positive impact (3.6). They believe large FCH power plants will have a positive effect on the environment (3.9), the local economy (3.7), the health of people living nearby (3.7) and the reliability of the electricity distribution system (3.7). Respondents also perceive FCH power plants to be slightly safer than dangerous (3.4) and are more ambivalent about the costs of this infrastructure (3.1).

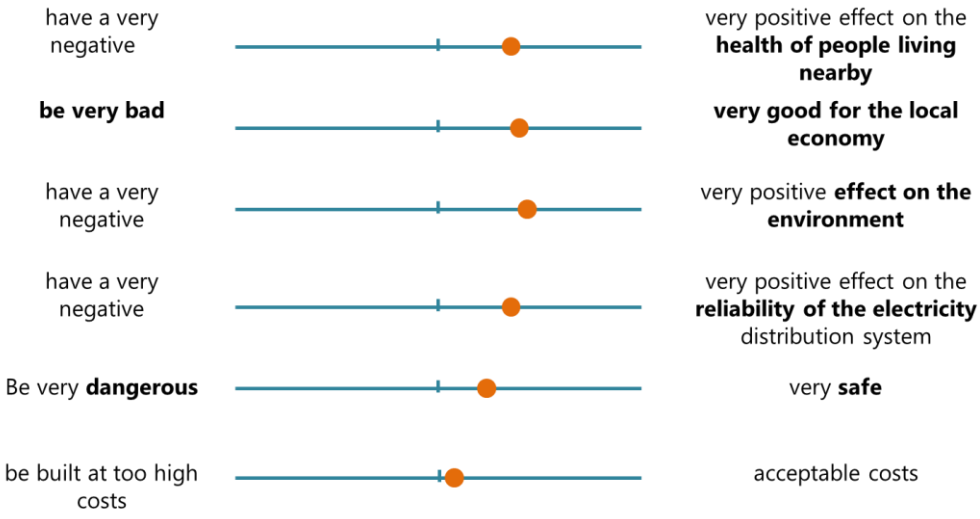


Figure 29. *Perception of benefits and costs associated to hydrogen fuel cell power plants (mean value)*

	BE (M)	FR (M)	DE (M)	NO (M)	SL (M)	ES (M)	UK (M)	Total	Difference (eta)
Be built at too high costs-acceptable costs	2.9	3.2	3.3	3.0	3.1	3.0	2.9	3.1	.11
Have a very negative-very positive effect on the reliability of the electricity distribution system	3.6	3.7	3.9	3.4	3.8	3.6	3.7	3.7	.13
Have a very negative-very	3.9	3.8	4.1	3.8	3.9	3.7	3.8	3.9	.11

positive effect on the environment									
Be very dangerous-very safe	3.4	3.5	3.6	3.3	3.4	3.3	3.3	3.4	.09
Be very bad-very good for the local economy	3.7	3.8	4.0	3.4	3.8	3.7	3.7	3.7	.16
Have a very negative-very positive effect on the health of people living nearby	3.7	3.7	3.9	3.5	3.7	3.5	3.6	3.7	.11
Total	3.5	3.6	3.8	3.4	3.6	3.5	3.5	3.6	

There are weak but significant differences between the countries in their beliefs about the impacts of FCH power plants. The perception of benefits is significantly higher than the average in Germany (3.8) and significantly lower than the average in Norway (3.4). The rest of the countries have a very similar evaluation of the benefits and costs of FCH power plants. Regarding the dimensions, the studied populations are more similar in terms of their evaluation of the safety of a FCH power plant (eta= 0.09) and more different in their evaluation of the potential effects on the local economy (eta= 0.16).

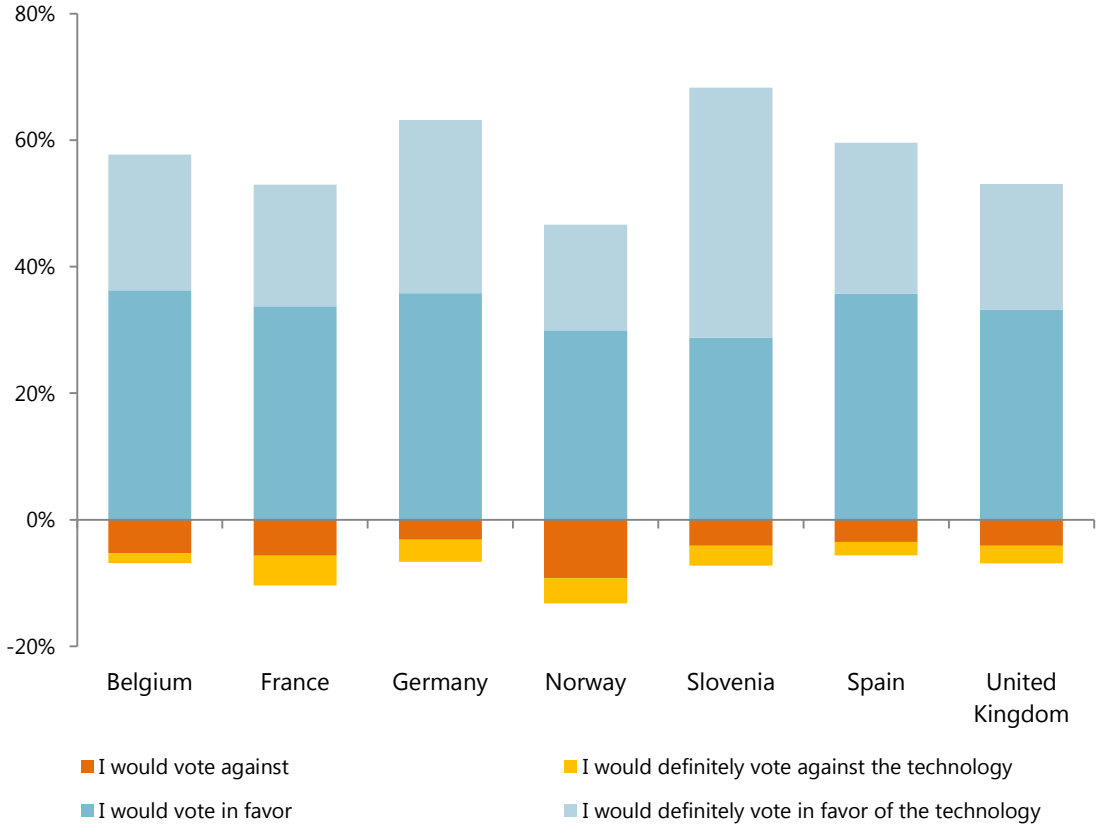


Figure 30. *Acceptance of hydrogen fuel cell power plants (% of respondents in the seven countries that would vote against-in favour of the siting of a fuel cell power plant)*

Participants were finally asked, if they could vote in their town on placing such a fuel cell power plant in their nearest energy plant, if they would vote in favour of it or against it. As seen in the figure below, the majority of the population in the seven studied countries would support the installation of a fuel cell power plant in their town. In the total sample, around 60% of respondents would vote in favour of the siting of the power plant, 30% are undecided and less than 10% would vote against it. Male respondents tend to be slightly more positive about the siting of a fuel cell power plant relative to female respondents. Also respondents aged 55 or more years are more positive relative to participants aged 18-34. There are no significant differences by educational level, size of population or income (Figure 30).

There are marked differences between the studied countries. Support is higher in Slovenia (69%), Germany (63%) and Spain (60%) and lower in Norway (47%) and UK (55%), where a significant part of the population is undecided or neutral (40% in Norway and UK). Very few people would initially oppose to a fuel cell power plant. This percentage varies from 5% in Spain to 13% in Norway.

Table 13. *Acceptance of the siting of a fuel cell power plant according to sociodemographics*

		Acceptance (mean)	**Acceptance (% I would definitely vote in favour)**
Overall (n=3592)		3.70	24
Gender	Male	3.83*	28*
	Female	3.58	20
Age	18-34	3.66*	20*
	35-44	3.62	20
	45-54	3.71	23
	55+	3.77	29
Educational level	Non-university degree	3.69	25
	University degree	3.72	23
Size of residence	<20.000	3.71	26
	20.000 – 1.000.000	3.70	22
	>1.000.000	3.84	28
Income	Finding it difficult to live with current income	3.69	27
	Coping on current income	3.67	21
	Living comfortably with current income	3.78	25

**the difference between categories is statistically significant, p<0.01*

3.2.9. Attitudes towards stationary fuel cells per country grouping

In order to examine the differences among the studied countries according to its level of policy support to hydrogen and fuel cell technologies, in this section we provide further details about the specific situation of the selected groups (as categorized in WP2 in advance, medium and low support).

Advanced policy support to hydrogen

Germany

Around 32% of respondents have heard about hydrogen fuel cell stationary applications in Germany. German respondents have a very positive attitude towards FCH stationary residential applications. Around 66% of the population in Germany rates residential hydrogen fuel cells as a very good or a good option for providing electricity and heat. Acceptance of residential fuel cells is very high. Around 70% of the population would like to have a hydrogen fuel cell system in their home. Support for this application is also very high, and 78% of respondents in Germany agree with using public funding to subsidize the purchase price of the fuel cell. Regarding stationary infrastructures, acceptance is also high. Around 63% would vote in favour of the siting of a fuel cell power plant.

Norway

Public awareness of hydrogen fuel cell residential applications in Norway is low, relative to the seven studied countries, as only 20% reports having heard about this application. Public attitudes towards home fuel cells are significantly more neutral, relative to Germany. Around 52% of the population in Norway rates residential hydrogen fuel cells as a very good or a good option for providing electricity and heat. Acceptance of residential fuel cells is high in Norway, but it is lower than in Germany (respondents in Norway express a clear preference for solar systems). Around 59% of the population would like to have a hydrogen fuel cell system in their home. Support for this application is also high but lower than in Germany, as 68% of respondents agree with using public funding to subsidize the purchase price of the fuel cell. Acceptance of stationary infrastructures is medium, with around 47% of the population that would vote in favour of the siting of a fuel cell power plant in their nearest energy plant.

United Kingdom

Public awareness of fuel cell residential applications is, similar to other countries, very limited, as only 23% of respondents report having heard about hydrogen fuel cells for residential use. Respondents in the UK have a general positive attitude towards FCH applications. But, on average, respondents seem to be more neutral or sceptic about these applications, relative to the other countries in the study. Around 57% of the population in the UK rates residential hydrogen fuel cells as a very good or a good option for providing electricity and heat. Acceptance of residential fuel cells is high in the UK. Around 60% of the population would like to have a hydrogen fuel

cell system in their home. Public support for subsidizing home fuel cells is relatively high, but significantly lower than in Germany and Norway. Around 60% of respondents agree with using public funding to subsidize the purchase price of the fuel cell. Acceptance of stationary infrastructures is medium-high, with around 53% of the population that would vote in favour of the siting of a fuel cell power plant in their nearest energy plant.

Medium policy support to hydrogen

Belgium

Public awareness of fuel cell residential applications is, similar to other countries, very limited, as only 23% of respondents report having heard about hydrogen fuel cells for residential use. Respondents in Belgium have a general positive attitude towards FCH applications. Around 64% of the population in Belgium rates residential hydrogen fuel cells as a very good or a good option for providing electricity and heat. Around 60% of the population would like to have a hydrogen fuel cell system in their home. Public support for subsidizing home fuel cells is very high and around 75% of respondents agree with using public funding to subsidize the purchase price of the fuel cell. Acceptance of stationary infrastructures is medium-high, with around 57% of the population that would vote in favour of the siting of a fuel cell power plant in their nearest energy plant.

France

Public awareness of fuel cell residential applications in France is similar to other countries, and only 25% of respondents report having heard about hydrogen fuel cells for residential use. Respondents in France have a general positive attitude towards FCH applications. Around 61% of the population in France rates residential hydrogen fuel cells as a very good or a good option for providing electricity and heat. Around 55% of the population would like to have a hydrogen fuel cell system in their home. Acceptance is lower than in Germany, Spain and Slovenia and very similar to Norway and United Kingdom. Public support for subsidizing home fuel cells is very high and around 74% of respondents agree with using public funding to subsidize the purchase price of the fuel cell. Acceptance of stationary infrastructures is medium-high, with around 53% of the population that would vote in favour of the siting of a fuel cell power plant in their nearest energy plant.

Spain

Public awareness of fuel cell residential applications in Spain is similar to other countries, and only 23% of respondents report having heard about hydrogen fuel cells for residential use. Respondents in Spain have a general positive attitude towards FCH applications. Around 68% of the population in Spain rates residential hydrogen fuel cells as a very good or a good option for providing electricity and heat. This percentage is higher than in France and Belgium. Public acceptance of residential fuel cell applications is very high in Spain. Around 71% of the population would like to have a hydrogen fuel cell system in their home. Acceptance is higher than in Belgium and France. Public support for subsidizing home fuel cells is very high and around 78% of

respondents agree with using public funding to subsidize the purchase price of the fuel cell. Acceptance of stationary infrastructures is medium-high, with around 60% of the population that would vote in favour of the siting of a fuel cell power plant in their nearest energy plant.

Low policy support to hydrogen

Slovenia

Public awareness of fuel cell residential applications in Slovenia is slightly higher than in other countries and similar to Germany, as 31% of respondents report having heard about hydrogen fuel cells for residential use. Respondents in Slovenia have a general positive attitude towards FCH applications. Around 69% of the population in Slovenia rates residential hydrogen fuel cells as a very good or a good option for providing electricity and heat. Public acceptance of residential fuel cell applications is very high in Slovenia. Around 71% of the population would like to have a hydrogen fuel cell system in their home. Public support for subsidizing home fuel cells is the highest among the studied countries and around 86% of respondents agree with using public funding to subsidize the purchase price of the fuel cell. Acceptance of stationary infrastructures is high, with around 69% of the population that would vote in favour of the siting of a fuel cell power plant in their nearest energy plant.

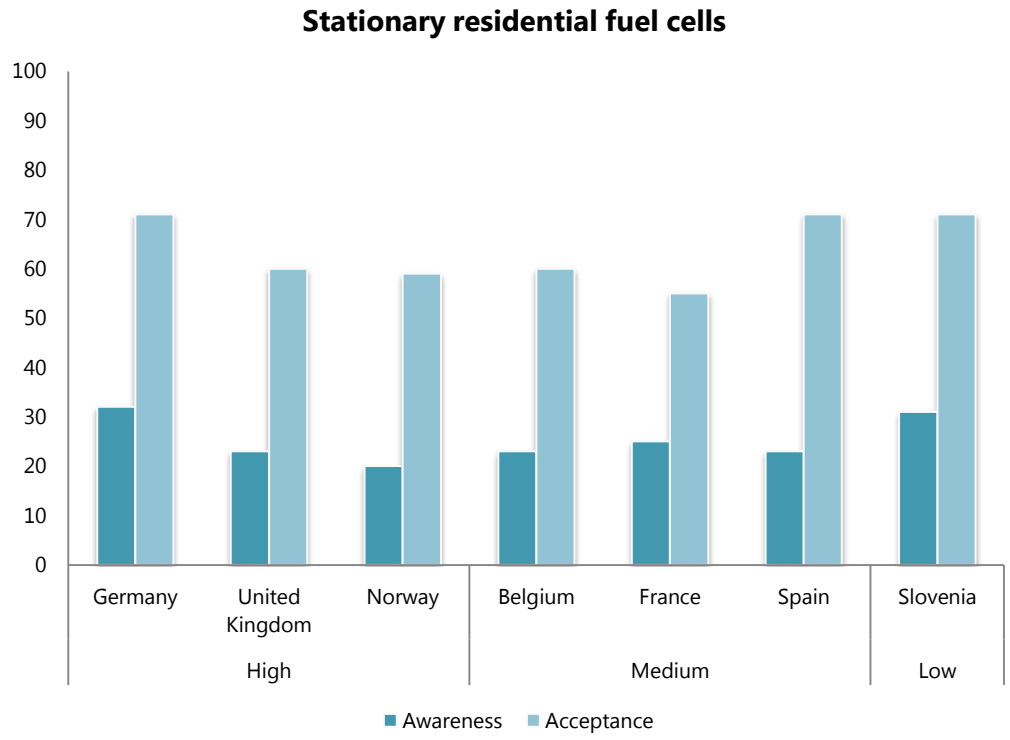


Figure 31. *Awareness and acceptance of stationary residential fuel cells per country-grouping*

3.3. Hydrogen Fuel Cell Electric Vehicles (FCEVs) and related infrastructures

This section provides an overview of public awareness, attitudes and acceptance of FCEVs. Prior to answering to the questions, respondents were shown one page factsheet providing basic information on hydrogen fuel cell vehicles. At this stage, no information on the consequences of FCEVs (e.g. cost, infrastructure needed, range etc.) had been given to respondents.

3.3.1. Awareness

Figure 31 displays the level of awareness about FCEVs in the full sample. Awareness is significantly higher for FCEV relative to residential fuel cell micro-CHP. Around 45% of respondents have heard a little bit about FCEV and even a 15% reports knowing a few things about fuel cell cars.

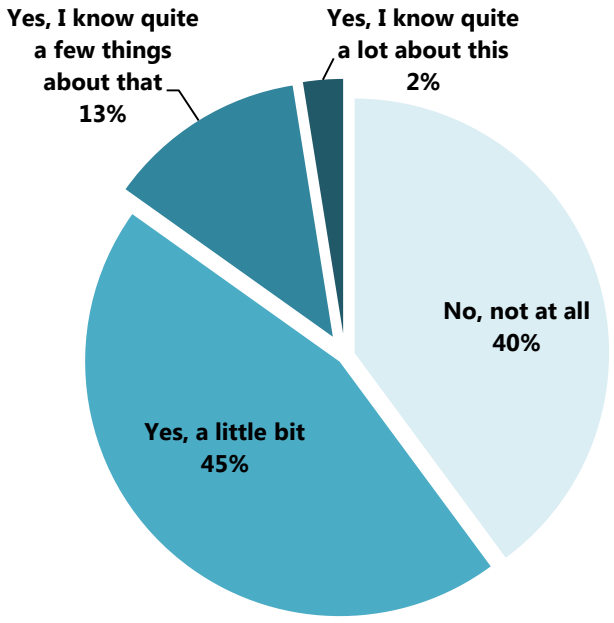


Figure 32. *Awareness of FCEVs (in %, all countries)*

There are significant differences across the countries. Norway and Germany are the countries with higher levels of awareness of FCEVs. For instance, more than 80% of respondents in Norway have heard about FCEV. Germany and Norway have the highest rate of respondents that know quite a few things or a lot about FCEVs (18% and 16% respectively). On the other hand, Spain is the country with a lower level of awareness of FCEV (53% of the respondents declare not having heard about this) (Figure 32).

There are also significant differences in awareness of FCEVs by gender, educational level and income. The percentage of respondents who have heard about fuel cell vehicles is higher for

male respondents relative to female respondents (75% vs. 45%), those with a university degree (65%), and those with a higher income (71%) (Table 14).

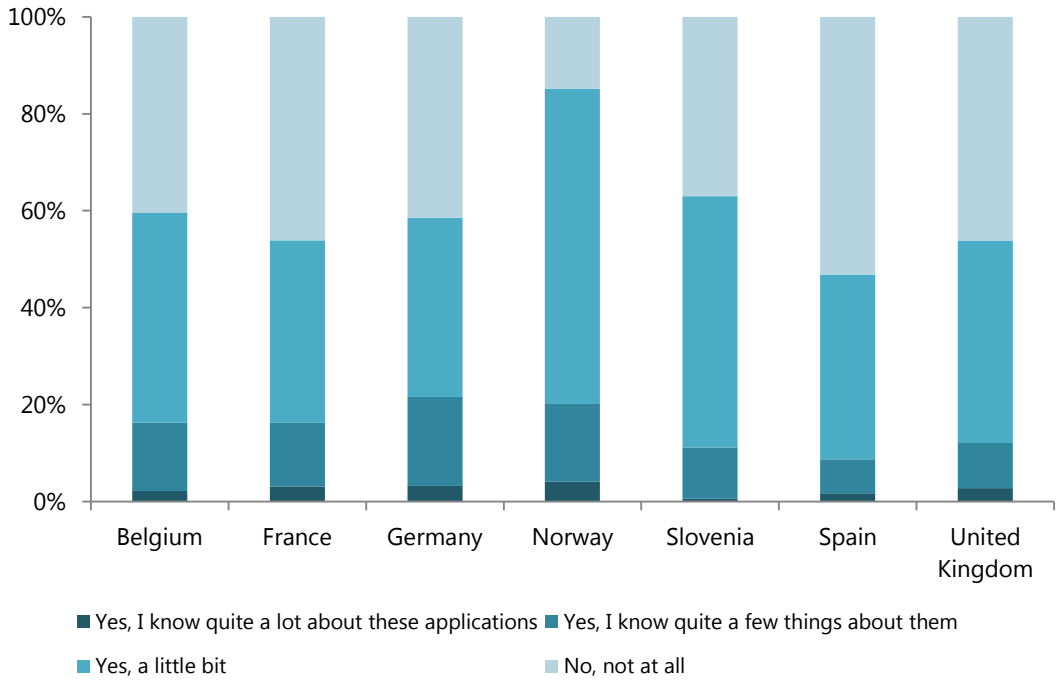


Figure 33. *Awareness of FCEVs in the seven studied countries (in %)*

Table 14. *Awareness of FCEVs according to sociodemographics*

		Awareness (% have ever heard)
Overall (n=3556)		60
Gender	Male	75*
	Female	45
Age	18-34	63
	35-44	60
	45-54	58
	55+	59
Educational level	Non-university degree	56*
	University degree	65
Size of residence	<20.000	60
	20.000 – 1.000.000	62
	>1.000.000	60
Income	Finding it difficult to live with current income	56*
	Coping on current income	58
	Living comfortably with current income	71

**the difference between categories is statistically significant, p<0.01*

3.3.2. Experience

Respondents' experience with FCH electric vehicles is very low across the studied countries. On average, 94% of the respondents report not having ever ridden a hydrogen vehicle. The differences across the countries are statistically non-significant.

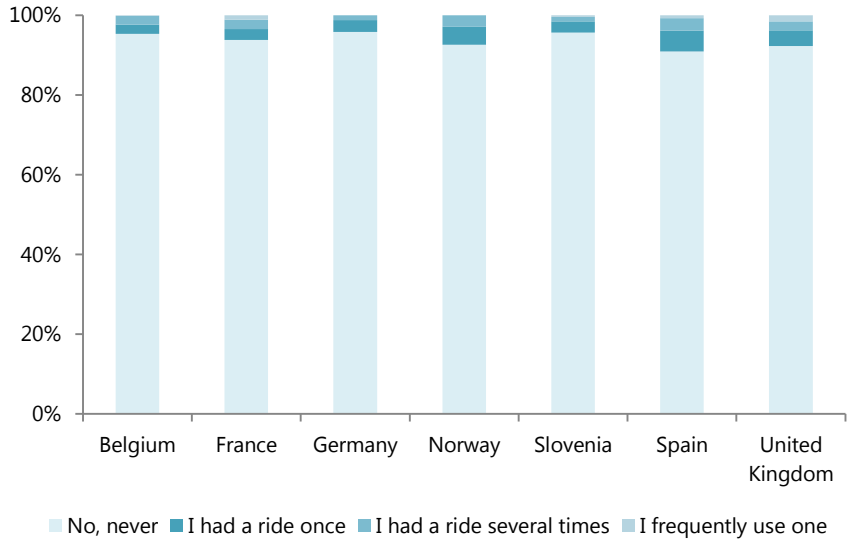


Figure 34. *Experience with fuel cell passenger cars in the seven studied countries (in %)*

Experience with hydrogen fuel cell buses seems to be a bit higher relative to experience with hydrogen fuel cell cars. In the full sample, 11% of respondents report having some experience with FCH buses. The differences between countries are also very small. Norway has the highest rate of experience with hydrogen fuel cell buses (10%) while Slovenia has the lowest (2%)[i].

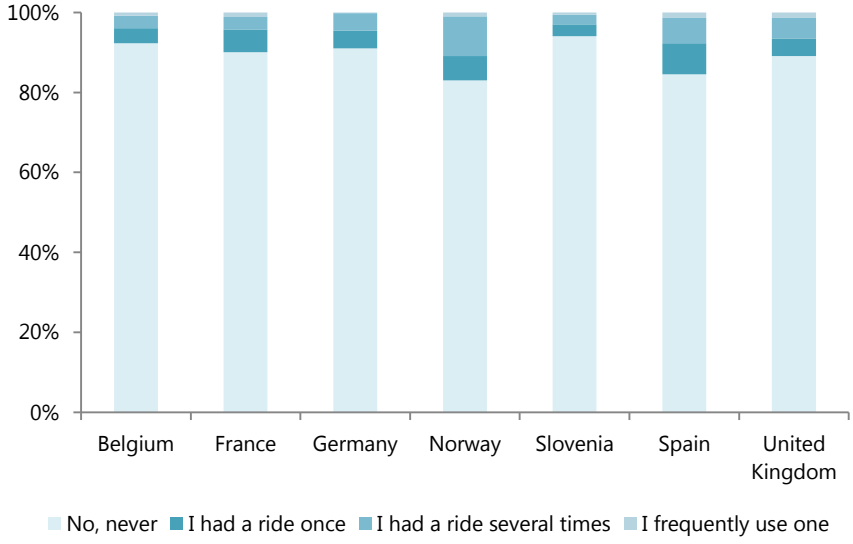


Figure 35. *Experience with fuel cell buses in the seven studied countries (in %)*

There are significant differences in experience with hydrogen cars or buses according to the sociodemographic variables. The percentage of respondents with some experience with hydrogen vehicles is higher among males, younger groups (aged from 18 to 44), those with a university degree, and those from bigger cities (Table 15)

Table 15. *Experience with hydrogen fuel cell cars and buses according to sociodemographics*

		Some experience with hydrogen cars (%)	**Some experience with hydrogen buses (%)**
Overall (n=3556)		6	11
Gender	Male	8*	13*
	Female	5	9
Age	18-34	12*	18*
	35-44	7	12
	45-54	4	8
	55+	2	6
Educational level	Non-university degree	5	8
	University degree	8*	14*
Size of residence	<20.000	4	6
	20.000 – 1.000.000	7	13
	>1.000.000	9*	22*
Income	Finding it difficult to live with current income	7	11
	Coping on current income	5	9
	Living comfortably with current income	7	13

**the difference between categories is statistically significant, p<0.01*

[i] These figures might be subject to over-reporting due to encoding and recall of information (false recall or false recognition)

3.3.3. Affect

In order to examine the potential emotional responses of individuals to hydrogen fuel cell cars, respondents were asked to what extent the technology, as presented in the information fact-sheet, evoked the following feelings: worry, aversion, hope and interest.

The majority of respondents in the seven studied populations report feelings of interest and hope regarding FCEVs. Specifically, 61% of respondents in the total sample report feeling interest and 56% "somewhat" or "very much" hope. Only around 13% report feeling "somewhat" or "very much" worry, and 9% report feeling aversion. Figure 35 presents the average score for the total sample in each of the four affects.

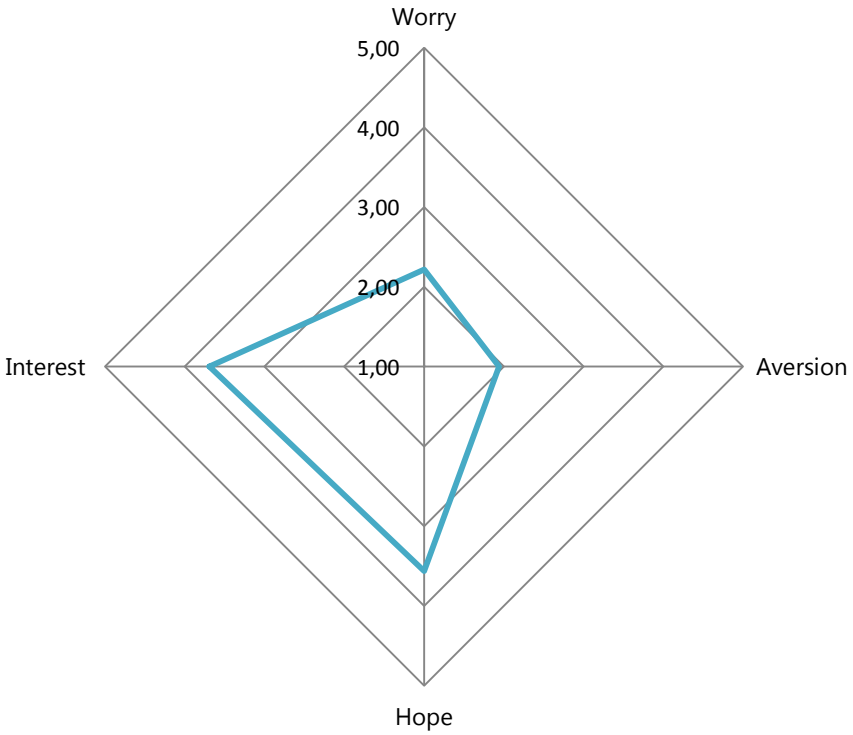


Figure 36. *Affect associated to FCEVs (mean value, all countries)*

	BE (M)	FR (M)	DE (M)	NO (M)	SL (M)	ES (M)	UK (M)	Total	Differences (eta)
Worry	2.3	2.4	2.2	1.9	2.1	2.3	2.2	2.22	0.13
Aversion	1.9	2.1	1.9	1.7	1.8	2.0	2.2	1.94	0.15
Hope	3.6	3.5	3.5	3.4	3.7	3.8	3.4	3.56	0.10
Interest	3.6	3.6	3.7	3.6	3.9	3.9	3.5	3.69	0.12

There are weak but significant differences across countries in the affects attributed to FCEVs. We find, for instance, that interest is higher in Spain and Slovenia (3.9) and lower in the UK (3.5). Worry is higher in Spain (2.3) and lower in Norway (1.9). As shown by the eta coefficient, differ-

ences among countries are slightly higher regarding aversion being the highest in the UK (2.2) and the lowest in Norway (1.7).

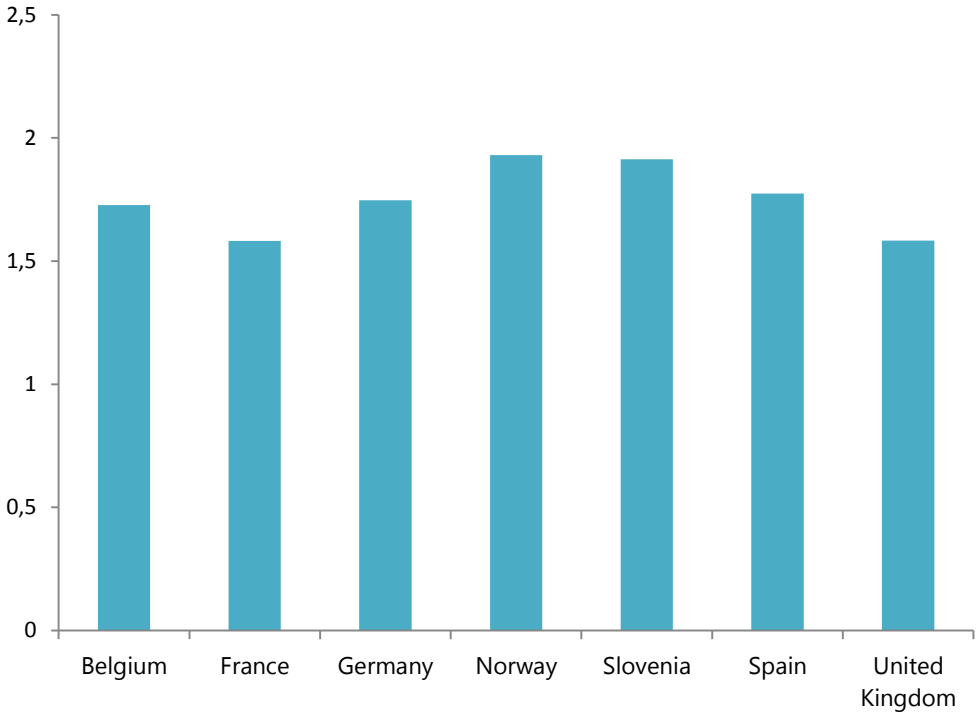


Figure 37. *Ratio between average positive and negative affect in the seven countries*

Figure 36 displays the ratio between positive (hope and interest) and negative (worry and aversion) affects regarding FCEVs in the seven countries. The ratio is higher than 1 in the seven countries, meaning that positive affect is more prevalent than negative affect. The countries with higher ratios are Norway and Slovenia. The countries with lower ratios are United Kingdom and France.

Levels of self-reported worry are significantly higher among female respondents relative to male respondents. There are not significant differences in self-reported affects associated to FCEVs for age, educational level, size of residence or income (Table 16).

Table 16. *Interest and worry according to sociodemographics*

		Worry (Mean)	Interest (Mean)
Overall (n=3556)		2.22	3.69
Gender	Male	2.15*	3.83*
	Female	2.28	3.56
Age	18-34	2.31	3.62
	35-44	2.21	3.63
	45-54	2.18	3.69
	55+	2.17	3.78
Educational level	Non-university degree	2.24	3.60
	University degree	2.19	3.80
Size of residence	<20.000	2.20	3.66
	20.000 – 1.000.000	2.21	3.78
	>1.000.000	2.32	3.70
Income	Finding it difficult to live with current income	2.35	3.66
	Coping on current income	2.22	3.66
	Living comfortably with current income	2.03	3.81

**the difference between categories is statistically significant, p<0.01*

3.3.4. Beliefs about costs and benefits

Beliefs about costs and benefits were evaluated by a semantic differential scale where 1 was the positive pole and 5 represented the negative pole.

In general, respondents perceive hydrogen vehicles as slightly beneficial, that is, perceived benefits outweigh perceived costs. Generally, respondents believe that FCEVs are environmentally friendly (mean of 2.1 in a scale from 1 to 5, being in this case 1 the positive pole and 5 the negative pole), safe to drive (2.2), reliable (2.3), easy to refuel (2.4), will make citizens' life easier (2.4), and will have sufficient range (2.5). Respondents have less positive beliefs about the initial costs (2.7). The main perceived benefit is, so, that hydrogen vehicles are environmentally friendly, while the lowest rated benefit is the cost of purchasing one of these.

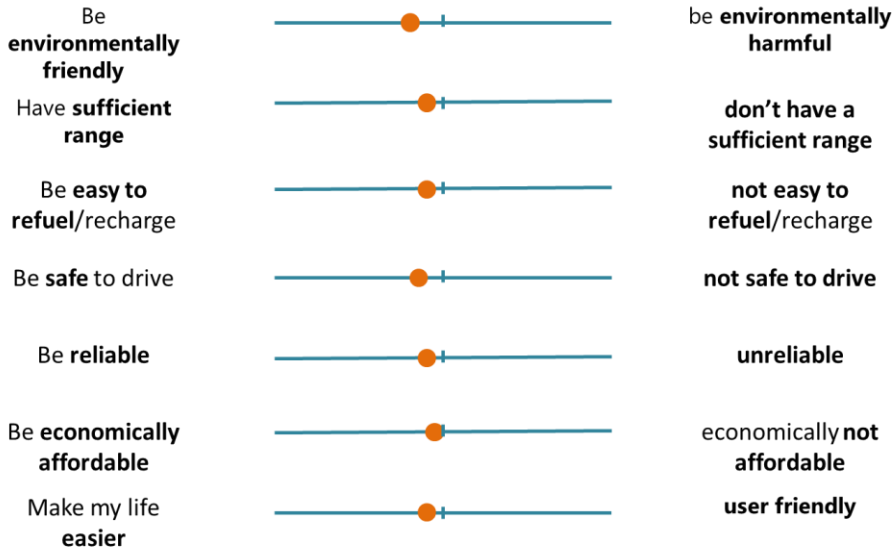


Figure 38. *Perception of benefits and costs associated to FCEVs (mean value)*

	BE (M)	FR (M)	DE (M)	NO (M)	SL (M)	ES (M)	UK (M)	Total	Difference (eta)
Be environmentally friendly – harmful	1.7	1.8	1.7	2.1	2.2	3.1	2.0	2.1	.323
Have sufficient range – don't have sufficient range	2.3	2.2	2.4	2.4	2.6	3.0	2.7	2.5	.190
Be easy to refuel – difficult to refuel	2.2	2.2	2.2	2.3	2.4	3.0	2.6	2.4	.211
Be safe to drive – not safe to drive	2.0	2.0	2.1	2.2	2.4	2.5	2.3	2.2	.138
Be reliable – unreliable	2.0	2.0	2.0	2.3	2.5	2.7	2.4	2.3	.199
Be economically affordable – not affordable	2.6	2.4	2.6	2.7	3.0	3.2	2.9	2.7	.205
Make my life easier – wouldn't make my life easier	2.2	2.2	2.3	2.7	2.6	2.6	2.7	2.4	.176
Total	2.1	2.1	2.2	2.4	2.5	2.9	2.5	2.4	

There are weak but significant differences across countries. FCEVs are perceived as having more benefits in Belgium (2.1), France (2.1) and Germany (2.2), whilst respondents in Spain (2.9) are, on average, the more neutral about the potential costs-benefits of hydrogen cars. The seven studied populations differ somewhat in their perception of how environmentally friendly hydrogen cars would be (eta= 0.323). They are more similar in their perception of how safe or dangerous FCEVs could be (eta= 0.138).

Not all participants have a stable belief about the potential benefits and costs associated with hydrogen fuel cells vehicles. In the figure below we have represented the percentage of respondents per country not providing an answer in the question about perceived benefits and costs. The prevalence of "don't know" ranges from 8% in Germany to 21% in Norway. A significant proportion of the sample is, therefore, unsure about the potential benefits and costs of FCEVs.

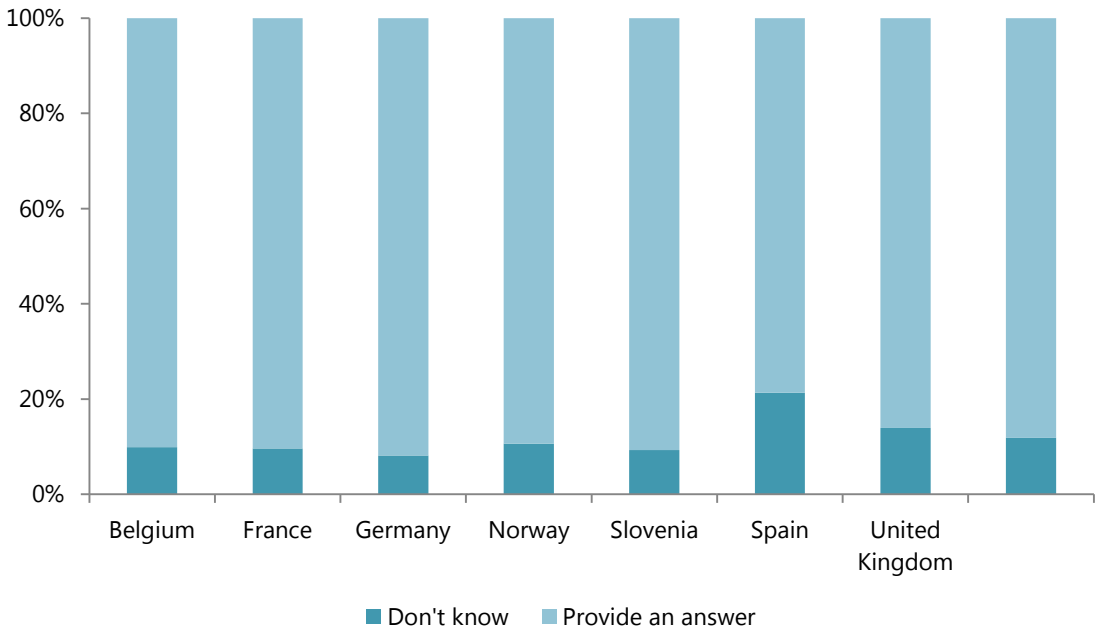


Figure 39. *Prevalence of don't know answers regarding benefits and costs of FCEVs (as % of respondents per country)*

3.3.5. Evaluation of consequences

Table 17 shows respondents' evaluation of various consequences generally associated to hydrogen vehicles. Seven consequences regarding the potential impacts of FCEVs were briefly introduced to study participants. Then, they were asked to evaluate, in a scale from 1 to 5, where 1 means very negative and 5 means very positive, each of the consequences.

The data show that the three consequences evaluated in the total sample as the most positive are the fact that "they will reduce the need for petroleum" (86% of participants rated it as a positive or very positive consequence, M= 4.31), it "would produce lower CO_2 emissions than conventional cars" (86%, M= 4.30) and the "price of hydrogen" (79%, M= 4.06). The "range" and "safety issues" were, on average, as positive to not important consequences (M= 3.53 and 2.89 respectively). The "infrastructure needed" and "price of fuel cell material" were rated as somehow negative consequences (M= 2.53 and 2.24 respectively).

In terms of agreement between participants, we find that the three consequences rated as more positive (reduction of the need for petroleum, lower CO_2 emissions and price of hydrogen) generate a greater degree of agreement (standard deviations between 0.80 and 0.94). Participants agree less on their evaluation of the two consequences rated as more negative; infrastructure needed and the price of fuel cell material (standard deviations between 1.32 and 1.28).

Table 17. *Evaluation of consequences for FCEVs (in % and mean, all countries)*

	Very negative (1)	Negative (2)	Not important (3)	Positive (4)	Very positive (5)	M	SD
They would reduce the need for petroleum	1%	3%	10%	37%	49%	4,31	0,84
Lower CO_2 emissions than conventional cars	1	2	11	39	47	4,30	0,80
Price of fuel cell material	38	28	12	16	6	2,24	1,28
Price of hydrogen	2	5	14	43	36	4,06	0,94
Infrastructure needed	27	31	13	20	9	2,53	1,32
Range	4	17	21	38	20	3,53	1,11
Safety issues	11	32	23	24	10	2,89	1,19

In terms of the differences between countries in the evaluation of the consequences, we find significant but weak differences between the countries. The consequence that generates less agreement among countries is the safety of hydrogen cars (eta=0.126). In that sense, respondents in UK (M=3.06), Spain (M=3.04) and Belgium (M=2.99) evaluate this consequence significantly more positive than respondents in Norway (M= 2.60). If we take into account all the consequences evaluated, we observe a slightly more positive evaluation of the consequences in Slovenia (M= 3.56) and a more negative evaluation in Norway (3.32) and Germany (3.34).

Table 18. *Evaluation of consequences for FCEVs (mean per country and consequence)*

	BE (M)	FR (M)	DE (M)	NO (M)	SL (M)	ES (M)	UK (M)	Difference (eta)
They would reduce the need for petroleum	4.31	4.33	4.33	4.15	4.45	4.37	4.21	.108
Lower CO_2 emissions than conventional cars	4.32	4.24	4.33	4.27	4.44	4.32	4.21	.086
Price of fuel cell material	2.18	2.22	2.14	2.34	2.25	2.13	2.40	.074
Price of hydrogen	4.08	4.09	4.13	3.99	4.22	3.88	4.07	.105
Infrastructure needed	2.45	2.50	2.30	2.52	2.83	2.50	2.59	.114
Range	3.57	3.54	3.36	3.35	3.77	3.55	3.55	.116
Safety issues	2.99	2.82	2.81	2.60	2.93	3.04	3.06	.126
Total per country	3.41	3.39	3.34	3.32	3.56	3.40	3.44	

Figure 39 displays the average score obtained by each consequence and the correlation between this assessment and the subsequent global attitude towards hydrogen cars. The closer to 1 in the correlation coefficient indicates that the evaluation of the consequence is associated, to a greater extent, to the overall attitude towards the application; while values close to 0 in the coefficient indicate that the evaluation of the consequence is not related to the overall assessment of technology.

As the data show, almost all the consequences have a moderate to medium association with the overall evaluation of the application. But there are significant differences between the consequences. The "reduction in the need for petroleum" is considered a positive consequence and it is the consequence most highly associated with the global attitude (rho= .41), followed by "the reduction in CO_2 emissions" (rho= 0.40) and "the price of hydrogen" (rho= 0.38). We could argue so, that the fact that a hydrogen car would reduce the need from petroleum is the most influential factor in forming individuals' attitude towards the application. On the other hand, the consequence regarding the "price of fuel cell materials" is more weakly associated (0.16) to the global evaluation, which means that this factor plays a less relevant role in forming the attitude. The "need for new infrastructure" and "safety issues" are also weakly associated (0.20 and 0.28 respectively).

Table 19. *Importance of consequences in global evaluation and self-reported likelihood of buying a FCEV*

	Global evaluation of FCEVs	Self-reported likelihood of purchasing a FCEV
Reduce the need for petroleum	,410	,074
Reduce CO_2 emissions	,398	,094
Price for fuel cell material	,159	,410
Price of hydrogen	,379	,146
Need for new infrastructure	,196	,404

Range	,331	,267
Safety issues	,284	,318

Interestingly, as shown in Table 19, the importance of each of the consequences change significantly if we consider the correlation with the self-reported likelihood of purchasing a FCEV, as compared to the correlation with the global attitude. The "price for fuel cell material" is the factor most highly associated (rho= 0.41) with the reported likelihood of purchasing a hydrogen car, followed by "the need for new infrastructure" whilst it was the least correlated factor with global attitude (rho= 0.16). On the other hand, the "reduction in in the need for petroleum" was moderately associated (rho=0.41) to the global attitude, but plays a weaker role in the likelihood of purchasing a hydrogen car (rho= 0.07). This means that the consequences of FCEVs, and their evaluation by participants, play a different role in individuals' attitude towards the application as compared to individuals' self-reported likelihood of purchasing a hydrogen car.

	Mean evaluation (1 – 5)	Correlation (Rho) (- 1 a 1)	Global attitude (1 – 5)
They would reduce the need for petroleum Fuel cell vehicles use hydrogen gas and oxygen to power an electric motor. As hydrogen can be produced from a variety of domestic resources, hydrogen vehicles would reduce the need for petroleum.	4.31	.41	
Lower CO_2 emissions than conventional cars When oxygen and hydrogen react, they produce only water and heat, making hydrogen vehicles "zero-emissions" vehicles (like battery-powered electric vehicles). Total CO_2 emissions depend on the source of energy used to produce the hydrogen. If solar, wind or other renewable resources generate the electricity, hydrogen could be produced without any carbon emissions at all…	4.30	.40	
Price of fuel cell material The cost of the vehicles powered by hydrogen is still a key issue. Platinum is one of the most commonly used catalysts for fuel cells, but it is a very expensive and scarce resource. Initial pricing of Toyota Mirai, for instance, has been set at 53 231 € (state incentives in some countries could reduce the price).	2.24	.16	
Price of hydrogen Hydrogen fuel cars are, on a simple per km basis, cheaper to run than regular gasoline engines. Right now, state-of-the-art hydrogen extraction from natural gas, pressurized and delivered to the customer, costs, before taxes, less than 1 euro for a liter of gasoline equivalent.	4.06	.38	
Infrastructure needed New infrastructure will be needed for hydrogen refueling. Very few countries have more than 15 hydrogen filling stations operational and the network is only slowly growing. Interested drivers should ensure they live near hydrogen refueling stations.	2.53	.20	
Range Current hydrogen cars have a range of around 450 km. This is a higher range than the majority of Electric Vehicles in the market and a lower range as compared to the performance of diesel vehicles.	3.53	.33	
Safety issues Hydrogen poses risks of the same order of magnitude as other fuels. In a collision in an open space, a hydrogen fuel cell car should have less potential hazard than either natural gas or a gasoline vehicle. A potential risk is a release in an enclosed home garage, where an accumulation of hydrogen could lead to fire or explosion if no hydrogen detection or risk mitigation devices or measures are applied (such as passive or active ventilation).	2.89	.28	

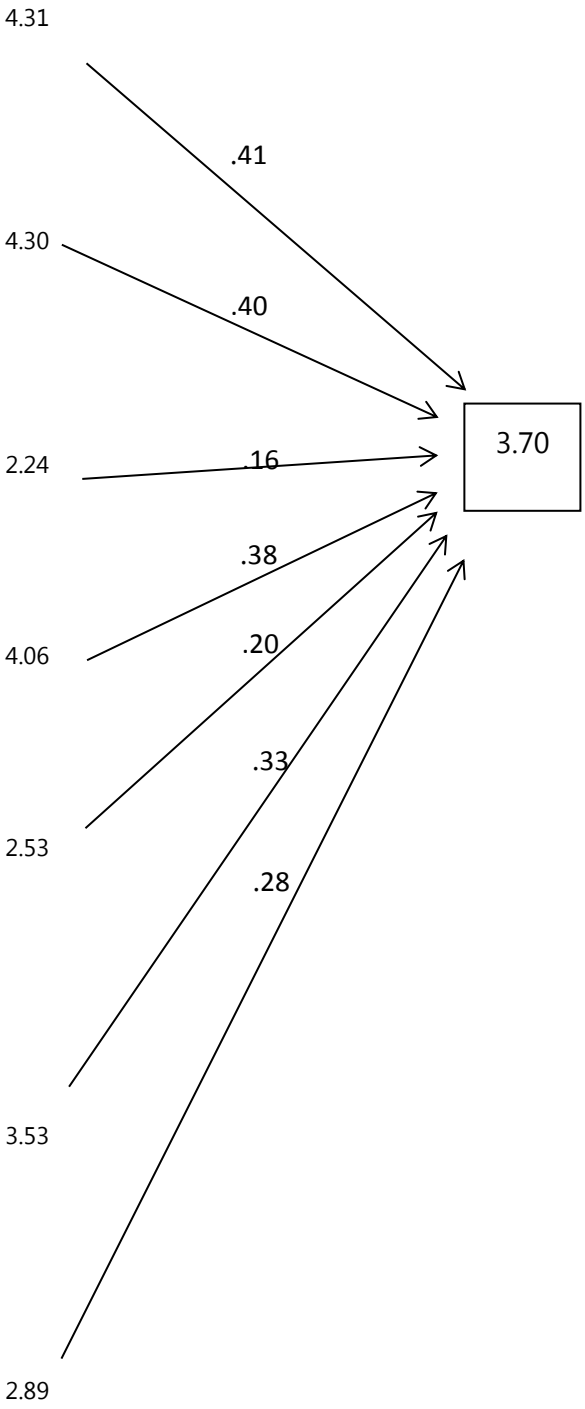


Figure 40. *Evaluation of consequences of FCEVs*

Figure 40 shows other potential consequences that respondents attribute to hydrogen fuel cell vehicles and that they consider also relevant. These potential consequences were raised by participants from an open question.

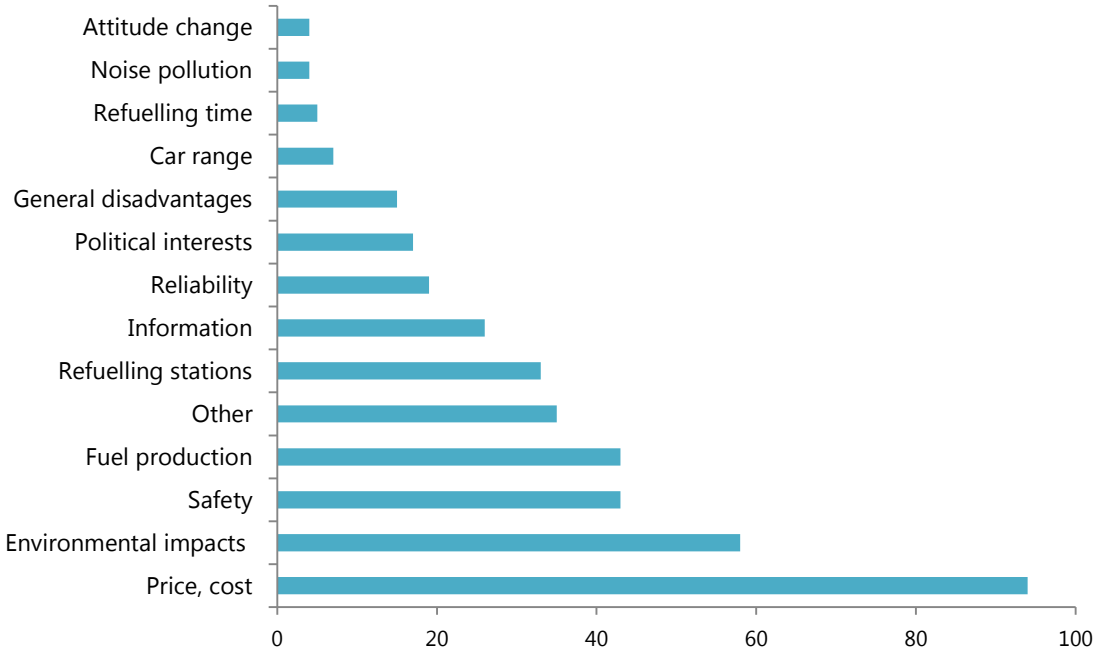


Figure 41. *Other consequences/attributes of FCEVs raised by respondents (in number of times mentioned)*

The majority of issues raised by respondents are related to the price of the fuel cell vehicle and the environmental impacts (see the Annex for details). Respondents generally consider the price of the hydrogen vehicle as too high. The second consequence more frequently raised by respondents is related to the environmental impacts associated with FCEVs. The majority of respondents pointing out to this consequence tend to mention the environmental benefits associated with the technology. The third most mentioned consequence regarding FCEVs has to do with safety. Some respondents refer to the risk of explosions. The fourth consequence is related to the use of hydrogen as a fuel. Some respondents consider it a positive consequence (e.g. it will reduce dependence on foreign fuel) while others perceive it as a negative consequence (e.g. dependency from natural gas, expensive production). The fifth most mentioned attribute is related to the lack of hydrogen refuelling stations. Other consequences mentioned by participants include the need for information, the reliability of the system, and the range and refuelling time of the vehicle.

3.3.6. Global evaluation

After the evaluation of the various consequences or attributes of hydrogen fuel cell vehicles, participants were asked to provide their overall evaluation of FCEVs.

As shown in figure 41, respondents in the full sample have a positive attitude towards FCEVs. The average evaluation of FCEV in the total sample is 3.7 in a scale of 1 to 5. Around 6 out of 10 respondents consider the technology a good or very good option; 3 out of 10 rate it as an acceptable option; and less than 1 out of 10 consider it a bad or very bad option.

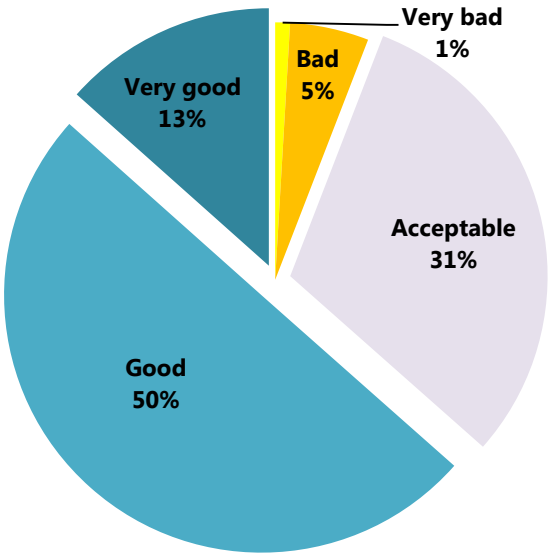


Figure 42. *Global evaluation of FCEVs (as % of respondents that consider them a very bad-very good solution)*

There are weak but significant differences among the countries studied. In all the countries surveyed we find that the majority of the population rates the technology as a good option (percentages vary between 44% and 56%), followed by those who rate it as acceptable (between 23% and 37%). The distribution of the attitude is, in a way, very similar in the seven studied populations. But on average, the attitude towards hydrogen vehicles is more positive in Slovenia (average in the scale of 3.78), Norway (3.77) and Spain (3.73) and more neutral in France (3.60) and Belgium (3.65).

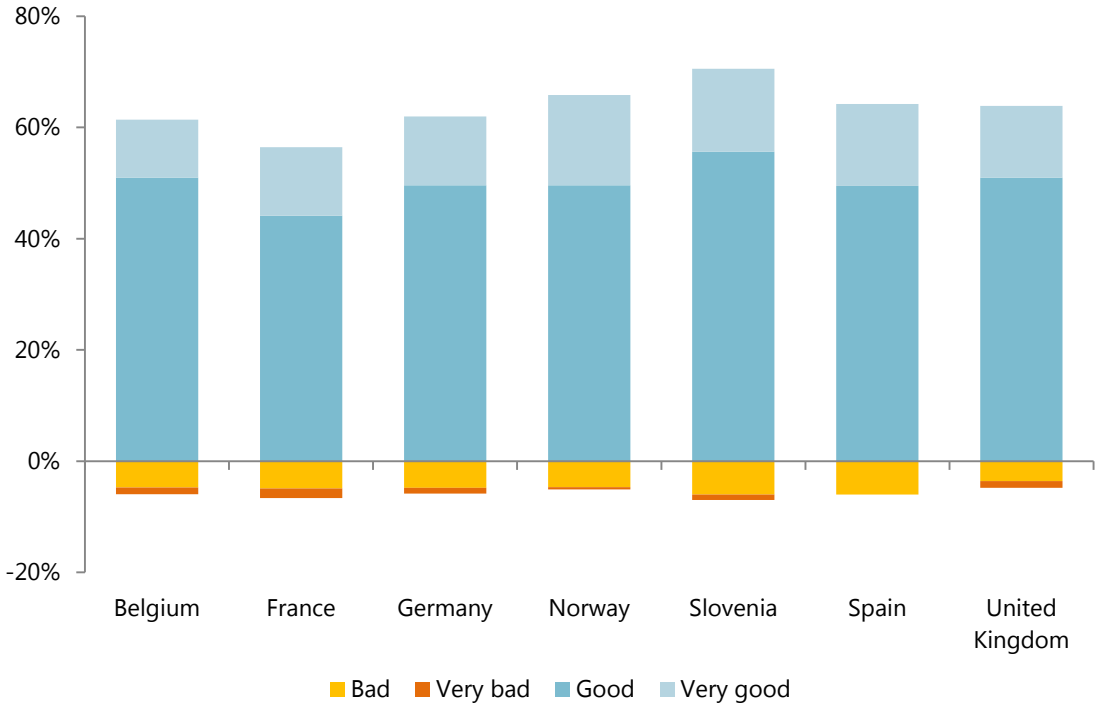


Figure 43. *Global evaluation of FCEVs in the seven countries (% of respondents that consider them a very bad-very good option)*

	BE (%)	FR (%)	DE (%)	NO (%)	SL (%)	ES (%)	UK (%)	Total	Difference (eta)
Very bad	1	2	1	0	1	0	1	1	
Bad	5	5	5	5	6	6	4	5	
Neutral	33	37	32	29	22	30	31	31	
Good	51	44	50	50	56	49	51	50	
Very good	10	12	12	16	15	15	13	13	
Total	100%	100%	100%	100%	100%	100%	100%	100%	
Mean	3,65	3,60	3,68	3,77	3,78	3,73	3,71	3.70	0.07

Male respondents tend to report a more positive evaluation of FCEVs relative to female respondents (3.80 vs. 3.60). Also respondents with a university degree report a more positive evaluation relative to those without a university degree (3.76 vs. 3.65). The informed evaluation of FCEVs does not vary significantly by age, size of residence or income (Table 20).

Table 20. *Global attitude according to sociodemographics*

		Global attitude (Mean)	Very good option (%)
Overall (n=3556)		3.70	13
Gender	Male	3.80*	16*
	Female	3.60	10
Age	18-34	3.72	13
	35-44	3.72	13
	45-54	3.67	13
	55+	3.70	14
Educational level	Non-university degree	3.65	13
	University degree	3.76*	13
Size of residence	<20.000	3.66	13
	20.000 – 1.000.000	3.77	15
	>1.000.000	3.73	12
Income	Finding it difficult to live with current income	3.66	14
	Coping on current income	3.68	11
	Living comfortably with current income	3.79	16*

**the difference between categories is statistically significant, p<0.01*

3.3.7. Preference for other technologies

In order to understand the preference for FCHs cars compared to other type of cars, respondents were asked to rate a set of alternative technologies as a worse, about the same or a better option than FCEVs.

As shown in figure 43, respondents generally express a preference for FCHs over conventional cars (the ratio of those who consider it a better option versus those who consider it a worse option is 0.45) and compressed or liquefied natural gas cars (ratio of 0.76). Full electric cars (ratio of 1.57) and hybrid cars (ratio of 1.95) are preferred options compared to hydrogen cars. The percentage of respondents that do not have a clear opinion on this (don't know option) is around 10%, standing out the 23% for the comparison between natural gas cars (CNG – LNG) and FCEVs.

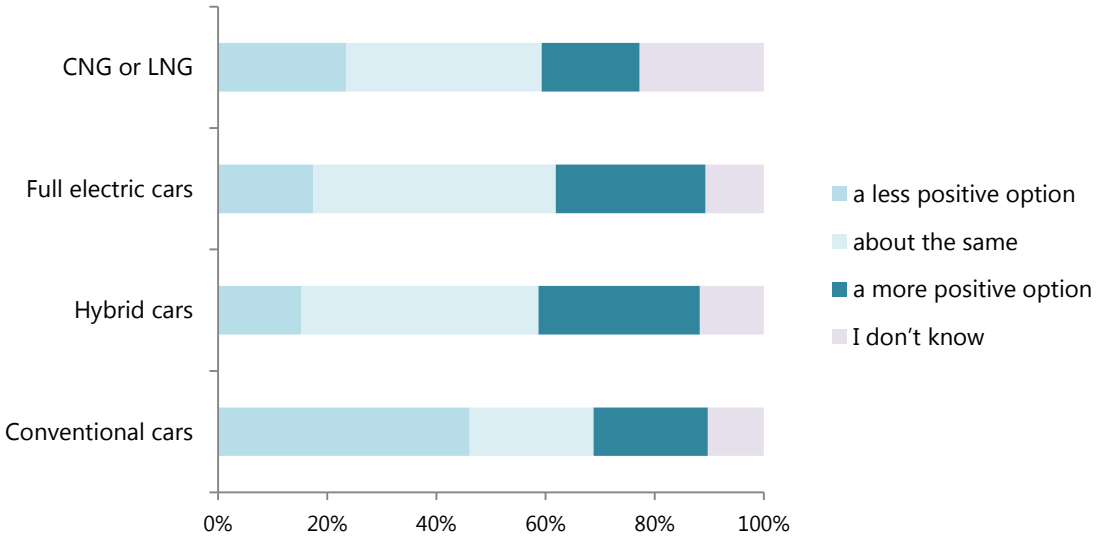


Figure 44. *Evaluation of alternative technologies as compared to FCEVs (as % of respondents that consider the alternatives a worse, about the same or a better option)*

There are significant differences across countries in their preference for alternative cars. So, although in all of the countries FCEVs are preferred over conventional cars (conventional cars are rated as a less preferred option), the average of the preference varies among the countries. Respondents in France and Spain have the highest preference for hybrid cars over FCEVs (39% and 35% respectively). In Norway and Slovenia, respondents have the highest preference for full electric vehicles over FCEVs. The details for the seven studied countries can be seen in the figure below which shows the rate of those preferring FCEV in comparison to other alternatives. Germany is the only country where the percentage of respondents that consider electric cars a worse option than FCHE cars is higher than the percentage that considers electric car a better option (Figure 44).

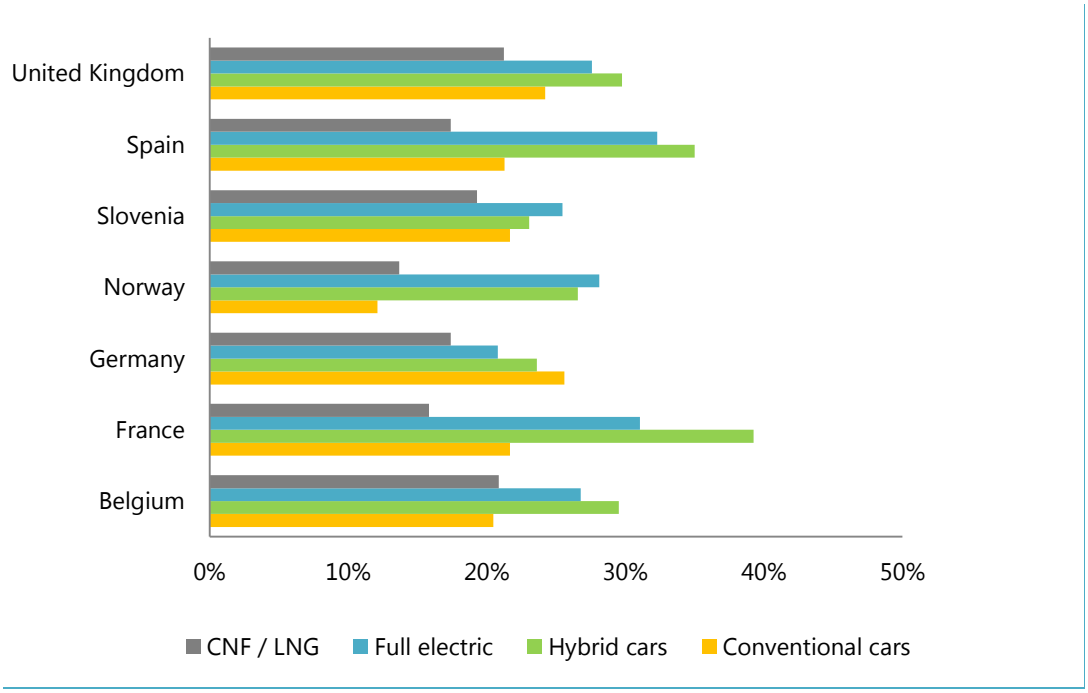


Figure 45. *Evaluation of alternative technologies as compared to FCEVs in the seven countries (as % of respondents that consider the alternatives a better option)*

3.3.8. Acceptance and support

The majority of participants in the seven studied populations would be happy to have a hydrogen fuel cell car in the future (keeping all else equal). More than 60% in the full sample would like to buy a FCH electric car in the future. Around 30% of respondents are undecided about it; and around 10% are not willing to have a hydrogen fuel cell car in the future.

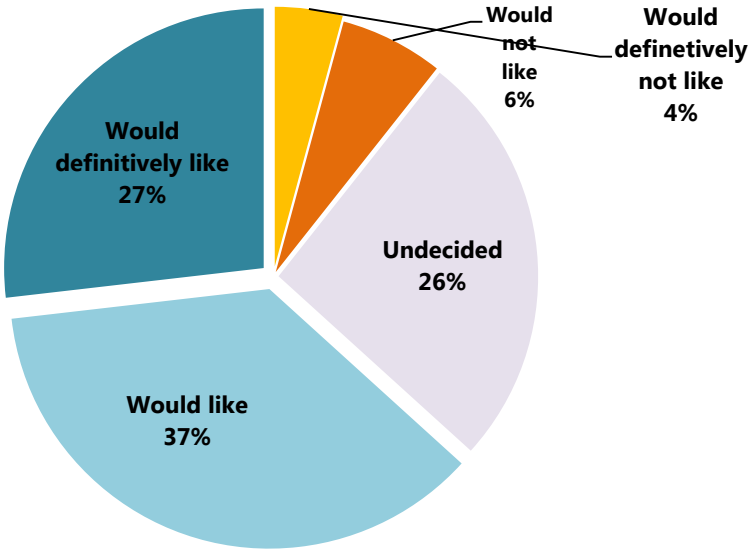


Figure 46. *Acceptance of FCEVs (% of respondents that would like to have a FCEV, all the countries)*

There are significant differences across countries. There is a higher level of acceptance of FCEVs in Norway and Spain (72%), and a lower level in Belgium (55%), United Kingdom (56%), and France (58%). In these three countries, more respondents are undecided about hydrogen cars (around 30%) and between 13 and 15% are not willing to have one in the future (Figure 46).

Willingness to buy a hydrogen car (acceptance) is significantly higher among male respondents relative to females (70% vs. 57%), respondents aged 35 to 44, and among those with a university degree. Willingness to buy a FCEV does not vary significantly by size of city of residence or income (Table 21)

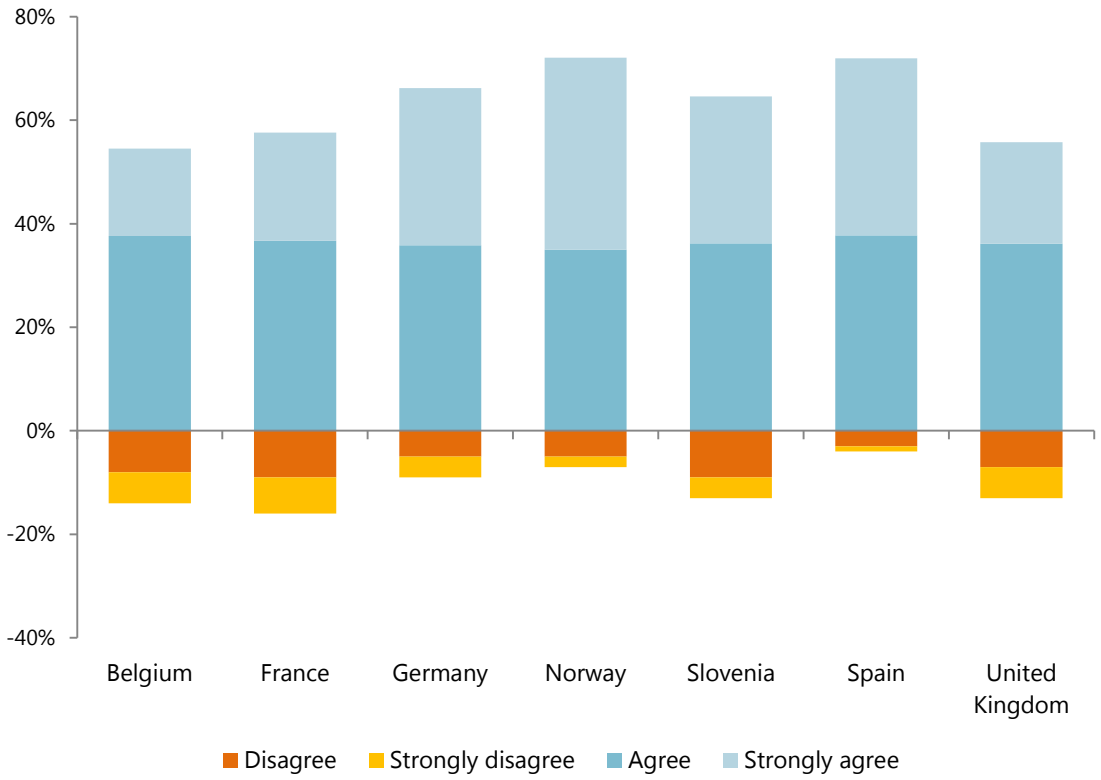


Figure 47. *Acceptance of FCEVs (% of respondents in the seven countries that would like to have a FCEV)*

Respondents were also asked if local communities should promote the substitution of conventional buses for hydrogen fuel-cells buses. This can be considered a measure of support to FCEVs. As shown in figure 47, support to public funding to FCHs is generally high in the seven studied countries, and higher than the intention to purchase a hydrogen car. Specifically, almost 80% of respondents agree with the substitution of conventional buses for hydrogen fuel cells buses. Less than 20% are undecided and less than 10% is reluctant to support FCH buses. So, in general terms, some of the individuals that were undecided about the purchasing of a FCEV in the future, are supportive of promoting hydrogen buses.

A similar pattern is found in the seven countries. UK and France are the most reluctant countries with higher percentages of respondents disagreeing (6.3% and 5.1% respectively) and undecided (22.8% and 21.3%) with the promotion of hydrogen buses.

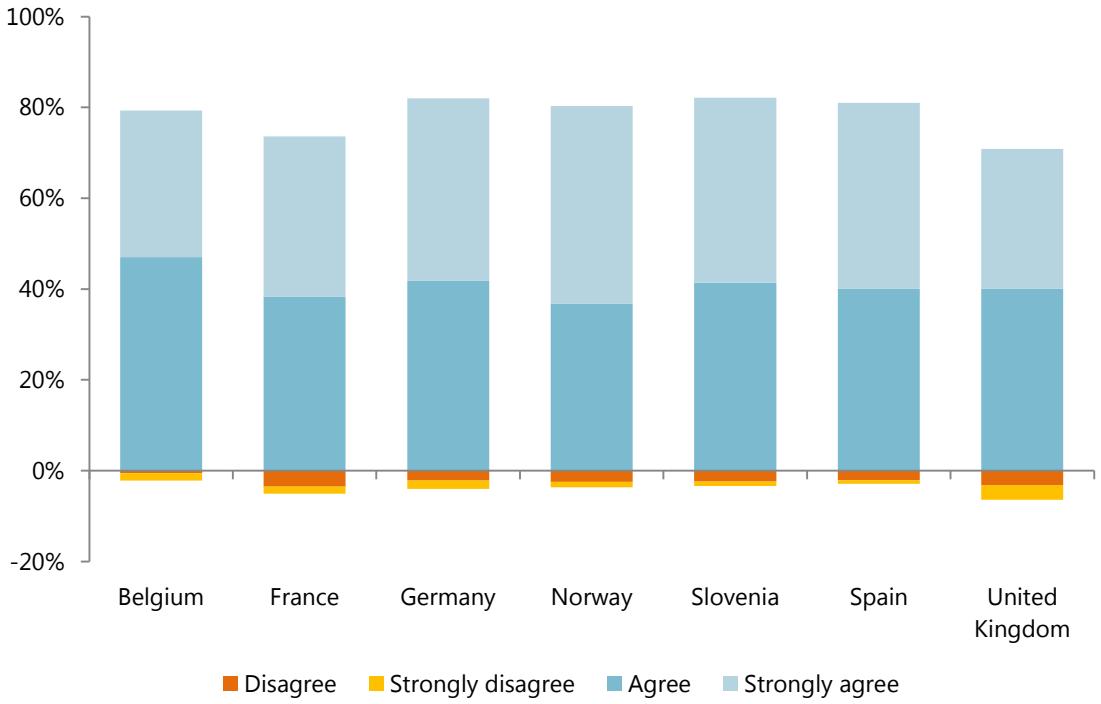


Figure 48. *Support to FCEVs (% of respondents in the seven countries that agree-disagree with the substitution of conventional buses for hydrogen fuel-cells buses)*

Table 21. *Acceptance and support to FCEVs according to sociodemographics*

		Acceptance (% of agree and strongly agree)	Support (% of agree and strongly agree)
Overall (n=3556)		63	78
Gender	Male	70*	82*
	Female	57	75
Age	18-34	66*	77
	35-44	68	80
	45-54	61	79
	55+	60	78
Educational level	Non-university degree	60	76
	University degree	67*	81
Size of residence	<20.000	62	78
	20.000 – 1.000.000	66	82
	>1.000.000	65	78
Income	Finding it difficult to live with current income	61	77
	Coping on current income	63	77
	Living comfortably with	68	82

current income	

**the difference between categories is statistically significant, p<0.01*

Self-reported likelihood of purchasing a hydrogen fuel cell car

Participants were asked to report how likely they would be to purchase a hydrogen fuel cell car in the case they need to purchase a car. To those who considered it unlikely or very unlikely, we asked the reasons for it.

In the general sample, we find that less than 20% of respondents consider it likely or very likely to purchase a FCEV. Around 10% considers it possible; and around 50% consider it unlikely or very unlikely. The country with a higher level of self-reported likelihood of purchasing a FCEV is United Kingdom (19%). Germany is the country with the lowest level of self-reported likelihood of purchasing a hydrogen car (8%).

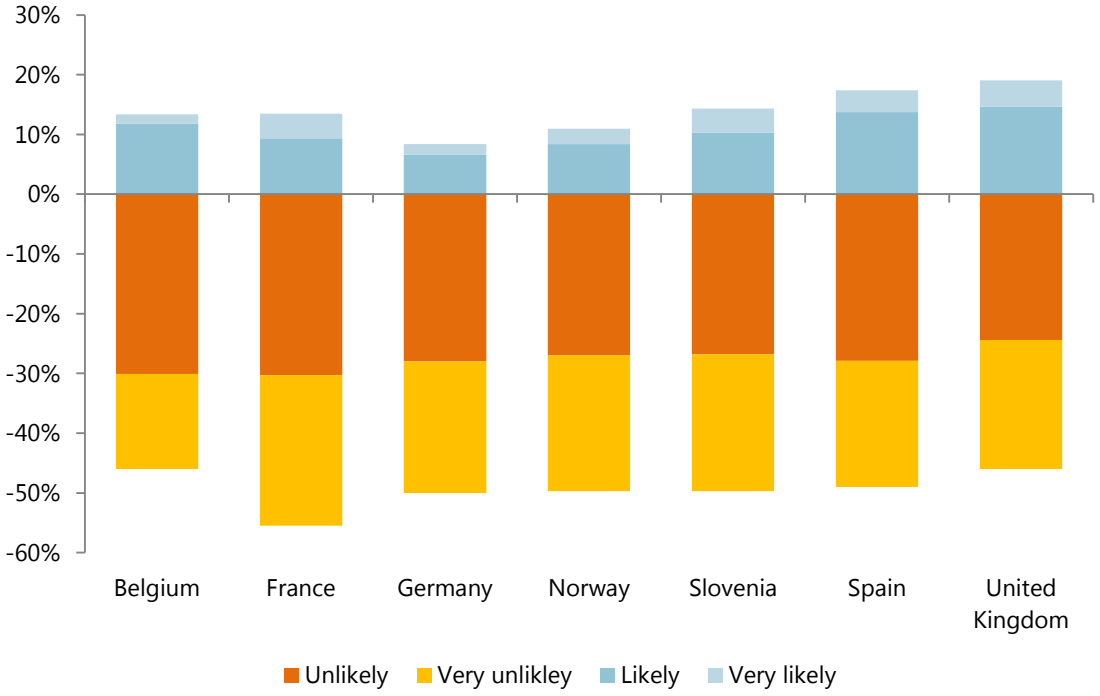


Figure 49. *Self-reported likelihood of purchasing a FCHE car (% of respondents in the seven countries that consider themselves very unlikely-very likely of purchasing a FCHE car)*

The self-reported likelihood of purchasing a hydrogen car in the future varies significantly by gender, age and size of place of residence. The percentage of respondents who report it is possible or very possible that they purchase a hydrogen car in the future is higher among male respondents, participants aged 18 to 34 and those living in cities with more than one million inhabitants (Table 22).

Table 22. *Self-reported likelihood of purchasing a hydrogen fuel cell car in the future according to sociodemographics*

		Self-reported likelihood (Mean)	Likely and very likely (%)
Overall (n=3556)		2.46	14
Gender	Male	2.57*	17*
	Female	2.35	11
Age	18-34	2.63*	19*
	35-44	2.49	15
	45-54	2.41	12
	55+	2.34	10
Educational level	Non-university degree	2.42	12
	University degree	2.51	16*
Size of residence	<20.000	2.39	12
	20.000 – 1.000.000	2.52	15
	>1.000.000	2.61*	21*
Income	Finding it difficult to live with current income	2.52	16
	Coping on current income	2.41	11
	Living comfortably with current income	2.48	16

**the difference between categories is statistically significant, p<0.01*

When respondents were asked about the reasons for not considering the purchase of a hydrogen fuel cell car, the price is reported as the most relevant factor (by 77% of participants considering unlikely to purchase a FCEV), followed by the maturity of the technology (by 43 % of respondents). The idea that having a hydrogen car would make participants life more difficult is the third mentioned factor (by 31% of the sample). Less than 30% of respondents argued that the reason for not purchasing a fuel cell vehicle would be that conventional cars are still a better option and less than 15% argued that full electric cars are a better option. Finally, 17% of those considering unlikely to purchase FCEV stated that they can't imagine themselves buying any car.

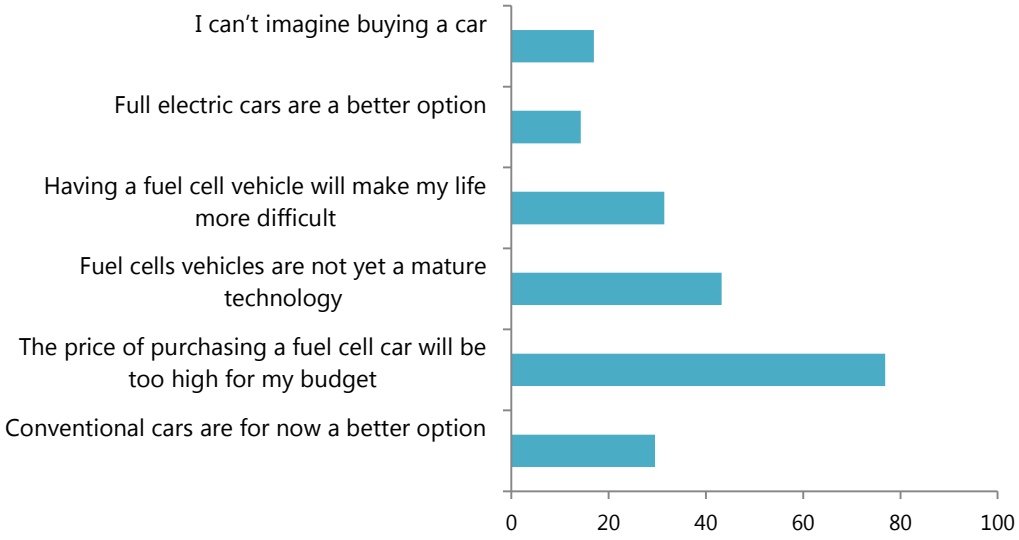


Figure 50. *Reasons for not purchasing FCEV (as % of those respondents that consider themselves very unlikely to purchase it)*

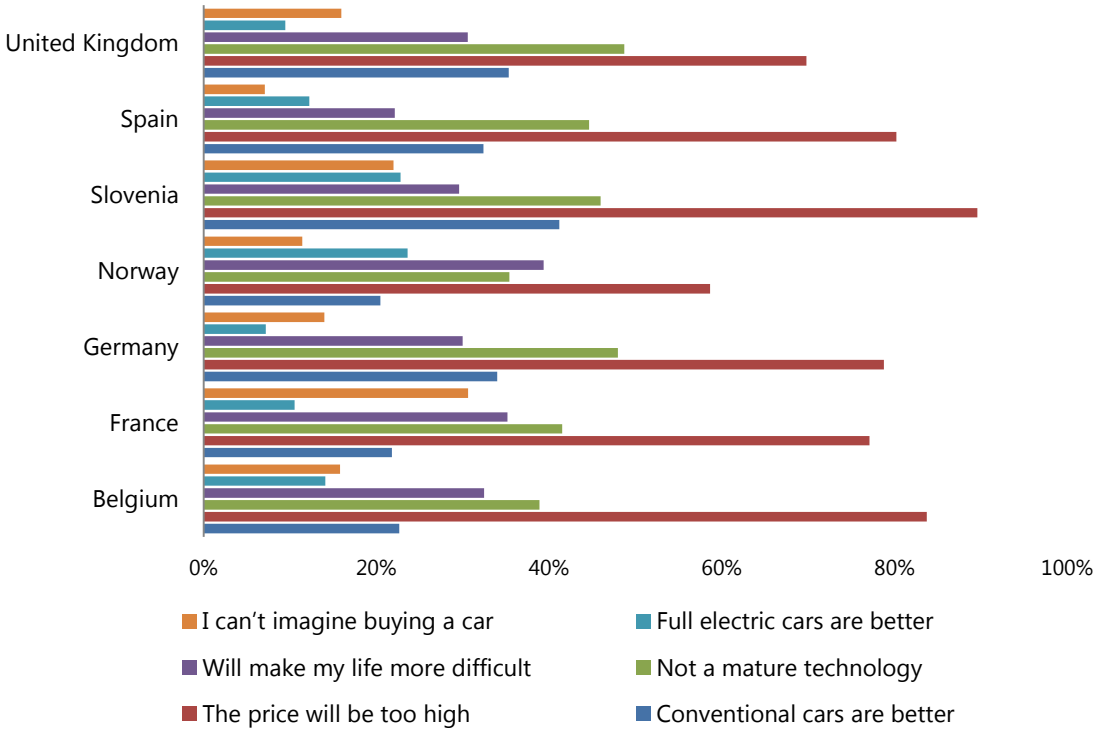


Figure 51. *Reasons for not purchasing FCEV (as % per country of those respondents that consider themselves unlikely to install a home fuel cell)*

Generally, we observe the same pattern in the seven studied populations. The price of the fuel cell vehicle is the main factor for respondents in the seven countries, followed by the perceived immaturity of the technology, the perception of associated difficulties and the perception that conventional cars are a better option. The differences between the factors slightly vary among the countries.

Respondents considering unlikely the purchase of a FCEV were asked for other reasons to not purchase a FCHE car. Around 10% of respondents provided an alternative reason for not purchasing a hydrogen car. As shown in Figure 51, the majority of respondents pointed out to the lack of refuelling stations as the main additional reason for not purchasing and FCEV (see Annex for more details on the reasons reported by respondents)

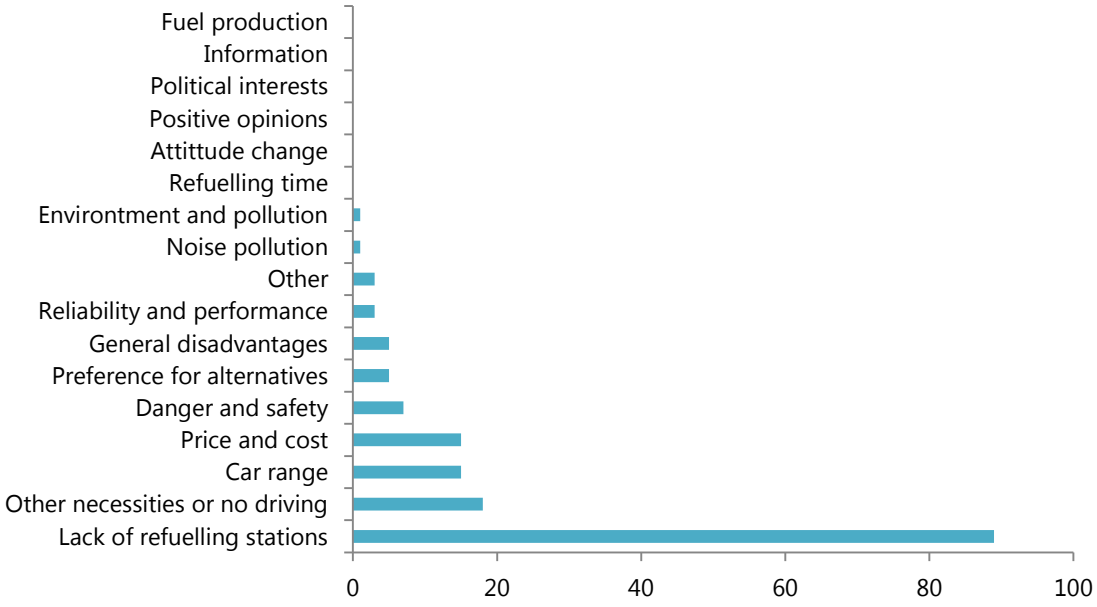


Figure 52. *Other reasons for not purchasing FCEV mentioned by respondents (in total number of mentions)*

3.3.9. Attitudes towards hydrogen refuelling stations

In order to explore the potential public acceptance of hydrogen station, participants were provided with information about the functioning of hydrogen refuelling station.

Then, respondents were first asked if they were aware of any hydrogen refuelling station in their region. Less than 5% of participants in the full sample reported being aware of any facility of this kind in their region. There are very small differences across countries. Norway is the country with a higher level of awareness of hydrogen refuelling stations, with 7% of the respondents reporting to be aware of one in their region.

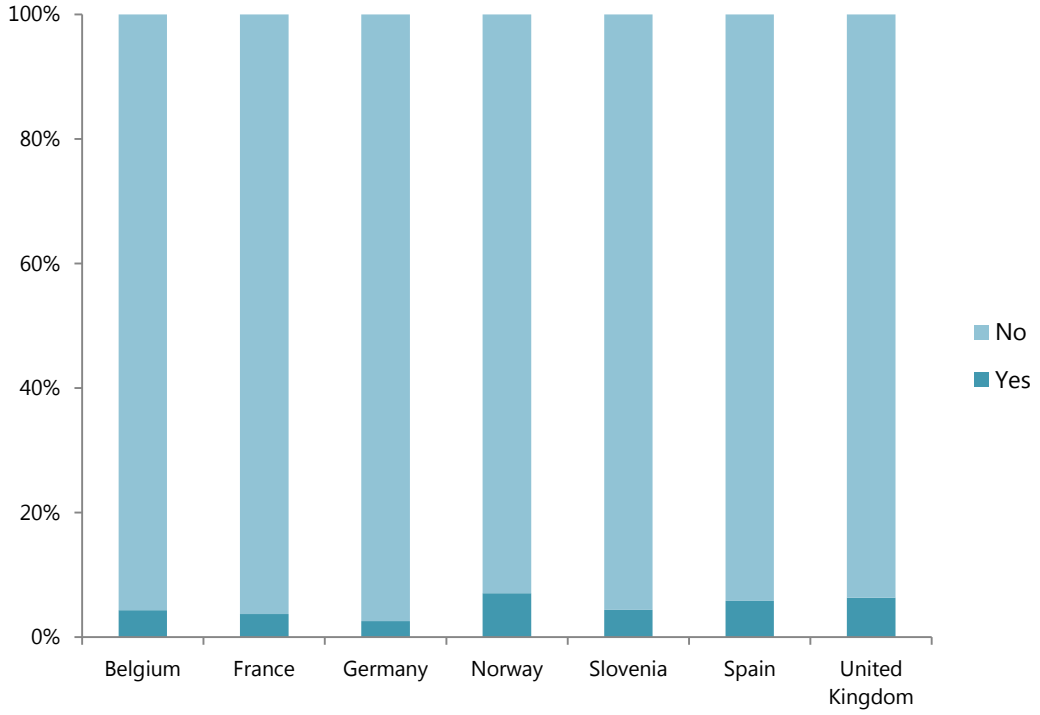


Figure 53. *Awareness of hydrogen refuelling stations in the seven countries (as % of respondents who is aware of the existence of a hydrogen refuelling station in their region)*

Expectations regarding hydrogen refuelling stations

Respondents were asked about their expectations with respect to hydrogen refuelling stations. Generally, as shown in figure 53, a hydrogen refuelling station is associated by the average respondent to more benefits than costs. In a scale from 1 to 5, being 1 a very negative impact and 5 a very positive impact, respondents rate hydrogen refuelling stations as having a general neutral-positive impact (3.7). They consider that hydrogen stations will have a positive effect on the environment (3.9), will be useful for people (3.7) and positive for the health of people living

nearby (3.7). Respondents also perceive hydrogen refuelling stations to be good for the local economy (3.6) and slightly safer than dangerous (3.5).

The seven studied populations differ weakly but significantly in their beliefs about the impacts of hydrogen refuelling stations. The perception of benefits is significantly higher than the average in Germany and France (3.8) and lower than the average in Norway (3.6). The seven studied populations are more similar in terms of their evaluation of the safety of this stations (eta= 0.053) and more different in their evaluation of the potential effects on the local economy (eta= 0.134).

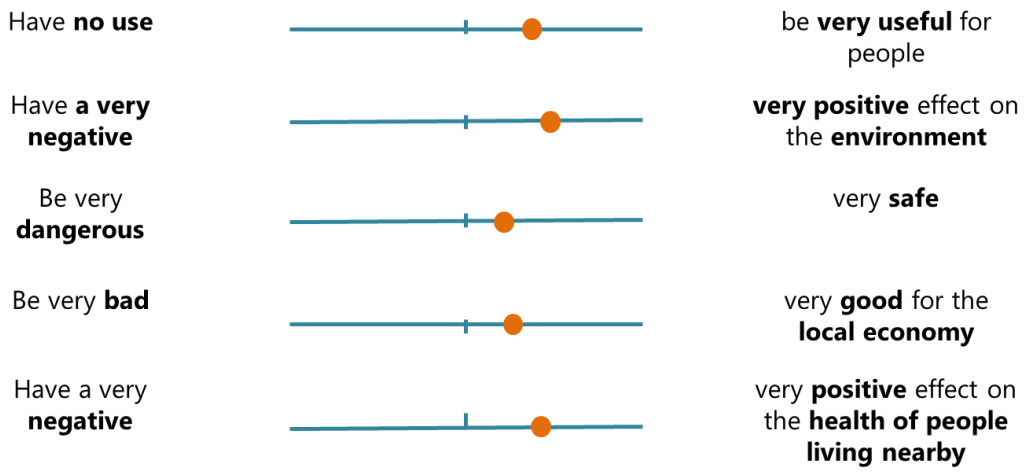


Figure 54. *Perception of benefits and costs associated to hydrogen refuelling stations (mean value)*

	Bg	Fr	Ger	Nor	Slov	Sp	UK	Total	Difference (eta)
Have no use - be very useful for people	3.81	3.90	3.90	3.61	3.67	3.63	3.63	3.74	0.11
Have a very negative - very positive effect on the environment	4.06	3.94	4.10	3.86	3.81	3.94	3.90	3.95	0.09
Be very dangerous - be very safe	3.53	3.52	3.56	3.45	3.44	3.37	3.45	3.47	0.053
Be very bad - very good for the local economy	3.67	3.81	3.75	3.33	3.74	3.63	3.68	3.66	0.134
Have a very negative - very positive effect on the health of people living nearby	3.84	3.76	3.87	3.68	3.68	3.73	3.68	3.75	0.066
Total	**3.78**	**3.79**	**3.84**	**3.59**	**3.67**	**3.66**	**3.67**	**3.71**	

Acceptance of hydrogen refuelling stations

Finally, respondents were asked, if they could vote in their town on placing a hydrogen refuelling station in their nearest petrol station, if they would vote in favour of it or against it. As seen in the figure below, the majority of the population in the seven studied countries would support the installation of a hydrogen refuelling station in their town. In the total sample, around 7 out of 10 respondents would vote in favour of the siting of the hydrogen refuelling station, 2.5 out of 10 are undecided and less than 1 out of 10 would vote against it.

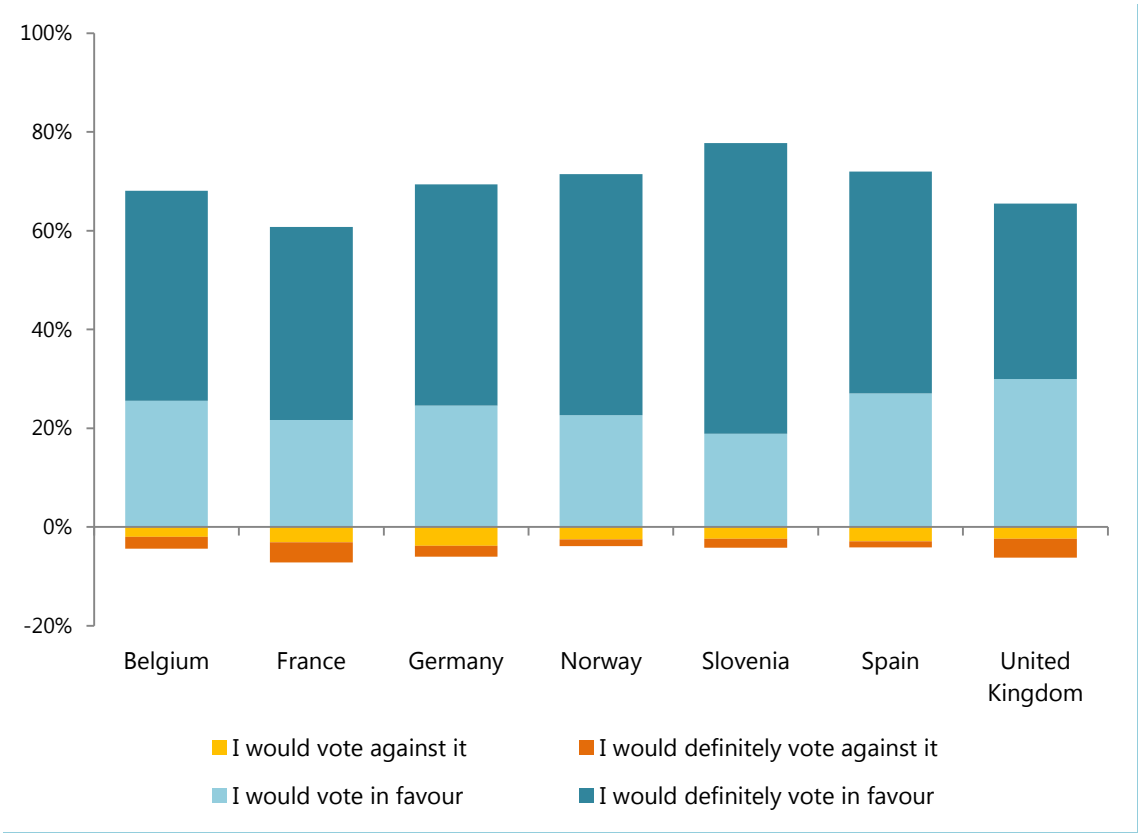


Figure 55. *Acceptance of hydrogen refuelling stations (% of respondents in the seven countries that would vote against-in favour of the siting of a hydrogen refuelling station)*

There are very small differences across the studied countries. Support is higher in Slovenia (78%) and Norway (72%); and lower in France (62%) and UK (65%), where a significant part of the population is undecided or neutral (around 30%). Very few people would initially oppose to a hydrogen refuelling station. This percentage varies from 4% in Norway to 7% in France.

There are very small and non-significant differences in the overall support to hydrogen refuelling stations by the sociodemographics. The percentage of respondents who report that they definitely would vote in favour of a hydrogen fuel station in their municipality is higher among males, those aged above 55, those with a university degree, and those with a higher income.

Table 23. *Support to hydrogen refuelling stations according to sociodemographics*

		Acceptance (Mean)	Definitely in favour (%)
Overall (n=3556)		4.51	45
Gender	Male	4.51	53*
	Female	4.50	37
Age	18-34	4.48	40
	35-44	4.44	42
	45-54	4.48	45
	55+	4.56	50*
Educational level	Non-university degree	4.50	44
	University degree	4.51	46*
Size of residence	<20.000	4.46	46
	20.000 – 1.000.000	4.54	47
	>1.000.000	4.47	40
Income	Finding it difficult to live with current income	4.49	44
	Coping on current income	4.50	42
	Living comfortably with current income	4.54	51*

**the difference between categories is statistically significant, p<0.01*

3.3.10. Attitudes towards FCEVs per country grouping

In order to examine the differences among the studied countries according to its level of technological implementation, in this section we provide further details about the specific situation of the selected groups (as categorized in WP2 in advance, medium and low support) regarding the public awareness and acceptance of FCEVs.

Advanced policy support to hydrogen

Germany

Public awareness of FCEVs is high in Germany (58% have heard or know a few things about FCEVs), but significantly lower than in Norway. Public attitude towards FCEVs is positive as 62% of respondents consider FCEVs as a very good or a good option. Acceptance of FCEVs is also high in Germany. Around 66% of respondents would like to have a FCEV. 82% of respondents would favour the substitution of conventional buses for hydrogen fuel-cells buses. Regarding hydrogen transport infrastructures, levels of public acceptance are also very high and 70% would vote in favour of the siting of a hydrogen refuelling station in their town.

Norway

Norway has the highest level of public awareness of FCEVs. Around 85% of respondents report having heard of this type of vehicles before the study. The informed evaluation of FCEVs is also significantly more positive in Norway relative to the other studied countries. Around 66% of respondents in Norway consider FCEVs as a very good or a good option. Norway has also the highest level of public acceptance of FCEVs among the seven countries. Around 72% of respondents would like to have a FCEV. 81% of respondents would favour the substitution of conventional buses for hydrogen fuel-cells buses and 73% would vote in favour of the siting of a hydrogen refuelling station in their town.

United Kingdom

Public awareness of FCEVs in the United Kingdom is high, similar to Slovenia and Belgium, but significantly lower than in Norway (54% have heard or know a few things about FCEVs). 56% of respondents consider FCEVs as a very good or a good option. In the same way, public acceptance of FCEVs in the UK is relatively low in comparison to the other studied countries with advanced support to hydrogen. Around 56% of respondents would like to have a FCEV. Support for hydrogen fuel cell buses is higher, and 70% of respondents would favour the substitution of conventional buses for hydrogen fuel-cells buses. 65% of respondents would vote in favour of the siting of a hydrogen refuelling station in their town.

Medium policy support to hydrogen

Belgium

Public awareness of FCEVs is relatively high in Belgium and very similar to other countries, as 60% of respondents report having heard of this type of vehicles before the study. 61% of respondents consider FCEVs as a very good or a good option. Public acceptance of FCEVs in Belgium is relatively low in comparison to Germany, Norway or Spain. Around 55% of respondents would like to have a FCEV. Support for hydrogen fuel cell buses is higher, and 79% of respondents would favour the substitution of conventional buses for hydrogen fuel-cells buses. 68% of respondents would vote in favour of the siting of a hydrogen fuelling station in their town.

France

Public awareness of FCEVs is relatively high and very similar to other countries, as 54% of respondents report having heard of this type of vehicles before the study. Global evaluation of FCEVs seems to be slightly more negative than in other countries as 56% of respondents consider FCEVs as a very good or a good option. Public acceptance of FCEVs in France is lower than in Germany, Norway or Spain, and very similar to Belgium and UK. Around 58% of respondents would like to have a FCEV. Compared to countries such as Germany, a significant percentage of the public in France seems to favour alternative technologies such as hybrid cars and full electric cars (39% and 31% respectively considers them a more positive option than FCEVs). Support for hydrogen fuel cell buses is higher, and 73% of respondents would favour the substitution of conventional buses for hydrogen fuel-cells buses. 61% of respondents would vote in favour of the siting of a hydrogen fuelling station in their town.

Spain

Public awareness of FCEVs is lower than other countries, as 47% of respondents report having heard of this type of vehicles before the study. Global evaluation of FCEVs seems to be slightly more positive than in France and very similar to other countries, as 65% of respondents consider FCEVs as a very good or a good option. Public acceptance of FCEVs and related infrastructures is also very high in Spain. Around 72% of respondents would like to have a FCEV. Support for hydrogen fuel cell buses is also high, and 81% of respondents would favour the substitution of conventional buses for hydrogen fuel-cells buses. 72% of respondents would vote in favour of the siting of a hydrogen fuelling station in their town.

Low policy support to hydrogen

Slovenia

Public awareness of FCEVs is relatively high, as compared to countries such as Spain and United Kingdom, as 63% of respondents report having heard of this type of vehicles before the study. Global evaluation of FCEVs is also slightly more positive in Slovenia than in other countries, and 71% of respondents consider FCEVs as a very good or a good option. Public acceptance of FCEVs is also high: around 64% of respondents would like to have a FCEV. Support for hydrogen

fuel cell buses is very high, and 82% of respondents would favour the substitution of conventional buses for hydrogen fuel-cells buses. 78% of respondents would vote in favour of the siting of a hydrogen fuelling station in their town.

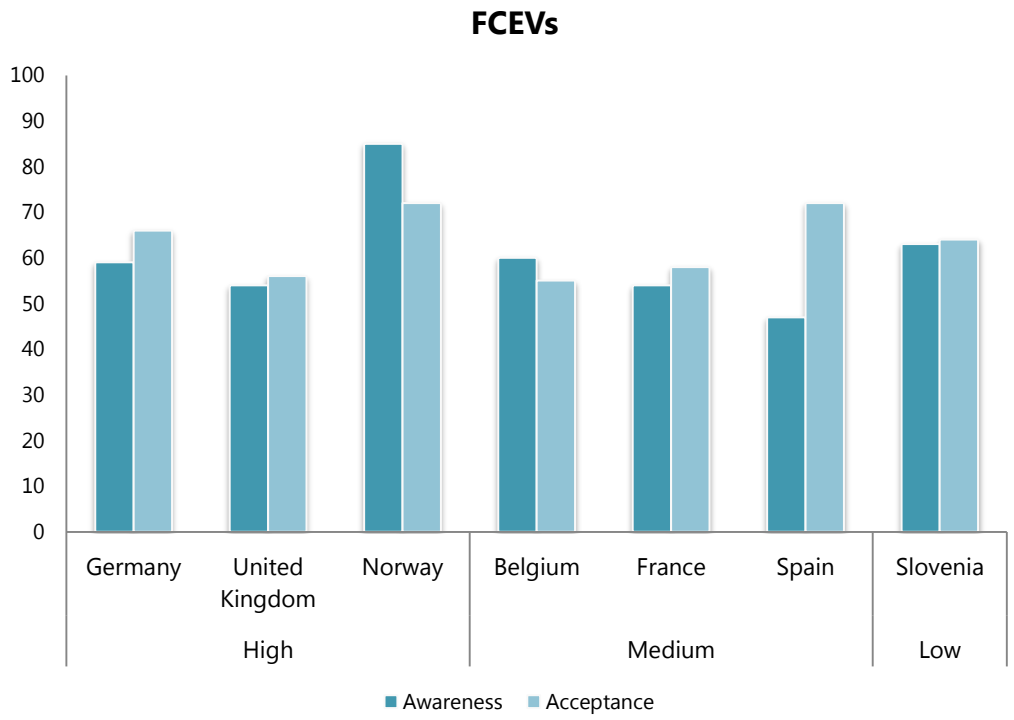


Figure 56. *Awareness and acceptance of FCEVs per country-grouping*

3.4. Other issues

3.4.1. Differences across countries in evaluation, acceptance and support of FCH applications

In order to summarize how strong the differences are across the countries in the main studied variables, table 24 below shows the strength of the difference through an association coefficient for each of the variables (Cramers' V coefficient for awareness and eta coefficient for the rest of the variables).

As shown in the table, in general, the differences among the studied populations are weak to moderate, as the majority of respondents in the seven countries report a neutral to positive attitude towards FCH applications. The differences among the countries are slightly higher regarding respondents' support to public funding to the purchase of residential FCHs (e.g. subsidizing the price of purchase) (eta= 0.20) and acceptance (willingness to adopt) of FCH electric vehicles (eta= 0.19). Interestingly, acceptance of hydrogen refuelling stations is very similar among the studied populations (the difference between the countries is statistically not significant). For the rest of the studied variables, the differences are statistically significant and range between 0.10 and 0.15.

Table 24. *Differences across countries in the main studied dimensions*

	Strength of the difference (eta)
Awareness of FCHs	0.12 (Cramer's V)*
Initial evaluation of FCHs	0.11*
Residential FCH	
Informed evaluation of home FCH	0.14*
Acceptance (willingness to adopt)	0.15*
Support to public funding of residential FCH	0.20*
FCH vehicles	
Informed evaluation of HFEV	0.07*
Acceptance (willingness to adopt)	0.19*
Support of FCHE buses in cities	0.11*
FCH Infrastructures	
Acceptance of FCH power plant	0.16*
Acceptance of H2 refuelling stations	0.05

** the difference is significant (p value <0.05; Brown-Forsythe test)*

3.4.2. Sociodemographic correlates of public attitudes towards FCH applications

To summarize how the various sociodemographic variables are associated to the main dependent variables in the study, such as awareness, interest, global attitude or acceptance, Table 25 shows, for each sociodemographic variable, the number of dependent variables for which exist a statistically significant association. The table also shows the percentage of significant associations that follow a similar pattern (e.g. having a university degree is associated with more awareness, more acceptance, etc.) for each sociodemographic variable,

Table 25. *Significant associations between sociodemographic variables and main dependent variables (23)*

	Number of significant associations	% of associations with the same polarity
Gender	20/23	100%
Age	15/23	60%
Educational level	12/23	100%
Size of residence	8/23	87%
Income	7/23	100%

The data show that gender is the sociodemographic variable associated to a higher number of dependent variables. It is associated to 20 of the 23 dependent variables studied. In terms of the form of the association, gender follows a similar pattern in 100% of the associations: male respondents are more positive, more aware and more supportive to FCH applications. Age is significantly associated to 15 of the 23 variables. But the pattern of association is less stable; for some variables younger participants are more positive while for other variables older participants express a higher valuation. Educational level is the third sociodemographic variable in terms of impact on dependent variables. It is significantly associated to 12 of the 23 studied variables. The pattern of association is very stable: participants with a university degree tend to report a higher valuation (e.g. awareness, interest, acceptance, support). Finally, size of residence and income are significantly associated to 8 and 7 of the 23 variables respectively (less than 40% of our studied dimensions). The pattern is stable for both variables: those living in cities bigger than one million inhabitant and those "living comfortably with current income" report more positive values in the studied variables (tend to be more interested, familiar, supportive, etc.).

3.4.3. Supporters and opponents

Based on the level of acceptance and support to the two studied FCH[2] applications, respondents can be categorized into three groups: supporters, neutrals and opponents. As shown in the figure below, 6 out of 10 respondents in the whole sample can be considered supporters of FCHs applications. Of these, more than half were initially unfamiliar with the technology. 3 out of 10 can be considered neutral about FCHs. The majority of them were unfamiliar with the technology. Finally, almost 1 out of 10 respondents can be considered opponents.

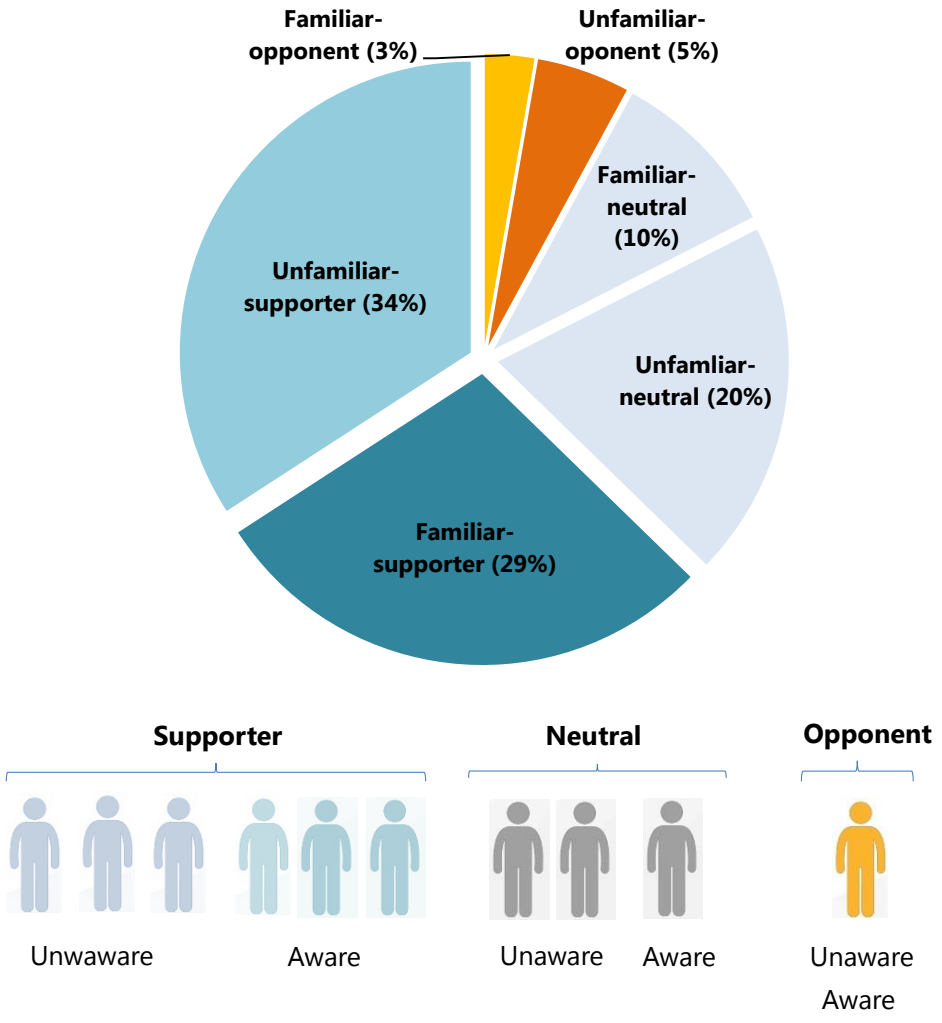


Figure 57. *Classification of all respondents according to their level of awareness and their attitude to FCH applications (%, all countries)*

[2] We created a new variable based on four items regarding acceptance and support to home HFCs and FCEVs.

The figure below displays the proportion of supporters, neutrals and opponents per country. There are significant differences between the seven countries (up to 16 percentage points). The highest percentages of supporters are found in Slovenia, Spain and Germany, where more than 60% of the population supports FCH applications. The lowest levels of support are found in United Kingdom, France and Belgium, where this percentage decreases to around 53%. In these three countries, the percentage of neutrals ranges from 33 to 37%. So, although support is generally high in the studied populations, scepticism is significant in some of the countries.

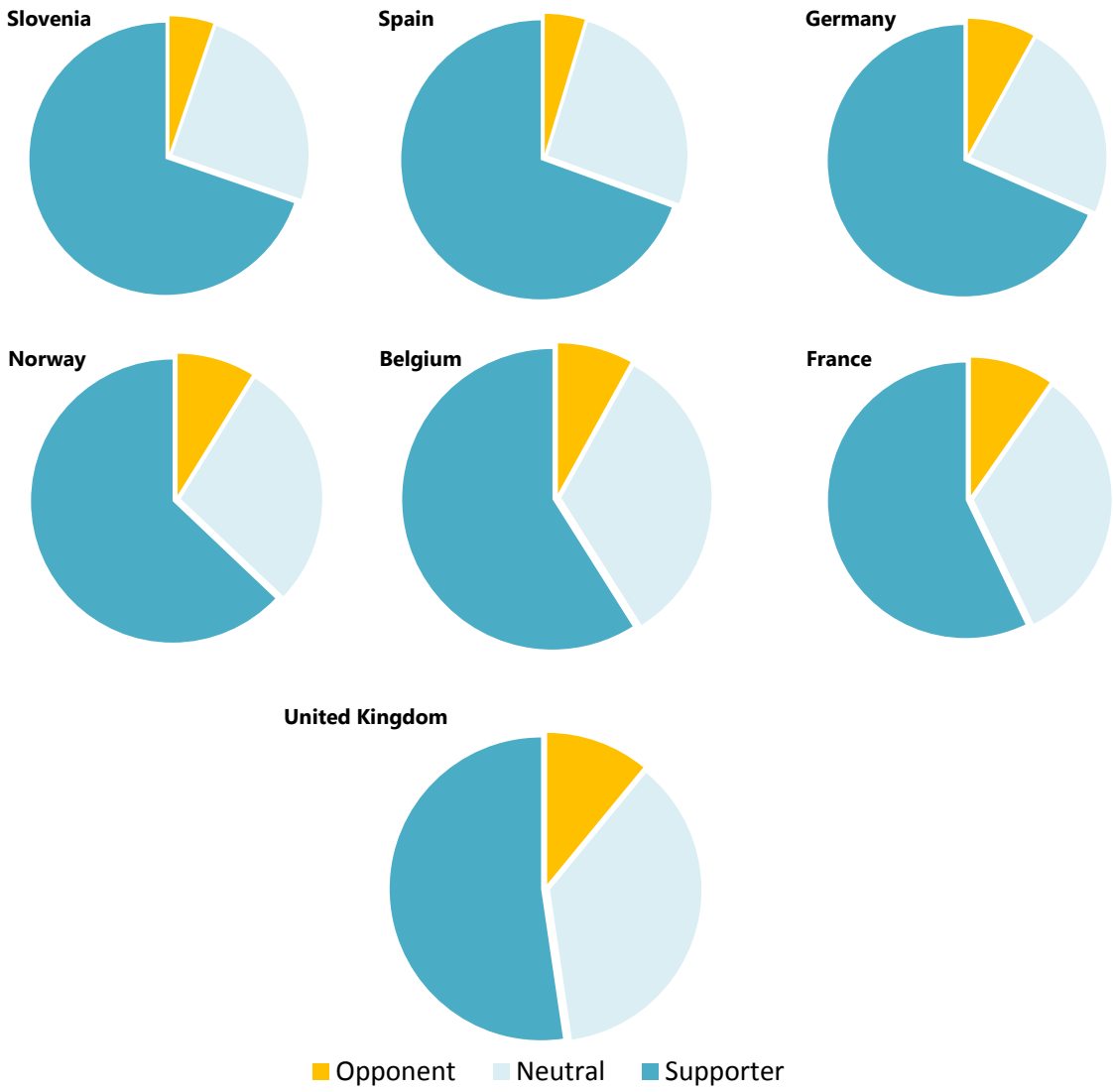


Figure 58. *Distribution of supporters, neutrals and opponents to FCH applications in the seven countries*

Supporters and opponents differ significantly in their affects, beliefs and reactions towards FCH technologies. The figure below displays the average value of supporters and opponents in a

number of relevant dimensions such as the uninformed evaluation of FCHs, interest, worry, beliefs (perception of benefits), global evaluation of home FCHs and FCEVs, self-reported likelihood of installing a home FCH and purchasing an FCHEH and general trust.

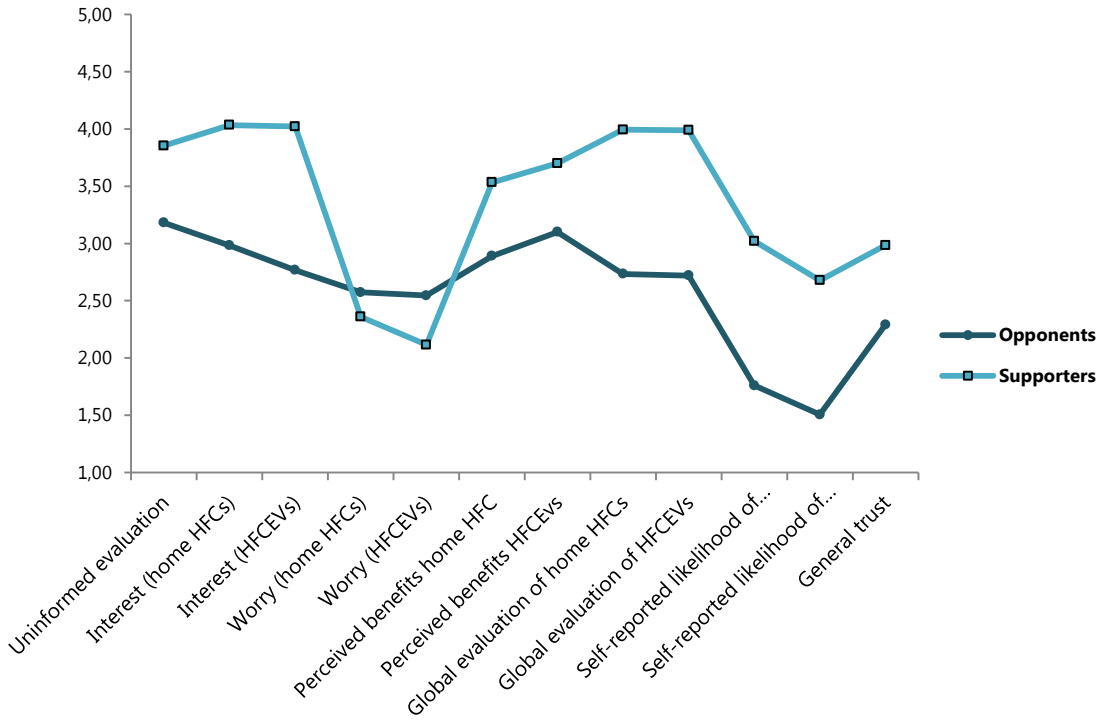


Figure 59. *Attitudes towards FCH applications of supporters and opponents to FCH applications (mean, all countries)*

	Opponents		Supporters		Strength of the difference
	M	SD	M	SD	Eta
Uninformed evaluation	3.2	0.8	3.9	0.7	0.29
Interest (home FCHs)	3.0	1.1	4.0	1.0	0.31
Interest (FCEVs)	2.8	1.2	4.0	1.1	0.34
Worry (home FCHs)	2.6	1.1	2.4	1.1	0.06
Worry (FCEVs)	2.5	1.2	2.1	1.1	0.12
Perceived benefits home FCH	2.9	0.9	3.5	0.9	0.22
Perceived benefits FCEVs	3.1	1.1	3.7	1.1	0.17
Global evaluation of home FCHs	2.7	0.9	4.0	0.7	0.49
Global evaluation of FCEVs	2.7	0.8	4.0	0.7	0.50
Self-reported likelihood of installing a home FCH	1.8	0.9	3.0	1.0	0.39
Self-reported likelihood of purchasing an FCEV	1.5	0.8	2.7	1.0	0.34
General trust	2.3	0.9	3.0	1.0	0.21

Opponents and supporters differ significantly in their cognitive and emotional responses to FCHs applications. Opponents report a more negative initial evaluation of FCHs. They also report

less interest in the technology, as well as a level of worry slightly higher than supporters. They perceive fewer benefits in micro-chp fuel cells as well as in FCEVs. They report a more negative global attitude towards home FCH units and FCEVs, a smaller likelihood of purchasing a home FCH or an FCEV and a lower level of trust in actors managing the technology. As shown by the eta coefficient, the differences between opponents and supporters are higher for the global (informed) evaluation of FCHs and lower for reported worry, where both profiles are more similar.

Both groups are very similar in their sociodemographic characteristics. But there is a significant difference regarding the age of both groups: opponents are older than supporters. Specifically, a 46% of opponents are 55 years of age or older, whilst they represent only a 36% of the supporters. Male respondents are also slightly overrepresented among supporters. There are no relevant differences between both groups in terms of educational level, size of the city and income.

Table 26. *Sociodemographic characteristics of opponents and supporters*

		Opponents (%)	**Supporters (%)**
Global (n= 5048)			
Gender	Male	47*	52
	Female	53	48
	Total	100%	100%
Age	18-34	19*	28
	35-44	17	19
	45-54	18	18
	55+	46	36
	Total	100%	100%
Educational level	Non-university degree	78	75
	University degree	22	25
	Total	100%	100%
Size of residence	<20.000	48	44
	20.000 – 1.000.000	41	45
	>1.000.000	11	11
	Total	100%	100%
Status/income	Finding it difficult to live with current income	31	30
	Coping on current income	42	46
	Living comfortably	27	24
	Total	100%	100%

**the difference between categories is statistically significant, p<0.01*

3.4.4. Trust

Participants were asked about their level of trust in industry and the government in their country to: a) to make good decisions about hydrogen technologies; and b) to solve possible problems and succeed in implementing hydrogen technologies safely and in a responsible way.

Figure 58 shows a general medium level of trust in the industry and governments to make good decisions and implement hydrogen technologies safely. On average, respondents in the seven countries have a medium level of trust in the industry and a medium to low level of trust in the government, regarding the implementation of FCH technologies. Specifically, respondents in the seven studied populations have the highest level of trust in the ability of the national industry to solve possible problems and succeed in implementing hydrogen technologies safely and in a responsible way (M= 3.11) and the lowest level of trust in the capacity of national governments to make good decisions about hydrogen technologies (M= 2.65).

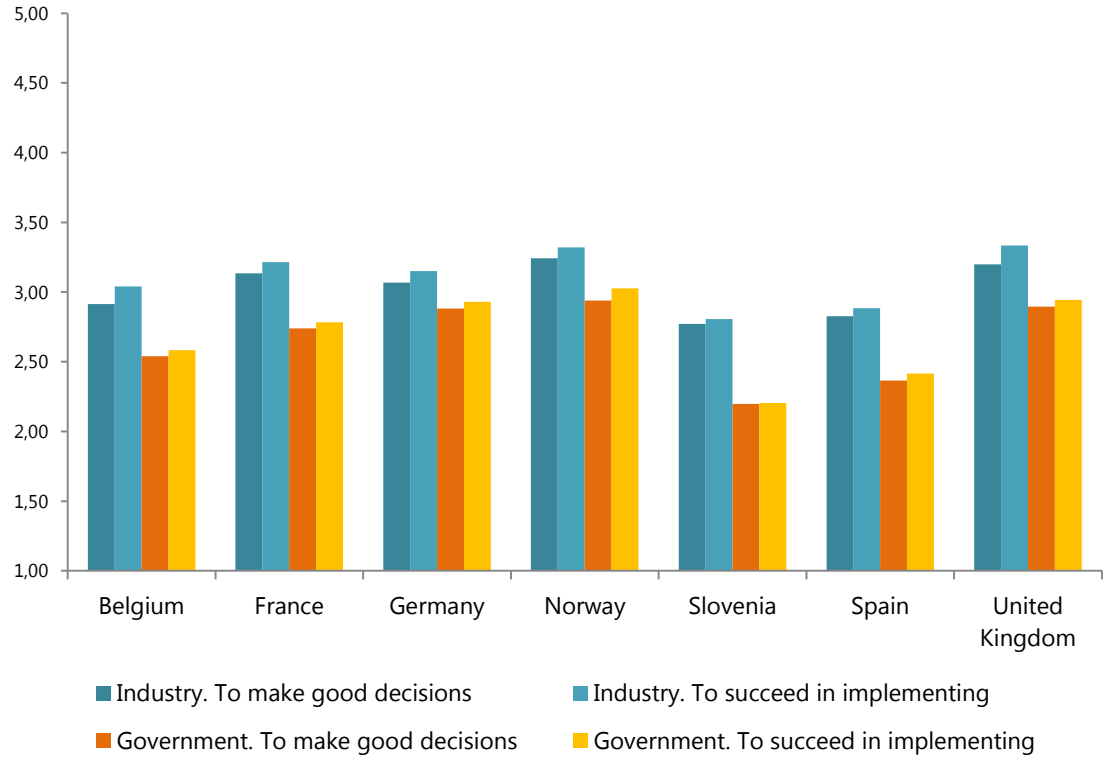


Figure 60. *Trust in government and industry to make good decisions and succeed implementing FCH technologies (mean, seven countries)*

There are significant differences across the countries. We find higher levels of trust in Norway, United Kingdom and France, where between 30 and 35% of the population reports a high level of trust in both the industry and the government to advance FCH technologies, and lower levels of trust in Slovenia and Spain, where this percentage decreases to around 20%.

3.4.5. Changes in the evaluation of FCH

By comparing the global evaluation or global attitude to FCHs reported by participants at the beginning of the questionnaire with the evaluation reported after having read information about the two specific FCH applications and its potential consequences, we can measure what happens in respondents' judgement when it becomes more informed (as they have read information about the consequences) and specific (as they are evaluating specific applications instead of FCHs in general).

Figure 59 displays the comparison of the uninformed evaluation of FCHs with the informed evaluation of domestic FCH units and FCEV for the seven studied populations and for the whole sample. Results show that in the whole sample, the evaluation changes from an average of 3.67 in the uninformed evaluation of FCHs to 3.70 and 3.70 in the informed evaluation of domestic FCH units and FCEVs respectively. Differences are statistically significant but almost non relevant (d= -0.04; d= -0.04). That is, there is a non-relevant improvement in the attitude when respondents' judgement becomes more informed and specific.

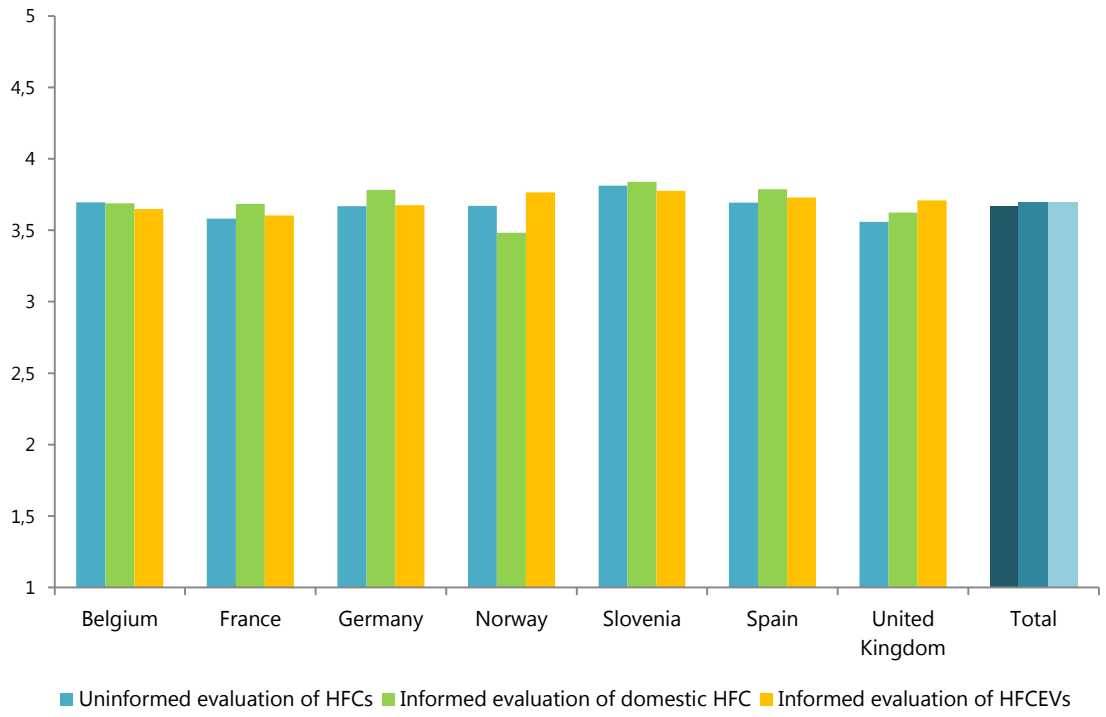


Figure 61. *Change from uninformed evaluation to informed evaluation (mean, seven countries)*

The variation from the uninformed evaluation to informed and specific evaluation is stronger, although still small, in some of the countries. For instance, the change between the uninformed global evaluation of FCHs and the informed evaluation of residential FCH units is higher in Norway (it declines from 3.67 to 3.48 respectively). In UK, on the other hand, we find a stronger difference if we compare the uninformed global evaluation of FCHs with the informed evaluation

of FCEVs. Specifically, the attitude improves from 3.56 to 3.71. Except from Norway and Belgium, where we observe a slight decrease in the evaluations after receiving the information, in all the other countries the evaluations increased or stayed at the same level.

The figure below displays the differences in the three evaluations depending on whether participants had heard about FCH technologies before participating in the study. The data show a different pattern for those respondents previously aware about the technology than for those respondents initially unaware of FCHs technologies. Among those participants that were initially aware of FCHs, the evaluation slightly declines from the uninformed judgement to the informed and specific evaluation of home FCH units and FCEVs. The difference in the evaluation is very small (*d*= 0.12 and 0.08 respectively) but statistically significant (t test for both comparisons p value= 0.00). On the contrary, for those participants that were not aware about FCHs, the evaluation slightly improves from the uninformed evaluation of FCHs to the informed evaluation of home FCHs and FCEVs. The difference in the evaluation is again very small (*d*= 0.14 and 0.12 respectively) but statistically significant (p= 0.00).

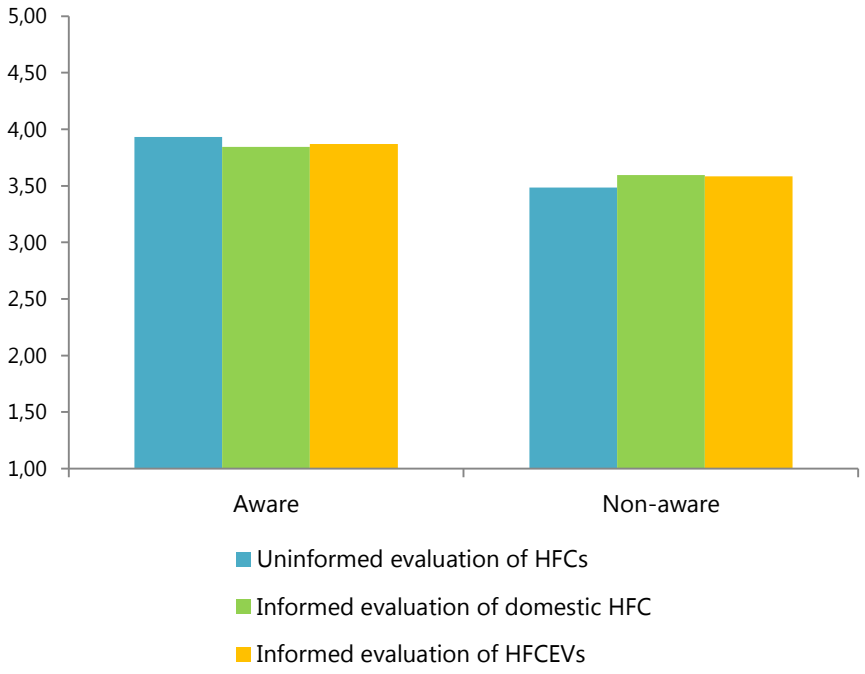


Figure 62. *Change from uninformed evaluation to informed evaluation for those previously aware and non-aware (mean, seven countries)*

We also examined the changes in the evaluation between supporters and opponents. As shown in the figure below, the effect of being informed and more specific differs significantly on the basis of the position of the participant. For supporters, the evaluation of FCHs improves slightly as the judgement becomes more informed and specific. Specifically, it improves from 3.85 to 3.99 and 3.99 respectively. This difference is small but statistically significant (*d*= 0.20 and 0.20, p= 0.00). For neutrals, we observe a slight decrease in the evaluation, from 3.40 to 3.35 and 3.32. This difference is very weak (d= 0.08 and 0.12; p= 0.00). For opponents, interestingly, there is a

stronger decrease in the evaluation, from 3.18 to 2.73 and 2.72 (d= 0.55 and 0.58, p= 0.000), meaning that as opponents become more informed about FCH applications, their evaluation of the technology gets worse, and this variation is significantly higher than for supporters or neutrals.

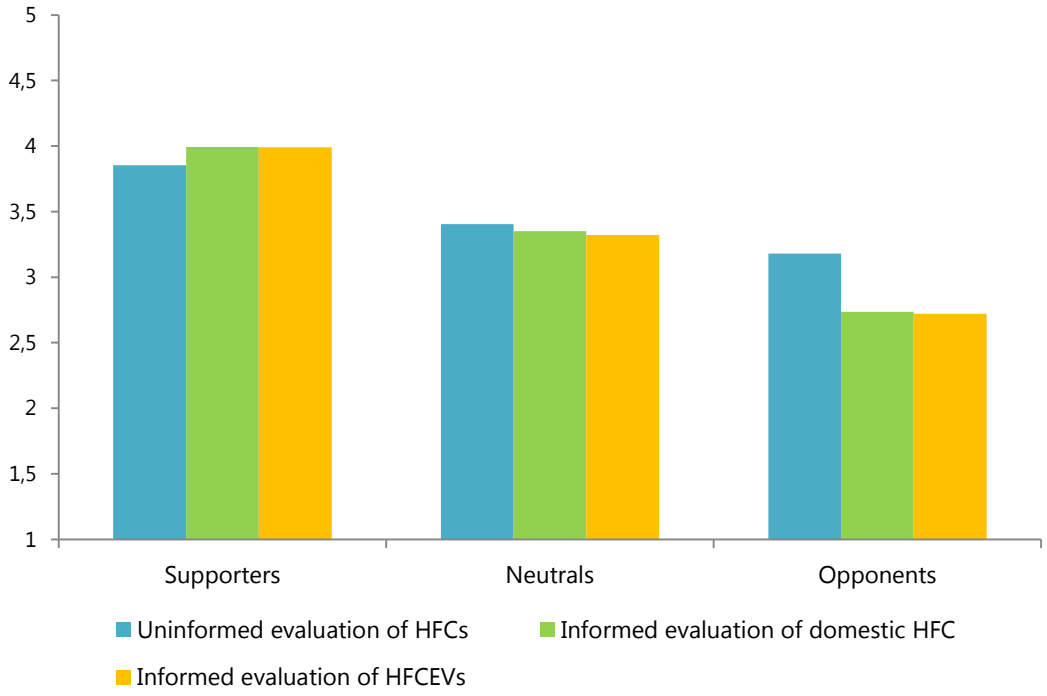


Figure 63. *Change from uninformed evaluation to informed evaluation for supporters, neutrals and opponents (mean, seven countries)*

3.4.6. Attitudinal predispositions

By combining participant's responses to four items measuring environmental self-identity, pro-technology beliefs and lifestyles, we clustered respondents into four orientations: pro-environmental and pro-technology; pro-environmental and non-pro-technology; pro-technology and non-pro-environmental; non pro-environmental and non-pro-technology. The four orientations were built based on a logical categorization of four questionnaire items and not on an empirical cluster statistical analysis.

The specific items included in the analysis were the following:

- "I think of myself as someone who is very concerned with environmental issues"
- "Technology will solve many environmental problems"
- "How often do you engage in each of the following activities?"
  - a) helping the environment;
  - b) researching or trying new technology

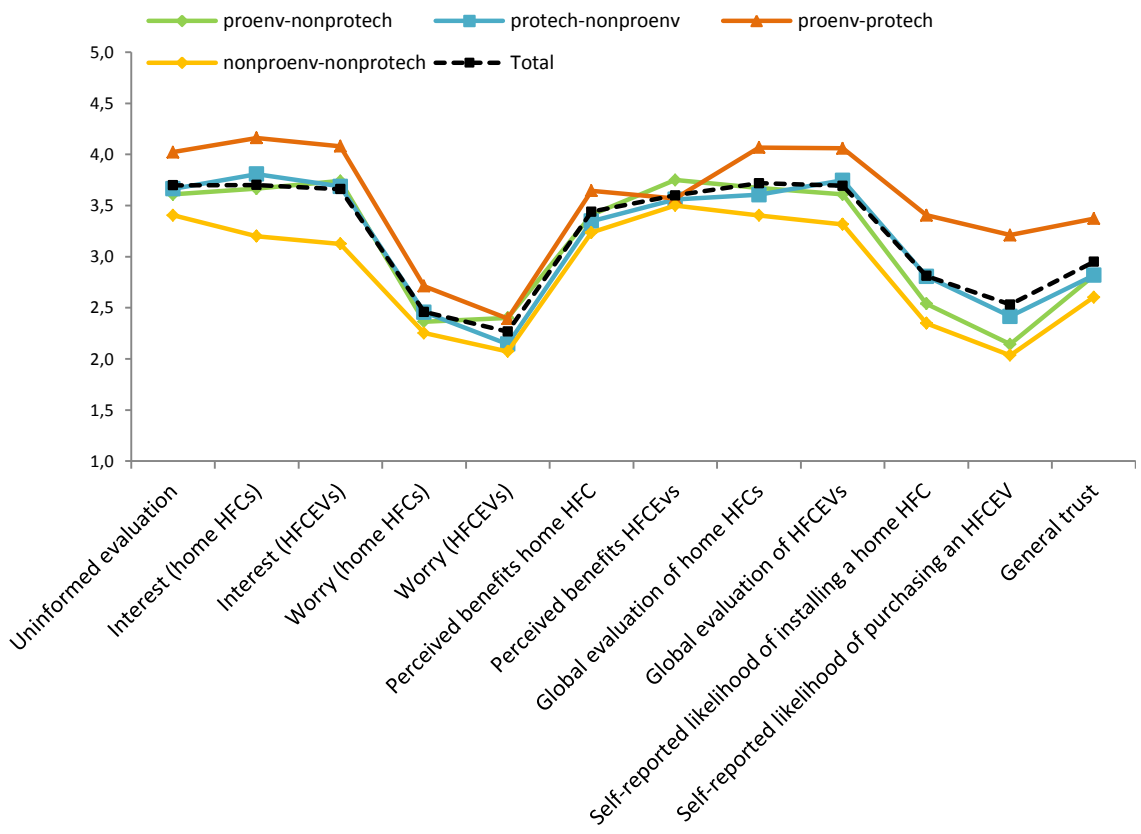


Figure 64. *Attitudes to FCH applications according to attitudinal predispositions*

	Proenv-protech (n=952)		Proenv-nonprotech (n= 544)		Protech-nonproenv (n=232)		Nonproenv-nonprotech (n=861)		Strength of the differences (eta)
	M	SD	M	SD	M	SD	M	SD	
Uninformed evaluation	4.0	0.72	3.6	0.76	3.7	0.76	3.4	0.66	0.35
Interest (home FCHs)	4.2	1.27	3.7	1.00	3.8	1.13	3.2	0.99	0.34
Interest (FCEVs)	4.1	1.27	3.7	1.17	3.7	1.14	3.1	1.02	0.32
Worry (home FCHs)	2.7	0.98	2.4	1.09	2.5	1.16	2.3	1.20	0.17
Worry (FCEVs)	2.4	1.13	2.4	1.13	2.1	1.21	2.1	1.25	0.13
Perceived benefits home FCH	3.6	0.90	3.4	0.98	3.3	0.79	3.2	0.89	0.19
Perceived benefits FCEVs	3.6	1.13	3.8	1.08	3.6	1.02	3.5	1.04	0.09
Global evaluation of home FCHs	4.1	0.78	3.7	0.82	3.6	0.87	3.4	0.86	0.32
Global evaluation of FCEVs	4.1	0.73	3.6	0.82	3.7	0.90	3.3	0.83	0.37
Self-reported likelihood of installing a home FCH	3.4	1.00	2.5	1.01	2.8	0.93	2.3	0.94	0.43
Self-reported likelihood of purchasing an FCEV	3.2	1.09	2.1	0.96	2.4	1.05	2.0	0.90	0.47
General trust	3.4	1.11	2.8	0.98	2.8	1.00	2.6	0.93	0.31

The results show that the four orientations differ significantly in their reactions to FCH applications. The four orientations differ more strongly on their self-reported likelihood of installing and purchasing a home FCH or an FCEV (eta=43 and .47), their evaluation of home FCH units and FCEVs (eta= .32 and .37), their initial evaluation of FCHs (eta= .35) and their self-reported interest in these applications (eta= .34 and .32). Differences in terms of perceived benefits/costs of home FCHs and FCEVs (eta= .19 and .09) and self-reported worry are smaller. So, in general, while the four orientations differ significantly in their general attitudes and willingness to adopt the applications as well as in their interest in the technology, they are more similar in their beliefs regarding the applications.

In general, those reporting an orientation towards the environment and towards technology tend to report a more positive evaluation of both applications, a higher level of interest and a higher self-reported likelihood of installing a home FCH or purchasing an FCEV. On the contrary, those without an orientation towards technology and the environment report a more negative attitude towards both applications, a lower level of interest and a lower self-reported likelihood of installing a home FCH or purchasing an FCEV. Those with an orientation to the environment or to technology report an intermediate attitude.

3.4.7. Empirical model of acceptance of residential stationary fuel cells

With the aim of examining the direct and indirect **determinants** of **acceptance** of **residential stationary fuel cells**, a path analysis was estimated for the whole sample. Figure 63 displays the causal model. Table 25 shows the direct and indirect standardized effects of the independent variables (trust, prior beliefs, affects, perceived benefits/costs and attitude) over the main dependent variable (acceptance of residential fuel cell).

Results show, first, that, according to the model presented, variables not directly related to the attitude such as trust, pro-technology beliefs and environmental self-identity have a significant but very small effect on acceptance. After controlling for other variables, trust has a non-relevant effect (.03) on the acceptance of home FCHs. However, it influences weakly perceived benefits/costs (.19). Endorsing a pro-technology belief is positively, but very weakly (.09), associated with acceptance, but it has a moderate influence on positive affect (average of two positive affects) (.29), which means that those who endorse pro-technology beliefs have, on average, more positive affect toward home FCHs, which in turns, results in a more positive attitude towards the application. Environmental self-identity is positively but very weakly associated to acceptance (.06). But it has also a relevant effect on positive affect (.24).

Table 27. *Direct and indirect effects on acceptance of residential hydrogen fuel cells of distinct variables (standardized coefficients β)*

	Direct effect	Indirect effect (one step)	Indirect effect (two steps)
Global attitude	.55		
Familiarity		0.04	
Positive affect		0.23	
Negative affect		-0.07	
Perceived benefits/costs		0.10	
Preference for gas boilers		-0.05	
Trust			0.03
Pro-technology belief			0.09
Environmental self-identity			0.06

Second, according to the model and the data analysed, familiarity, affect and perceived benefits/costs have a moderate influence on acceptance through attitude. Positive affect is the variable most strongly associated with acceptance of residential fuel cell micro-CHP (.23). Those who report more positive emotions regarding home FCH units tend to have a more positive attitude towards it and a higher level of acceptance. Negative emotions seem to play a weaker role in the acceptance of home FCH units. The effect of negative emotions on acceptance is, as expected, negative (-.07) but very small. Perceived benefits/costs has the second strongest association with acceptance in the model. The effect is positive but small (.10), meaning that the more benefits are perceived, the better the global attitude towards the technology and the

more the technology is accepted. Familiarity has a significant but almost non-relevant positive effect on acceptance (.04). Preference for gas boilers has a significant but very small negative effect on acceptance (-.05). Those who prefer gas boilers to FCH units have a slightly more negative attitude towards FCH units, which in turn produces a lower level of acceptance of home hydrogen fuel cells. Finally, attitude has a positive medium association (.55) with acceptance.

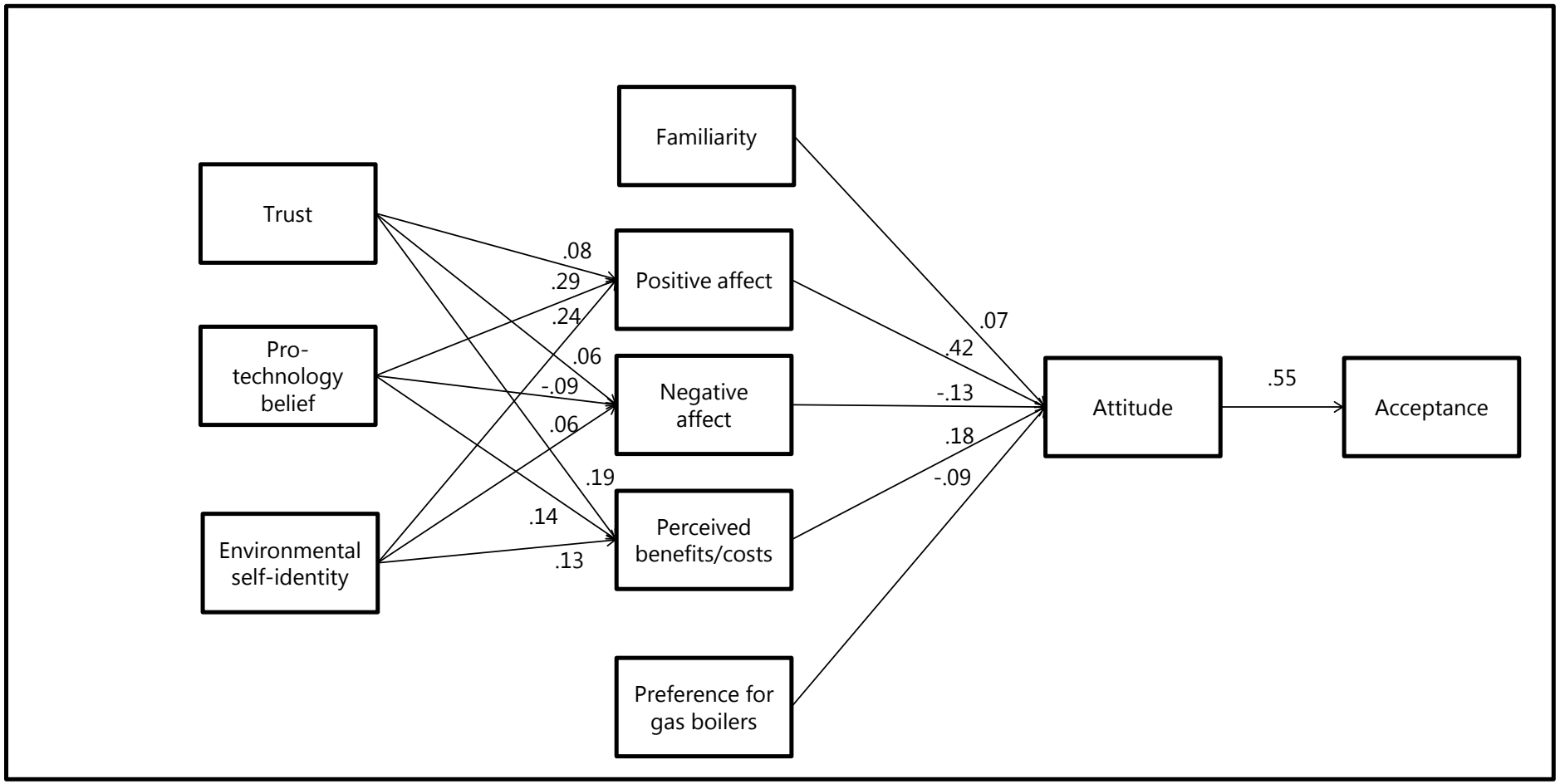


Figure 65. *Summary of path analysis on acceptance of home hydrogen fuel cell (standardized coefficients β)*

3.4.8. Empirical model of acceptance of FCEVs

With the aim of examining the direct and indirect **determinants** of **acceptance** of **hydrogen fuel cell cars**, a path analysis was estimated for the whole sample. Figure 64 displays the causal model. Table 28 shows the direct and indirect standardized effects of the independent variables (trust, prior beliefs, affects, perceived benefits/costs and attitude) over the main dependent variable ("All else equal (cost, range, etc.) I would like to purchase a hydrogen fuel cell car in the future").

Results show, first, that, according to the model presented, variables not directly related to the attitude such as trust, pro-technology beliefs and environmental self-identity have a significant but very small effect on acceptance. After controlling for other variables, trust has a non-relevant positive effect (.01) on the acceptance of FCEVs. Endorsing a pro-technology belief is positively, but very weakly (.07), associated with acceptance, but it has a moderate influence on positive affect (.28), which means that those who endorse pro-technology beliefs have, on average, more positive affect toward FCEVs, which in turns, results in a more positive attitude towards the application. Environmental self-identity is positively but very weakly associated to acceptance (.04). But it has also a relevant effect on positive affect (.23).

Table 28. *Direct and indirect effects on acceptance of hydrogen fuel cell vehicles of distinct variables (standardized coefficients β)*

	Direct effect	Indirect effect (one step)	Indirect effect (two steps)
Global attitude	.54		
Familiarity		0.07	
Positive affect		0.20	
Negative affect		-0.06	
Perceived benefits/costs		0.03	
Preference for conventional cars		-0.10	
Trust			0.01
Pro-technology belief			0.07
Environmental self-identity			0.04

Second, according to the model and the data analysed, familiarity and affect have a moderate influence on acceptance through attitude. Positive affect is the variable most strongly associated with acceptance of hydrogen fuel cell cars (.38). Those who report more positive emotions regarding FCEV tend to have a more positive attitude towards it and a higher level of acceptance. Negative emotions seem to play a weaker role in the acceptance of FCEVs. The effect of negative emotions on acceptance is, as expected, negative (-.11) but small. Perceived benefits/costs have the weakest association with acceptance in the model. The effect is positive but very small (.06), meaning that the more benefits are perceived, the better the global attitude towards the technology and the more the technology is accepted. Familiarity has a significant but small positive effect on acceptance (.13). Preference for conventional cars has a significant negative effect

on acceptance (-.19); those who prefer conventional cars to FCEVs have a slightly more negative attitude towards FCEVs, which in turn produces a lower level of acceptance of hydrogen fuel cell cars. Finally, attitude has a positive medium association (.54) with acceptance.

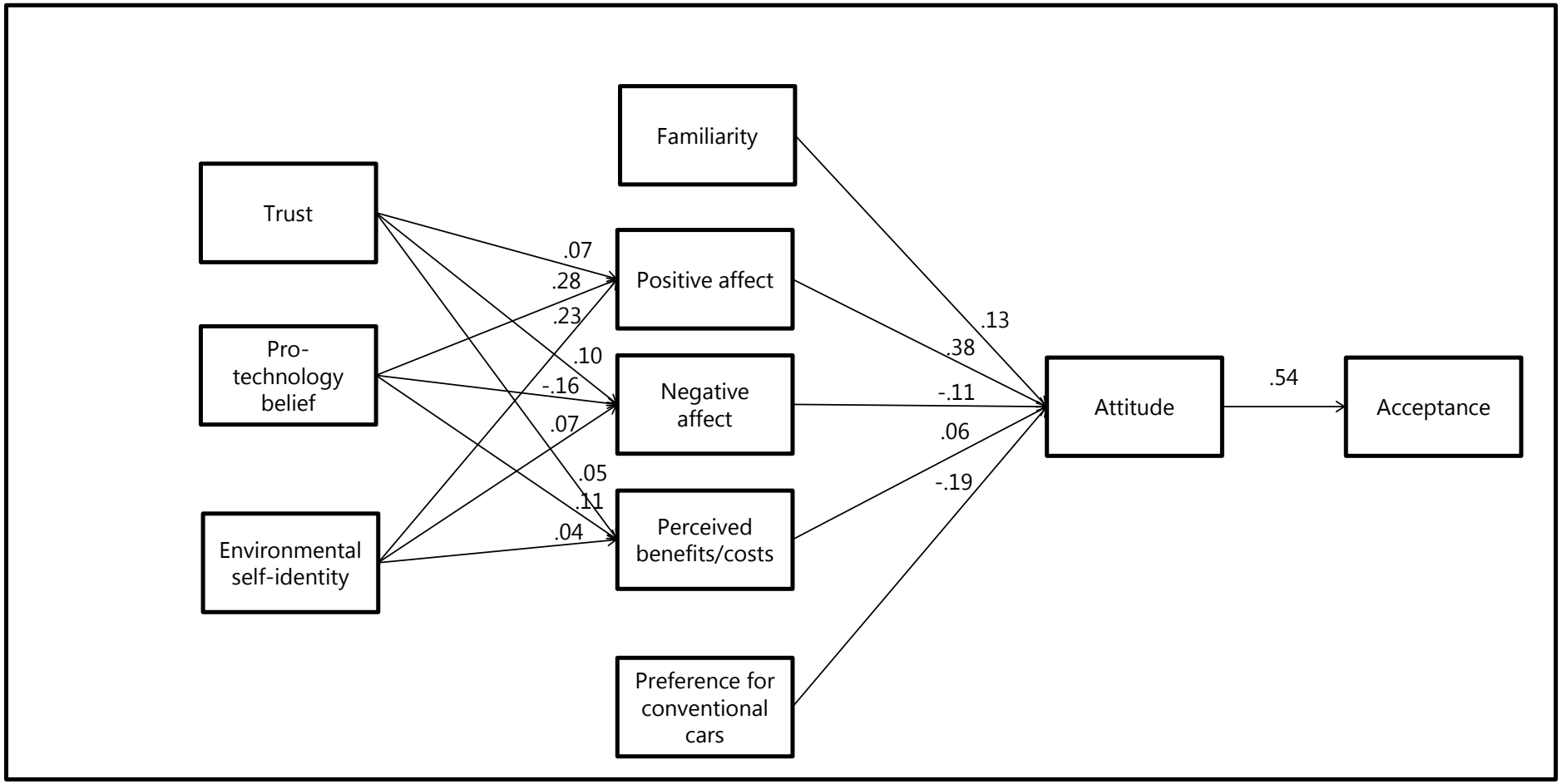


Figure 66. *Summary of path analysis on acceptance of FCEVs (standardized coefficients β)*

4. Summary

This report has examined public awareness, attitudes and acceptance of two hydrogen fuel cell applications in seven European countries with different levels of market penetration and government support. The analysis has been based on survey data collected from a representative sample of residents in the seven countries and specifically examines the differences in awareness, affects, beliefs, attitude, acceptance and support of home fuel cells and hydrogen fuel cell electric vehicles.

4.1. Hydrogen and fuel cell technologies

- First, the results of the study show that the levels of public awareness about hydrogen and fuel cell technologies in the context of energy production vary across the seven countries. More than 40% of respondents report having heard of FCH technologies in the context of energy production. Levels of public awareness are higher in Germany and Norway (50%) and lower in Spain (29%). Only around 6% of respondents consider themselves familiar with the technology.
- Despite this, the European public tends to provide a neutral to positive initial evaluation of FCH technologies as a potential solution to energy and environmental challenges. The data show that almost 6 out of 10 respondents (57%) evaluate FCHs as a good or very good solution to energy challenges. There are small but significant differences in the initial evaluation of FCH technologies across the seven countries.

4.2. Stationary hydrogen fuel cells

- The level of public awareness of residential fuel cell units specifically is significantly lower than awareness of about hydrogen and fuel cell technologies in general, in all of the countries studied. Only around 25% of respondents report having heard of this application. The level of awareness ranges from 32% in Germany to 20% in Norway. Fewer than 5% of respondents consider themselves knowledgeable about this specific application.
- More than 60% of participants report feeling somewhat or very much interested in the technology, 54% report feeling somewhat or very much hopeful about it (hope, anxiety and aversion relate to risk perceptions), 15% report feeling somewhat or very much worried about the technology and 11% report feeling somewhat or very much averse. There are small but significant differences across countries in relation to home FCHs. Mean interest is slightly higher in Spain and Slovenia than in Belgium.
- In general, respondents perceive home fuel cell micro-CHP to be only slightly beneficial, that is, perceived that the benefits outweigh perceived costs. Generally, respondents believe that home FCs will have a positive effect on the environment (mean= 3.9 on a scale from 1 to 5), will be moderately user friendly (3.6), convenient (in terms of noise, vibration, specific location) (3.5), and safe (3.4). Respondents have less positive beliefs about the costs of the installation (2.9), the cost of running the installation (3.2) and maintenance (3.3).

- Regarding the evaluation of the consequences of home fuel cells, the consequences evaluated as the most positive are the propositions that fuel cell home units: "will reduce the cost of producing energy", "would reduce CO_2 emissions" and "would reduce the need to purchase electricity from the power company". The "house space requirements" and the "potential risks" are, on average, rated as not important consequences. The "initial capital costs" is rated as a negative-neutral consequence.
- All the consequences have a moderate to medium association with the overall evaluation of the application. The "reduction in the need to purchase electricity" is the most highly associated with the global attitude. However, the "initial capital cost" is the factor most highly associated with the reported likelihood of purchasing a home fuel cell. This means that the distinct consequences of residential FCHs, and their evaluation by participants, have a different effect on individuals' attitude towards the application than on individuals' self-reported likelihood of installing a home fuel cell.
- Generally, respondents provide a positive evaluation of home FCHs (average of 3.7 in a scale of 1 to 5). Around 60% respondents consider the technology a good or very good electricity and heating system. There are small but significant differences across the countries studied. The attitude towards home fuel cells is more positive in Slovenia (mean 3.84), Spain (3.79) and Germany (3.78) and more neutral in Norway (3.48) and United Kingdom (3.62).
- Respondents generally express a preference for FCHs relative to more traditional technologies such as gas boilers but also a preference for renewable systems, specifically for solar thermal, relative to FCHs.
- Regarding acceptance and support, the majority of participants (64%) in the seven studied populations would be happy to have a hydrogen fuel cell unit installed in their home in the future. There is a higher level of acceptance in Germany, Spain and Slovenia (71% in the three countries), and a lower level in France (55%), Norway (58%), Belgium (60%) and UK (60%). Support of public funding for FCHs is generally high in the seven studied countries, and higher than personal acceptance. More than 7 out of 10 respondents agree with providing subsidies to home FCHs.
- Finally, only around 2 out of 10 respondents consider it likely or very likely that they would purchase a home FCH. The price the fuel cell is the most relevant reason for not installing a fuel cell at home (73% of respondents), followed by the perceived lack of maturity of the technology (45%). Other issues raised include not being the owner of the residence, already having other electricity and heating system installed, the suitability for various types of homes, potential installation problems, safety and lack of information.
- The majority of respondents in all seven countries would support the installation of a fuel cell power plant in their town. In the full sample, around 6 out of 10 respondents would vote in favour of the siting of the power plant, 3 out of 10 are undecided and 1 out of 10 would vote against it.

4.3. Hydrogen fuel cell electric vehicles (FCEVs)

- Public awareness of hydrogen fuel cell electric vehicles (FCEVs) is higher than that for residential fuel cell units. Around 45% of respondents have heard a little bit about FCEV and 15% report knowing a little about fuel cell cars. There are significant differences across the countries. Norway and Germany are the countries with higher levels of awareness of FCEVs. Respondents' experience with FCH electric vehicles is low across the studied countries. Fewer than 10% of respondents have had some experience with FCEVs (passenger cars or buses).
- The majority of respondents in the seven studied populations report feelings of interest and hope regarding FCEVs. Specifically, 60% of respondents in the total sample report feeling interest and hope 56% "somewhat" or "very much". Only around 13% report feeling "somewhat" or "very much" worry, and 9% report feeling aversion. In general, respondents perceive hydrogen vehicles as slightly beneficial, that is, perceived benefits slightly outweigh perceived costs. However, respondents seem to be somewhat unsure about the potential benefits of FCEVs. There are weak but significant differences across countries.
- Regarding the evaluation of the consequences of FCEVs, the three consequences evaluated in the total sample as the most positive are the propositions that: "they will reduce the need for petroleum", it "would produce lower CO_2 emissions than convention al cars" and the "price of hydrogen" (79%, M= 4.06). The "range" and "safety issues" were, on average, rated as unimportant consequences. The "need for new infrastructure" and the "price of fuel cell material" were rated as negative consequences.
- The evaluation of the consequence "reduction in the need for petroleum" is the best predictor of respondent's global attitude towards FCEVs, followed by "the reduction in CO2 emissions" and "the price of hydrogen" (rho= 0.38). However, the "price for fuel cell material" and the "need for new infrastructure" are the most predictive factors in the self-reported likelihood of purchasing a hydrogen car.
- Generally, respondents in the seven countries provide a positive evaluation of FCEVs (average of 3.7 in a scale from 1 to 5). Around 6 out of 10 respondents consider the technology a good or very good option. There are small but significant differences among the countries studied.
- Respondents generally express a preference for FCHs over conventional cars and compressed or liquefied natural gas cars. However, battery electric cars and hybrid (battery and fossil fuel combined) cars are preferred options compared to hydrogen fuel cell electric cars. There are significant differences across countries in their preference for alternative cars. Germany is the only country where the percentage of respondents who consider electric cars a worse option than FCHE cars is higher than the percentage that considers electric cars a better option.
- Regarding acceptance and support for FCEVs, the majority of participants in the seven countries would be happy to have a hydrogen fuel cell car in the future (assuming all things being equal, including price equivalence with contemporary cars and refuelling

availability). Specifically, more than 60% in the full sample would like to buy an FCH electric car in the future, again under conditions of equivalence.

- Almost 80% of respondents are in favour of the substitution of conventional buses for hydrogen fuel cell buses, though with significant differences across countries.
- Without the condition of equivalence, only a minority of respondents consider it likely or very likely that they would purchase an FCEV if they need to purchase a car. The price is reported as the most relevant factor for not purchasing a FCEV, followed by lack the maturity of the technology. Other reasons for not purchasing a FCEV include the lack of refuelling stations, having other necessities or not wanting to have a car, safety and other perceived disadvantages.
- Finally, less than 5% of respondents are aware of the existence of a hydrogen refuelling facility in their city. Generally, a hydrogen refuelling station is considered by the average respondent to have more benefits than costs. Respondents generally support the siting of hydrogen refuelling stations. Around 7 out of 10 respondents would vote in favour of the siting of the hydrogen refuelling station. Differences across countries are not significant.

4.4. Findings per country grouping

When the data was examined according to the country grouping developed in deliverable 2.1 (countries were classified in advanced, medium and low policy support to hydrogen), the following patterns were observed:

- Countries with advanced policy support to hydrogen: Norway and Germany have a similar position in terms of public awareness and initial uninformed evaluation of FCHs. As expected given its level of hydrogen and fuel cell implementation, Germany is the country with the highest levels of public awareness, acceptance and support to hydrogen and fuel cell applications. The levels of awareness and acceptance of FCHs are also high in Norway, but interestingly, the public in Norway is very positive about FCEVs but no so positive about residential fuel cells. In the United Kingdom the general public is significantly more sceptic or neutral towards FCH applications than in Germany and Norway. Public awareness about the technology in the UK is also lower than expected, given the level of implementation of these technologies. Interestingly, the UK shares a similar level of awareness of FCHs and uninformed evaluation to France.
- Countries with medium policy support to hydrogen: Public acceptance and support to hydrogen and fuel cell technologies in Belgium is relatively high. Public acceptance of hydrogen and fuel cell technologies in France is slightly lower than in Belgium. The public in France is less positive about these technologies than in other countries, but the level of support to funding for these technologies is high. The public in France seems to express a relatively higher preference for alternative technologies such as hybrid and full electric cars. In Spain, despite the low levels of awareness about the technology, the general attitude of the public towards hydrogen and fuel cell applications is very positive. Levels of public acceptance in Spain are significantly higher than in France or Belgium.

- Countries with low policy support to hydrogen: Despite the low level of implementation of FCH technologies in Slovenia, the level of public awareness of FCHs and the general attitude of the public towards hydrogen and fuel cell applications is very positive. Levels of public acceptance of hydrogen fuel cell applications in Slovenia are significantly higher than in countries such as France, Belgium or the UK.
- According to the data, and focusing only on the level of public awareness about hydrogen fuel cell technologies in general and the initial uninformed evaluation of these technologies, Germany and Norway share a similar profile, and also France and the United Kingdom. Slovenia, Spain and Belgium show a particular profile.

4.5. Supporters and opponents

Overall, based on the level of acceptance and support for the two FCH applications studied, respondents can be categorized into three groups: supporters, neutrals and opponents. In the full sample, 6 out of 10 respondents can be considered supporters of FCHs applications, 3 out of 10 as neutral and fewer than 1 out of 10 respondents as opponents to FCH applications. There are significant differences across the seven countries. The highest percentage of supporters is found in Slovenia, Spain and Germany, and the lowest is found in United Kingdom, France and Belgium.

Supporters and opponents differ significantly in their affects, beliefs and reactions towards home FCHs and FCEVs. Both categories of respondent evaluate both hydrogen fuel cell applications in significantly different ways.

4.6. Sociodemographic correlates of public attitudes towards FCH applications

The data show the existence of small but significant socio-demographic differences in public attitudes towards FCH applications. Gender and age were the sociodemographic variables associated to more dependent variables. The pattern of association was very clear for sex: male respondents reported, on average, higher levels of awareness, interest, acceptance and support relative to female respondents. The patter of association was unclear for age. Younger participants reported higher values in some of the variables, whilst older participants reported higher values for other variables. Educational level, size of residence and income were positively associated to almost half of the studied variables. Briefly, male respondents with university degrees living in cities with more than one million inhabitants and living comfortably with current income had, on average, the most favourable profile of acceptability.

4.7. The effect of information and prior attitudinal orientations

Regarding the effect of providing information on respondents' evaluation of FCEV, the data show an average non-significant increase in favourable attitude (after comparing the differences

between the uninformed evaluation of FCHs and the informed evaluation of domestic FCH units and FCEV). Interestingly, the effect seems to differ between opponents and supporters: as opponents become more informed about FCH applications, their evaluation of the technology gets worse, and this variation is significantly higher than for supporters or neutrals.

Considering the previous attitudinal orientations of respondents, we find that those reporting a positive orientation towards the both environment *and* towards technology tend to report a more positive evaluation of both applications, a higher level of interest and a higher self-reported likelihood of installing a home FCH or purchasing an FCEV. On the contrary, those without an orientation towards technology and the environment report a more negative attitude towards both applications, a lower level of interest and a lower self-reported likelihood of installing a home FCH or purchasing an FCEV. Those with a positive orientation to the environment *or* to technology report an intermediate attitude to both applications.

4.8. A model of public acceptance of FCH applications

Finally, a number of independent variables have an indirect effect on acceptance of home FCH and FCEVs. The acceptance of both applications is influenced by the global attitude towards the applications, which in turns, is influenced by familiarity, positive affect, negative affect, the perception of benefits and costs and the preference for alternative technologies. Positive affect is the variable most strongly associated with acceptance, for both the acceptance of home fuel cell units and for the acceptance of FCEVs. Perceived benefits play a more relevant role in the acceptance of home fuel cells, whilst the preference for alternative technologies (conventional cars) plays a more relevant (though negative) role in the acceptance of hydrogen fuel cell cars. Trust, having a pro-technology belief and environmental self-identity have a positive but small effect on acceptance of both residential FCH units and FCEVs.

5. Discussion and conclusion

There are relatively few studies combining data on public acceptance of residential stationary fuel cells and hydrogen fuel cell electric vehicles (FCEVs). Even less commonly available are cross-national comparable data on public awareness and attitudes towards these two FCH applications. Yet, it is important for governments and the industry to understand public beliefs and attitudes regarding hydrogen and fuel cell technologies and especially regarding two applications, in the residential and the transportation sectors, that have mass-market potential and that will have a significant impact on reducing emissions and primary energy consumption where they are deployed.

In order to capture the multidimensionality of the attitudes towards emergent technologies, the study adopted a social-psychological perspective, drawing partly on a technology acceptance model (Huijts, Molin, & Steg, 2012), describing the causal links among the attitudinal elements that directly and indirectly affect technology acceptance, as well as on previous research on public attitudes towards hydrogen and fuel cell technologies and other energy technologies. The design of the questionnaire also aimed at building a predictive model for the acceptance of FCH technologies based on segmented responses to FCH technologies, including factors known to be relevant in this context.

To address concerns about the reliability and comparability of the data on acceptance of FCH applications, the study employed different strategies. To ensure the validity of the measures, many of the items in the questionnaire were derived from previous studies on public acceptance of hydrogen and fuel cell technologies. To limit the problem of pseudo-opinions, participants in the study received neutral general information about the technology as well as specific information about the consequences of residential fuel cells and hydrogen fuel cell electric vehicles[3]. The information was carefully crafted by the research team in collaboration with experts in the field of hydrogen and fuel cells. Special attention was also paid to the translation of the questionnaires into the various languages to ensure that the questionnaire was measuring the same concept in the same way across various populations of respondents. Other technical measures were adopted during the data collection (online) process by the recruiting company.

Findings from this report show that, based on self-reporting, just under half of the population in the seven countries is aware of the existence of hydrogen and fuel cell technologies in the context of energy production. Public *awareness* is significantly lower for residential fuel cells and higher for hydrogen fuel cell vehicles. The level of *familiarity* with both applications is even lower and less than 10% of the population in the seven countries consider themselves familiar or knowledgeable about FCH technologies (again, the level of familiarity is significantly lower for residential fuel cells than for hydrogen fuel cell vehicles). These results are very similar to previous reports by the Eurobarometer (European Commission, 2007), where five out of ten EU citizens reported having heard about hydrogen energy and cars and four out of ten reported hav-

[3] Even if this may have limited the presence of non-attitudes or pseudo-opinions, we acknowledge that the topic of the survey was quite complex and the information provided might be difficult to understand for some respondents.

ing heard about fuel cells (European Commission, 2007), and by the DOE, where almost 9 out of 10 individuals considered themselves "not at all familiar" or "slightly familiar" with hydrogen and fuel cell technologies.

In general, the results show that the majority of the population in the seven studied countries have a positive *attitude* towards FCH technologies. This finding seems to confirm findings of previous research about the public's perception of hydrogen technologies. Initially, and without having any additional information about the technology, respondents tend to rate FCHs as a good or very good solution to energy challenges (the percentages vary significantly across countries). This positive uninformed evaluation suggests that the label associated to hydrogen and fuel cells somehow invoke positive feelings and thoughts among respondents. This is relevant given that research on public perception of energy technologies have shown that individuals infer some of the attributes of the technology from a label, product names, technology names or brand names that function as heuristic cues (Van Rijnsoever, F. J., Van Mossel, A., & Broecks, K. P., 2015). The data in this study suggest that individuals hold a positive affect toward residential hydrogen fuel cells and hydrogen fuel cell vehicles, and perceive that both applications bring more benefits than risks.

The results from this report have also allowed examining respondents' informed evaluation of FCH applications. Again, respondents in the seven countries generally provide a positive evaluation of FCH residential units and FCEVs, rating them, on average, as "acceptable-good". Respondents seem to value the fact that adopting fuel cell home units would reduce the cost of producing energy, reduce CO_2 emissions and reduce the need to purchase electricity from the power company. And the evaluation of these consequences has a relevant effect on their global evaluation of the application. The estimated initial capital cost of a residential fuel cell is rated more negatively by participants and this evaluation has a significant effect on the self-reported likelihood of purchasing a home fuel cell. Respondents also value that FCEVs would reduce the need for petroleum, and produce lower CO_2 emissions than convention al cars. The need for new infrastructures to provide hydrogen to vehicles and the price of fuel cell material are rated as negative attributes of the technology.

All in all, the results of the study appear to suggest that, after processing relevant information, people in the seven countries are likely to accept and support the adoption of residential fuel cells and hydrogen fuel cell electric vehicles. Although there are significant differences across the seven countries, more than six out of ten respondents accept and would support the introduction of residential hydrogen fuel cells and hydrogen fuel cell vehicles in the majority of studied countries. The majority of the public seems to be willing to adopt FCH applications in the future and support public funding to promote the implementation of these applications. However, they consider themselves unlikely to buy a residential fuel cell or a hydrogen fuel cell electric vehicle in the near future.

When we explored the reasons behind the attitude towards home FCH and FCEVs and the reasons behind self-reported likelihood of purchasing a FCH application, an interesting pattern emerged. For both applications (home FCHs and FCEVs), the potential societal and environmen-

tal advantages associated with these applications (such as the reduction in the need for petroleum or the reduction in CO_2 emissions) play an important role in the formation of the attitude, but a weaker role when it comes to the self-reported likelihood of purchasing the technology, where the price is the most important factor. The global evaluation of the technology is partially grounded on different reasons than the self-reported likelihood of purchasing it in the short term.

The results from this report point to the existence of relevant differences across countries in awareness and acceptance of FCH applications, despite the fact that the majority of respondents in the seven countries are unfamiliar with FCH applications but generally positive about its implementation. The present situation might be characterised as one in which awareness and support for FCH technologies is highest in those countries where there is most R&D activity and policy support. For instance, levels of public awareness of hydrogen and fuel cell technologies are higher in Germany and Norway, where technology implementation is more advanced. However, we have not sought to regress against R&D indicators, though – as with many of the findings, this merits further investigation.

In fact, the data shows that each country's level of policy and industrial support to hydrogen and fuel cell technologies is far from perfectly associated to the levels of awareness and acceptance found among the public. For instance, the global evaluation and acceptance of FCHs is significantly higher among respondents in Slovenia and Spain, and lower among respondents in United Kingdom and France, with differences reaching twenty percentage points. The public in Slovenia and Spain, where levels of political support and technological implementation are lower, seems to be consistently more positive and optimistic about hydrogen and fuel cell technologies relative to the other studied countries, which might be partially explained by individual-level variables (mainly the affects and perceived benefits associated to fuel cell applications). The data also show that the public in France and Belgium seems to be less positive about residential fuel cells and FCEVs but also that a majority of the public in both countries support public funding of these applications. Finally, the public in the United Kingdom is slightly more neutral towards hydrogen and fuel cell technologies and less willing to support public funding to these applications than initially expected given the level of implementation of hydrogen technologies in this country.

So, while some of the results of the study seem to indicate that countries with higher levels of policy support and technological implementation tend to have higher levels of public awareness (this seems to be true for Germany and Norway, although not necessarily in a similar way for stationary and mobile applications), overall, public reactions to hydrogen and fuel cell applications seem to be, to a large extent, independent from the country's level of technological implementation and institutional support. In this sense, public reactions to hydrogen and fuel cell applications are not only the result of the specific levels of market penetration, government and industry support to FCH technologies but are partially explained by individual-level cultural predispositions regarding the acceptance of new energy technologies, prior orientations and political attitudes.

Another key observation of the study is the existence of internal variations in attitudes to FCH technologies within countries. Consistent across the seven countries, male respondents provide a more positive evaluation of residential fuel cells and hydrogen cars relative to female respondents; older respondents provide a more positive evaluation of FCH technologies in general and residential fuel cells relative to younger age groups, while younger age groups report a higher likelihood of purchasing a fuel cell vehicle. Interest in both applications seems to be higher among those with a university degree and those living in cities with more than one million inhabitants. Apart from the differences between the sociodemographic categories, the data suggest that attitudes to FCH technologies might vary according to individuals' attitudes and orientations towards technology and the environment. The data suggest that the level of interest, acceptance and support to FCH applications seems to be significantly lower among those respondents not expressing an orientation towards the environment and towards technology. This is consistent with previous research (Achterberg et al. 2010) showing that people's cultural predispositions influence the way people react to hydrogen technology, and specifically, that people who do not trust technology (as much) and are not concerned with the environment (as much) are less inclined to support hydrogen fuel cell technology.

The explanatory power of the public acceptance model was substantial. Acceptance of FCH applications is partially determined by positive and negative affect, the perception of benefits and costs of the applications, preference for alternative technologies and familiarity. Interestingly, the weight of these factors in acceptance slightly varies between home fuel cells and fuel cell vehicles. Other relevant factors with an indirect potential effect on acceptance are the orientation of the individual towards technology and the environment as well as individuals' level of trust in the government and industry. None of the models tested in this study fully explain acceptance of FCH applications, but they do help in understanding the correlates of acceptance. There may be other factors not included in the study that might further explain acceptance of FCH applications (e.g. norms and values that we could not include in what is already quite a lengthy questionnaire). Additionally, attitudes and opinions might be unstable and also easily affected by contextual factors.

Finally, another observation of the study is that providing information seems in some cases to be responsible for decreased, and in others, for increased evaluation of the technologies. When respondents' judgement becomes more informed (as they have read information about the consequences of the applications) and specific (as they are evaluating specific applications instead of FCHs in general), there is a very small improvement in the average evaluation of hydrogen and fuel cell applications. However, the effect of the information on the evaluation seems to differ significantly in supporters, neutrals and opponents. So, while for supporters, the evaluation of consequences task resulted in a slightly better evaluation of home hydrogen fuel cells and hydrogen fuel cell vehicles, for opponents, the evaluation of the consequences resulted in worse evaluation of both applications. This suggest that, as previously found in research on public acceptance of technologies, providing neutral or positive information to those with a prior negative attitude towards the technology or without much trust in science and technology, often fails to generate a more positive evaluation of the technology.

This report, building on previous studies on the social acceptance of hydrogen and fuel cell technologies, provided an overview of public attitudes towards residential fuel cells and hydrogen fuel cell electric vehicles in seven European countries. These results contribute to improve our understanding of public acceptance of hydrogen and fuel cell technologies through cross-national research. As markets for hydrogen and fuel cell technologies develop, public and consumer acceptance will likely play a role in the success of hydrogen fuel cells, both in the residential and the transportation sectors. Acceptance of hydrogen and fuel cells technologies will likely vary across time, countries and regions and segments of the population. Future research will provide the evidence needed to examine the trends of public acceptance of FCHs and attempt to document and explain some of the observations in this report.

6. Overview and policy implications

Based on the research questions specified in Deliverable 3.1, we have examined a number of key issues with regard to the public attitudes towards residential fuel cell systems and hydrogen fuel cell vehicles. This analysis has been based on survey research carried out in seven European countries. From this, it has been possible to examine some of the factors influencing public acceptance of hydrogen fuel cell applications. The findings suggest that:

1. **A majority of people are concerned about the problems that the technology is intended to solve**

The data shows that the majority of respondents consider, in this order, reducing local air pollution, reducing emissions of greenhouse gases, improving energy security and creating opportunities for national industries to increase their capability to provide innovative technologies as important challenges for their country. In addition, there are indications that those who are more concerned about local air pollution and climate change might perceive hydrogen and fuel cell technologies as more beneficial than those who are less concerned.

2. **There is a medium-low level of public awareness of FCH technologies. The level of awareness varies significantly across countries and the specific fuel cell application**

The data show that less than half of the population in each of the seven countries is aware of the existence of hydrogen and fuel cell technologies in the context of energy production. Public awareness differs significantly across countries, with differences of around 20 percentage points. Public *awareness* is significantly lower for stationary residential fuel cells and higher for hydrogen fuel cell vehicles. The level of stated *familiarity* with both applications is very low; less than 10% of the public consider themselves familiar or knowledgeable about FCH technologies (again, the level of familiarity is significantly lower for residential fuel cells than for hydrogen fuel cell vehicles).

European publics in the countries surveyed are likely to be receptive to policy support for hydrogen and fuel cell applications generally, but information-based (educational) work will probably need to be undertaken to raise awareness of their potential. This might be especially the case for some applications (e.g. fuel cell residential applications) in some European countries, which in turn may slow market penetration.

3. **There is a generally positive evaluation of FCH residential units and FCEVs**

The data show that initially, and without having any additional information about the technology, respondents in the seven countries tend to rate FCHs as a good or very good solution to energy challenges. This positive uninformed evaluation suggests that the terms 'hydrogen and fuel cells' somehow invoke positive feelings (interest) and thoughts, i.e. that they have a positive symbolism. When *most* (but not all) individuals become informed about FCH residential units and FCEVs and their specific consequences or characteristics, they tend to provide a positive

evaluation of both applications, rating them as "acceptable-good". The perception that both applications have more benefits than costs seems to play a role in this evaluation. Respondents, on average, perceive hydrogen residential fuel cell units and hydrogen electric vehicles as beneficial in terms of personal and environmental impacts. But a relevant proportion of the public does not have a stable belief about the potential benefits and costs of both fuel cell applications. Hydrogen residential fuel cell units and hydrogen electric vehicles seem to be perceived and felt as personally and globally beneficial by the public.

4. Different sociodemographic groups may react differently to hydrogen fuel cell applications

There are small but significant differences in how the various sociodemographic groups react to home fuel cells and fuel cell vehicles. Briefly, male respondents with university degrees living in cities with more than one million inhabitants and living comfortably with current income have, on average, the most favourable profile of acceptability.

The findings indicate that certain sociodemographic groups may react differently to the technology as well as to promotional campaigns aimed at increasing the uptake of these applications.

5. Prior cultural orientations may also play a role

Although prior values, attitudes and personal norms regarding technology and the environment might be considered unrelated to acceptance of fuel cell applications, the data show that individual's general values and attitudes regarding the environment and the role of technology in solving environmental problems can influence attitude towards hydrogen fuel cells.

An implication of these results is that individuals' prior cultural orientations may influence how individuals react to the technology as well as to promotional campaigns aimed at increasing the uptake of these applications.

6. A small percentage of people may simply dislike or be uninterested in these technologies

Overall, 6 out of 10 respondents in our study can be considered supporters of FCHs applications, 3 out of 10 as neutral and fewer than 1 out of 10 respondents as opponents to FCH applications. Supporters and opponents differ significantly in their affects, beliefs and reactions towards home FCHs and FCEVs. Both categories of respondents evaluate hydrogen fuel cell applications in significantly different ways. Supporters and opponents also react differently to new information. Opponents tend to provide a slightly more negative evaluation of fuel cell applications after receiving information on the consequences of these applications.

We should expect that some consumers and members of the public dislike these innovations and are not willing to invest on them or support them via public funding. Simple information provision interventions may be insufficient when engaging some members of the public.

7. Consumer preferences could be a significant barrier to the adoption of hydrogen fuel cell technologies

Some consumers may be satisfied with incumbent or conventional technologies. Other consumers might prefer other technologies such as solar thermal, in the case of residential electricity and heating, or hybrid or full electric vehicles, relative to FCEVs. Independently of how the hydrogen fuel cell application is perceived, consumer preferences for alternative technologies may play a role in adoption.

Some consumers may prefer investing in conventional or alternative technologies for transportation and electricity and heat generation. They will be less likely to accept and support fuel cell applications.

Application	Main perceived advantages (from most important to less important)	Main perceived disadvantages (from most important to less important)	Other issues found and barriers to adoption and
Home fuel cell units	• Reduction in the cost of producing energy • Reduction in CO2 emissions • Reduction in the need to purchase electricity from a power company • House space requirements • Safety	• Initial capital costs	• Cost of purchasing the hydrogen fuel cell system • Potential risks associated with the use of the hydrogen fuel cell unit • Lack of information • Environmental benefits and risks • The production of hydrogen • Problems associated with the maintenance of the system • Suitability of the system for different types of homes • The role of companies and governments • Doubts regarding installation • The recycling of the fuel cells • Lack of decision due to not owning the house • Alternative types of energy already installed at home
Hydrogen fuel cell electric vehicles	• Reduction in the need for petroleum • Lower CO2 emissions • Price of hydrogen • Range	• Price of fuel cell material • Infrastructure needed • Safety issues	• Cost of purchase and maintenance • Time spent refueling • Range of the car • Infrastructure not in place and costly • Environmental benefits and risks • Perceived danger and risks • Advantages and disadvantages of fuel production • Availability of refueling sta-

			tions • Lack of information • Reliability and performance • Lack of support from the governments and oil industry • Noise related advantages and disadvantages • Need of attitude change • Other driving necessities • Preference for alternatives

8. There are a wide range of factors that influence technology choice and not all are technology-specific

The study variables enable examination of how a number of attitudinal or internal factors can influence public acceptance of hydrogen fuel cell applications, which in turn can influence intention to use these applications, adoption and choice. Specifically, we have documented that positive affect (e.g. being interested in the technology), perceived benefits (e.g. believing that the technology is safe, or convenient or affordable to run), preference for alternative technologies, familiarity and trust in the industry and the government to make good decisions about these technologies, influence acceptance of both residential fuel cells and fuel cell vehicles.

However there are many other 'external' factors not included in the model that may have an impact on future adoption. Some of them might be related to the housing environment, somehow outside the control of consumers such as dwelling characteristics, type of tenure, access to gas, etc.; whilst others might be related to issues such as trust in the companies involved; the market environment (e.g. availability of products) and the broader social system (incentives, regulations, social norms).

Overall, it is important to be aware that a range of diverse factors influence acceptance and adoption of new energy applications. On the one hand, background variables such as demographic variables, culture and socioeconomic variables, individual difference variables, interventions and media coverage may influence individuals' beliefs and affects associated to these applications which, in turn, influence acceptance. On the other hand, it is important to acknowledge that moving from acceptance to adoption can be a challenging process, since the latter requires the translation of attitude into action. Here, a range of environmental factors and personal capabilities can play a relevant role.

6.1. Policy recommendations

Europe needs to decarbonize its economy and this requires action within the domestic and transportation sectors. Among the alternative technologies for generating low-carbon heat and electricity and to replace fossil-fuel based powertrains, residential stationary fuel cells and hy-

drogen fuel cell electric vehicles (FCEVs) are receiving support towards commercialization. Consumer preferences and choice will likely play a role in the degree in which these applications will impact on reducing emissions and primary energy consumption. Public preferences may become a hurdle to a hydrogen future. Understanding attitudes and behaviours provide insights into the factors that influence how individuals and households take decisions on technologies for electricity and heat and transportation. Together with other measures, European carbon targets should be supported by an evaluation of the likely role of public and customer preference and choice.

The data show that the European public is generally positive about hydrogen and fuel cell applications and willing to support the funding and the adoption of these applications both in the residential and the transportation sectors. But the evidence also shows that people tend to seek technologies and fuels which are cost-efficient and affordable (to buy, install and run) and which are easy, reliable and compatible with their current systems and lifestyles (Hoggett, Ward, and Mitchell 2011). Even when people may perceive the personal and environmental benefits of new electricity and heating or transportation systems, inertia and a low priority to changing these systems, among other issues, may difficult the adoption of new technologies.

Based on these findings and in order to promote the adoption of hydrogen and fuel cell applications, we suggest that:

- There is a need for further work with consumers to understand their attitudes and preferences towards transportation and provision of electricity and heat.
- Attitudes and perceptions as well as emotions need to be accounted for promotional campaigns. Understanding perceptions, needs and reservations of individuals is critical in any campaign. Creating a positive frame for the introduction of hydrogen and fuel cell technologies that resonates with individuals' lifestyles and identities, making the personal (for consumers) benefits of these applications specific, tangible, increasing familiarity and interest with the technology could favour the future adoption of the technology.
- Promotional campaigns should also take into account the existence of various socio-demographics, cultural identities, prior orientations and lifestyles among consumers. Targeting audience attitudes may allow a better connection with the public.
- There is also a need for interventions aimed at helping avoid the range of barriers associated with adoption of alternative forms heat and electricity and transportation (e.g. government grants, micro-loans).

7. References

Achterberg, P. (2012). Knowing hydrogen and loving it too? Information provision, cultural predispositions, and support for hydrogen technology among the Dutch. *Public Understanding of Science*. http://doi.org/10.1177/0963662512453117

Achterberg, P. (2014). The changing face of public support for hydrogen technology explaining declining support among the Dutch (2008–2013). *International Journal of Hydrogen Energy*, *39*(33), 18711–18717. http://doi.org/10.1016/j.ijhydene.2014.08.053

Achterberg, P., Houtman, D., van Bohemen, S., & Manevska, K. (2010). Unknowing but supportive? Predispositions, knowledge, and support for hydrogen technology in the Netherlands. *International Journal of Hydrogen Energy*, *35*(12), 6075–6083. http://doi.org/10.1016/j.ijhydene.2010.03.091

Air Resources Board, California Environmental Protection Agency. (2015). Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development. https://www.arb.ca.gov/msprog/zevprog/ab8/ab8_report_2015.pdf

Altmann, M., Schmidt, P., Mourato, S., & O'Garra, T. (2003). Analysis and comparisons of existing studies. *Study in the Framework of the ACCEPTH2 Project*, (August).

Altmann, M., Schmidt, P., Wurster, R., Garra, T. O., Mourato, S., Garrity, L., … Whitehouse, S. (2004). AcceptH2 : Public Acceptance and Economic Preferences Related to Hydrogen Transport Technologies in Five Countries. *Energy*, 1–8.

Ammermann, H., Hoff, P., Atanasiu, M., Aylor, J, Kaufmann, M. and Tisler, O. (2015). Advancing Europe's energy systems: Stationary fuel cells in distributed generation. A study for the Fuel Cells and Hydrogen Joint Undertaking. Luxemburg: Publications Office of the European Union.

Axsen, J., TyreeHageman, J., & Lentz, A. (2012). Lifestyle practices and pro-environmental technology. *Ecological Economics*, *82*, 64–74. http://doi.org/10.1016/j.ecolecon.2012.07.013

Bellaby, P., & Clark, A. (2014). Lay discourse about hydrogen energy and the environment: Discussion by young people and adults following a first visit to a Hydrogen Research and Demonstration Centre. *International Journal of Hydrogen Energy*, *39*(27), 15125–15133. http://doi.org/10.1016/j.ijhydene.2014.07.090

De Best-waldhober, M. De, & Daamen, D. (2006). Public perceptions and preferences regarding large scale implementation of six CO 2 capture and storage. NWO/SenterNovem Project: "Transition to sustainable use of fossil fuels"

Dodds, P. E., Staffell, I., Hawkes, A. D., Li, F., Grünewald, P., McDowall, W., & Ekins, P. (2015). Hydrogen and fuel cell technologies for heating: A review. *International journal of hydrogen energy*, 40(5), 2065-2083.

Eberle, U., Müller, B., & von Helmolt, R. (2012). Fuel cell electric vehicles and hydrogen infrastructure: status 2012. Energy & Environmental Science, 5(10), 8780-8798.

European Commission. 2007. Special Eurobarometer on Energy Technologies: Knowledge,

Perception, Measures. http://ec.europa.eu/public_opinion/archives/ebs/ebs_262_en.pdf

Fleishman, L. A., De Bruin, W. B., & Morgan, M. G. (2010). Informed Public Preferences for Electricity Portfolios with CCS and Other Low-Carbon Technologies. *Risk Analysis*, 30(9), 1399-1410.

Heinz, B., & Erdmann, G. (2008). Dynamic effects on the acceptance of hydrogen technologies—an international comparison. *International Journal of Hydrogen Energy*, 33(12), 3004-3008.

Heo, J. Y., & Yoo, S. H. (2013). The public's value of hydrogen fuel cell buses: A contingent valuation study. *International Journal of Hydrogen Energy*, *38*(11), 4232–4240. http://doi.org/10.1016/j.ijhydene.2013.01.166

Hoggett, Richard, Judith Ward, and Catherine Mitchell. 2011. "Heat in Homes: Customer Choice on Fuel and Technologies. Study for Scotia Gas Networks." *Study for Scotia Gas Networks* (July).

Huijts, N. M. A., De Groot, J. I. M., Molin, E. J. E., & van Wee, B. (2013). Intention to act towards a local hydrogen refueling facility: Moral considerations versus self-interest. *Transportation Research Part A: Policy and Practice*, *48*, 63–74. http://doi.org/10.1016/j.tra.2012.10.006

Huijts, N. M. a., Molin, E. J. E., & Steg, L. (2012). Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. *Renewable and Sustainable Energy Reviews*, *16*(1), 525–531. http://doi.org/10.1016/j.rser.2011.08.018

Huijts, N. M. a. and B. van Wee. 2015. "The Evaluation of Hydrogen Fuel Stations by Citizens: The Interrelated Effects of Socio-Demographic, Spatial and Psychological Variables." International Journal of Hydrogen Energy 40(33):10367–81. Retrieved (http://linkinghub.elsevier.com/retrieve/pii/S036031991501616X).

Midden, C. J. H., & Huijts, N. M. a. (2009). The role of trust in the affective evaluation of novel risks: the case of CO2 storage. *Risk Analysis : An Official Publication of the Society for Risk Analysis*, *29*(5), 743–51. http://doi.org/10.1111/j.1539-6924.2009.01201.x

O'Garra, T., Mourato, S., & Pearson, P. (2008). Investigating attitudes to hydrogen refuelling facilities and the social cost to local residents. *Energy Policy*, *36*, 2074–2085. http://doi.org/10.1016/j.enpol.2008.02.026

Ricci, M., Bellaby, P., & Flynn, R. (2008). What do we know about public perceptions and acceptance of hydrogen? A critical review and new case study evidence. *International Journal of Hydrogen Energy*, *33*(21), 5868–5880. http://doi.org/10.1016/j.ijhydene.2008.07.106

Schmoyer, R. ., Truett, T., Cooper, C., & Chew, A. (2010). *Results of the 2008/2009 knowledge and opinions surveys conducted for the U.S. Department of Energy hydrogen program*. Retrieved from http://energy.gov/eere/fuelcells/downloads/results-20082009-knowledge-and-opinions-surveys-conducted-us-department

Schmoyer, R., & Cooper, C. (2008). *Compendium : Surveys Evaluating Knowledge and Opinions of Hydrogen and Fuel Cell Technologies October 2008*.

Schulte, I., Hart, D., & Van der Vorst, R. (2004). Issues affecting the acceptance of hydrogen fuel.

International Journal of Hydrogen Energy, 29(7), 677-685.

Tarigan, A. K. M., Bayer, S. B., Langhelle, O., & Thesen, G. (2012). Estimating determinants of public acceptance of hydrogen vehicles and refuelling stations in greater Stavanger. *International Journal of Hydrogen Energy*, *37*(7), 6063–6073. http://doi.org/10.1016/j.ijhydene.2011.12.138

Truett, T., & Schmoyer, R. (2008). *Compendium : Surveys Evaluating Knowledge and Opinions of Hydrogen and Fuel Cell Technologies*.

Upham, P., & García Pérez, J. (2015). A cognitive mapping approach to understanding public objection to energy infrastructure: The case of wind power in Galicia, Spain. *Renewable Energy*, *83*, 587–596. http://doi.org/10.1016/j.renene.2015.05.009

Van Rijnsoever, F. J., Van Mossel, A., & Broecks, K. P. (2015). Public acceptance of energy technologies: The effects of labeling, time, and heterogeneity in a discrete choice experiment. Renewable and Sustainable Energy Reviews, 45, 817-829.

Whitmarsh, L., & O'Neill, S. (2010). Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours. *Journal of Environmental Psychology*, *30*(3), 305–314. http://doi.org/10.1016/j.jenvp.2010.01.003

Wüstenhagen, R., Wolsink, M., & Bürer, M. J. (2007). Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy*, *35*(5), 2683–2691. http://doi.org/10.1016/j.enpol.2006.12.001

Yetano Roche, M., Mourato, S., Fischedick, M., Pietzner, K., & Viebahn, P. (2010). Public attitudes towards and demand for hydrogen and fuel cell vehicles: A review of the evidence and methodological implications. *Energy Policy*, *38*(10), 5301–5310. http://doi.org/10.1016/j.enpol.2009.03.029

Zachariah-Wolff, J. L., & Hemmes, K. (2006). Public Acceptance of Hydrogen in the Netherlands: Two Surveys That Demystify Public Views on a Hydrogen Economy. *Bulletin of Science, Technology & Society*, *26*(4), 339–345. http://doi.org/10.1177/0270467606290308

Zimmer, R., & Welke, J. (2012). Let's go green with hydrogen! The general public's perspective. *International Journal of Hydrogen Energy*, *37*(22), 17502–17508. http://doi.org/10.1016/j.ijhydene.2012.02.126

8. Annex 1. Questionnaire

Demographic questions

S1) Are you male or female?	Male\ Female
S2) How old are you?	____ years
S3) Region:	North East North West Yorkshire & Humber East Midlands West Midlands East of England Greater London South East South West Wales Scotland Northern Ireland
S4) What is the highest level of education that you have completed?	Did not graduate from high school High school graduate Some college or 2-year college degree 4-year college degree Postgraduate degree
S5) Are you?	▪ A student ▪ Employed ▪ Self-employed ▪ Unemployed ▪ Retired
S6) Size of place of residence	<2.000 inhabitants 2.000-20.000 20.001-199.000 200.000-1.000.000 > 1.000.000 Don't know
S7) Do you work in energy and/or environmental issues? ***Filter: show question only if S5 code 2 or 3***	Yes/No
S8) How would you describe your household's current income?	1. Finding it very difficult to live on current income 2. Finding it difficult to live on current income 3. Coping on current income 4. Living comfortably on current income 5. Living very comfortably on current income

S9) Counting yourself, how many people live in your household?	____

General questions

Evaluation of problems	Q1. How would you rate the following problems in terms of importance for your country? Q1_1. The need to improve energy security by being less dependent on fuel imports from other countries Q1_2. The need to reduce the greenhouse gas emissions that cause climate change Q1_3. The need to reduce local air pollution in urban areas Q1_4. The need to create opportunities for #national#(→UK: British; *countyspecific*) industries to increase their capability to provide innovative technologies	Scale 1-5: ▪ Not important (1) ▪ Slightly important (2) ▪ Moderately Important (3) ▪ Important (4) ▪ Very important (5)

Why this study?

The search for alternative methods of energy supply and use has lead governments and companies to develop a portfolio of **energy technologies** (such as solar, wind, and geothermal energy) and energy solutions for transportation, like next generation biofuels, advanced batteries for electric vehicles, and hydrogen fuel cell technologies.

Among these potential solutions to future energy challenges, here we are focusing on **hydrogen fuel cell technologies**. These have various possible end-uses, such as for electricity and heat generation; automobiles, buses and other vehicles; and portable electronics.

It is possible that you may not know much about hydrogen fuel cell technologies at the moment, but it is important that we get to know **public opinion** at an early stage, so this can be taken into account in the design of future products and infrastructures.

Construct	Item	Scale
Awareness	Q2. Before participating in this study, had you ever heard of hydrogen fuel cell technologies in the context of energy production?	▪ Yes (1) ▪ No (2)
	If Q2=2 (NO) skip Q3, go to Q4	
Familiarity ***FILTER: IF Q2=1 (YES)***	Q3. Please rate your familiarity with hydrogen and fuel cell developments. Are you…?	▪ **Not at all familiar** – You know nothing about hydrogen and fuel cell technologies (1) ▪ **Slightly familiar** – You've heard about hydrogen and fuel cell technologies, read an article or watched a television feature about the technology, or participated in a casual conversation about the technology (2)

		▪ **Familiar** – You've had limited experience with hydrogen and fuel cell technologies, researched the subject for school, work, or personal interest, or learned about the technology in a class or workshop (3) ▪ **Very familiar** – You consider yourself an expert in hydrogen and fuel cell technologies (4)

Initial evaluation	Q4. Overall, how do you feel about hydrogen fuel cell technologies as a possible solution for energy and environmental challenges?	Scale 1 to 5 ▪ Very bad solution (1) ▪ Bad (2) ▪ Neutral (3) ▪ Good (4) ▪ Very good solution (5)

Background information on hydrogen

Over the last decades, **hydrogen** (H2) has gained increasing attention as a fuel and for energy storage. Governments and companies across Europe are devoting efforts to the development and implementation of **fuel cells** for *power generation* and *residential heating* and *fuel cell vehicles* (FCVs). The main reasons for this include the need to reduce air pollution in towns and cities and to reduce reliance on fossil fuels.

Photo: H2, the chemical formula for hydrogen gas

A **hydrogen fuel cell** is an electrochemical device (like a battery) that combines hydrogen and oxygen to produce electricity. Fuel cells and batteries are similar because they use a chemical reaction to provide electricity. But fuel cells differ from batteries in that they produce electricity whilst batteries only store electricity. Small fuel cells can power devices such as phones or laptops, while larger fuel cells can provide energy for homes, buildings, industry as well as to power vehicles.

A fuel cell will produce electricity as long as it has a **fuel** supply (hydrogen). Although hydrogen is the most common of all elements in the universe, energy has to be used to generate hydrogen. Hydrogen can be produced from any primary energy source. Currently, most hydrogen is produced from natural gas. But also wind power can be used to separate hydrogen from seawater. The hydrogen then acts as a store of energy that can be transported and used in different ways. In other words, hydrogen is not an energy source but an **energy carrier**.

[Application A: half of the sample]

We would like to know your views on home hydrogen fuel cells. But, please, first let us know…

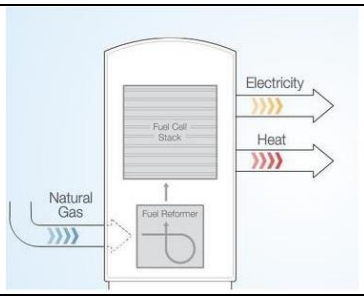
Q5. The type of house you are currently living in	▪ Detached House ▪ Semi-detached House ▪ Terraced House ▪ Flat/Apartment [see filter]
Q6. Is this #pipe in answer text from Q5# (Detached House, Semi-detached House, Terraced House or Flat/ Apartment) your own or rent?	▪ Own ▪ Renting it ▪ Other situation
Q7. What type of heating system provides most of your heat and hot water?	▪ Natural gas ▪ Electricity from the national grid ▪ Other, please specify:_____

Home hydrogen fuel cells

For many years, electricity has mostly been generated in large-scale power stations. However with the increasing use of renewable energy, power is being generated with smaller and more numerous devices. **Stationary fuel cells** are another example of this trend. When located in the home, they allow households to generate part of the electricity and heat they require. As fuel cells are very efficient and can generate electricity from gas, they can reduce the amount of gas that a household needs to buy and eliminate the need to buy electricity.

About the size of a washing machine and powered by fuel cell technology, these fuel cell applications can be installed in a home utility room. The fuel cell system is connected to the normal gas supply and hot water unit, and then to the homes heating and electricity system. **Hydrogen** is generated from the home's natural gas supply and is fed to the **fuel cell**.

Stationary fuel cells can be also installed in **buildings** such as apartment blocks, to provide central heat and electricity to households. So far, large capacity fuel cells are utilized in some countries for schools, hospitals, and other energy-intensive facilities. But multi-family residential buildings represent a new opportunity for fuel cell technology because of their ability to continually provide electricity and heat.

Photo: BlueGen fuel cell installed in a Sheffield home (Source: CFCL) *Photo: Fuel cell technology in a compact system converts natural gas, propane, and eventually biofuels—into both electricity and heat*	

Construct	Item	Scale
Awareness	Q8. Had you ever heard (before this questionnaire) of hydrogen fuel cell applications for home use? If you would like to re-read the background information please click on the info button This button will be shown on each of the following pages.	▪ No, not at all (1) ▪ Yes, a little bit (2) ▪ Yes, I know quite a few things about them (3) ▪ Yes, I know quite a lot about these applications (4)

Affect: *items random*	Q9. To what extent does this technology evoke the following feelings in you, if at all? ▪ Worry ▪ Aversion ▪ Hope ▪ Interest	Scale 1 to 5 for each affect ▪ Not at all (1) ▪ Not really (2) ▪ A little (3) ▪ Somewhat (4) ▪ Very much (5)

Perceived costs, risks and benefits (perceived effects) *Slider* *items randomized*	Q10. What are your expectations with respect to this technology? I expect that it would… • **Cost too much** to **install** –have **acceptable costs** • **Cost too much** to **run**— be **affordable** to **run** • Be very **inconvenient** (in terms of noise, vibration, specific location) –very **convenient** • Have a very **negative**--very **positive** effect on the **environment** • Require a **high** frequency of **maintenance**—**low** frequency of **maintenance** • Be very **dangerous**--very **safe** • Be **inconvenient to use**--**user friendly**	Scale 1 to 5 + don't know option

Evaluation of consequences Q11: items random	The following pages will show few possible consequences of hydrogen and fuell cell technologies. It would be very interesting for us to know your opinion about these. (see text in Annex). Q11. Do you consider this consequence as…? Q12. If you would you like to add any other potential consequence, please add it and indicate its importance:	For each consequence: Scale from 1 to 5 Very negative (1) — Not important (3) —Very positive (5)

Construct	Item	Scale
Global attitude	Q13. Taking into account all the information, what is your overall evaluation of hydrogen fuel cell stationary home applications as a heating and electricity source?	Scale 1-5: • Very bad (1) • Bad (2) • Neutral (3) • Good (4) • Very good (5)

Preference over other technologies *items randomized*	Q14. How would you rate the following technologies to heat the home compared to hydrogen fuel cell systems: Compared to hydrogen fuel cell systems, I think ▪ Electric heat pumps are… ▪ Ground source heat pumps are… ▪ Solar termal are… ▪ Gas boilers are… ▪ Biomass boilers are…	(1-3 scale) ▪ a more negative option (1) ▪ about the same (2) ▪ a more positive option(3) ▪ I don't know

Acceptance and support	Q15. Imagine that you are considering replacing your current heating system. How likely, if at all, would you be to install a hydrogen fuel cell system as a heating and electricity source?	Scale 1-5 (very unlikely -very likely) ▪ Very unlikely (1) ▪ Unlikely (2) ▪ Possible (3) ▪ Likely (4) ▪ Very likely (5)

Wording item other	[filter If answered very unlikely or unlikely]Q16. Why is this? Please check all that apply:	(*multiresponse*) ▪ I think fuel cells applications for residential use are not a yet mature technology ▪ I would prefer to invest in traditional systems of electricity and heat genera-

		tion for (e.g. natural gas) ▪ The hydrogen fuel cells described here rely on fossil fuel ▪ I would prefer to invest in renewable forms of electricity and heat generation for my home (e.g. solar thermal, photovoltaics; biomass boiler) ▪ I think the price of installing a fuel cell will be too high for my budget ▪ other: _____

Acceptance	[filter: only those leaving in a flat in Q5] Q17. Imagine you could vote in your homeowners association on placing a hydrogen fuel cell station at your building, would you vote in favor of it, or against it?	Scale 1 to 5. 1 - I would definitely vote **against** the proposal to 5 - I would definitely vote **in favor of** the proposal.

Intention to install and support of government interventions	Q18. To what extent do you agree with the following statements? Q18_1. All else equal (price, comfort, maintenance cost, etc.), I would be happy to have an hydrogen fuel cell unit in my home in future Q18_2. Public funding should be used to subsidize the purchase price of the fuel cell system	Scale 1-5 (totally disagree-totally agree) ▪ Strongly disagree (1) ▪ Disagree (2) ▪ Undecided (3) ▪ Agree (4) ▪ Strongly agree (5)

Finally, a group of fuel cells can act as an integrated fuel **cell power plant** to generate power and heat for homes, business and industries. About the size of a home, a fuel cell power plant is composed of a collection of various box-shaped fuel cell modules. As stated above, these are usually fueled by natural gas and can be installed close to customers (industrial parks and houses). Hydrogen produced with renewable energy is also possible. A typical fuel cell power plant can have a combined capacity of 15 megawatts: enough to power about 15,000 homes.

Photo: Many fuel cells, like these FuelCell Energy units, can run on natural gas or biogas

Construct	Item	Scale

Awareness/ familiarity	Q19. Are you aware of any specific installation of this kind in your region? If you would like to re-read the background information please click on the info button This button will be shown on each of the following pages	▪ Yes (1) ▪ No (2)

Construct	Items	Scale
Perceived costs, risks and benefits (perceived effects) *Slider* *items randomized*	Q20. What are your expectations with respect to this technology? I expect that fuel cell power plants would… • be built at **too high costs**--**acceptable costs** • have a very **negative**—very **positive effect** on the **reliability of the electricity distribution system** • have a very **negative**--very **positive effect** on the **environment** • be very **dangerous**--very **safe**, • be very **bad**--very **good** for the **local economy** • have a very **negative**--very **positive effect** on the **health of people living nearby**.	Scale 1 to 5 + don't know option

Acceptance	Q21. If you could vote in your town on placing a fuel cell power plant at your nearest energy plant, would you vote in favor of it, or against it?'	Scale 1 to 5 1 - I would definitely vote **against** the technology to 5 - I would definitely vote **in favor of** the technology.

[Application B: half of the sample]

We would like to know your views on hydrogen fueled vehicles.

But, please, first let us know…

Q5b. For the most part of the year, how often do you use? For Car---Public transport—Bicycle (*table form*)	• Every day or nearly every day • 2-5 days a week • Once a week • 1-3 times a month • Less often than that • Never

Fuel-cell hydrogen vehicles

Fuel cell hydrogen vehicles use hydrogen gas to power an electric motor. Unlike conventional vehicles which run on gasoline or diesel, fuel cell vehicles combine hydrogen and oxygen on a fuel cell to produce electricity, which runs an **electric motor**.

Unlike battery-powered electric vehicles, fuel cell vehicles create electricity in an **onboard fuel cell**, usually using stored hydrogen (from a refueling hydrogen station) and oxygen from the air.

Fuel-cell hydrogen cars have to be refilled with hydrogen from a filling station. Refueling a fuel cell vehicle is comparable to refueling a conventional car. It takes less than 10 minutes to fill current models. Once filled, the driving ranges of a fuel cell vehicle vary, but are expected to be around 300-450 km.

Although a few automakers currently offer FCEVs, today, every major car manufacturer has some sort of fuel-cell development program or partnership in the works.

Photo: An hydrogen fuel-cell car leaves an hydrogen fueling station
Photo: *Arrival of First Hydrogen Buses in Aberdeen Project*

Construct	Item	Scale
Awareness	Q6b. Had you ever heard (before this questionnaire) of hydrogen fuel cell vehicles? If you would like to re-read the background	▪ No, not at all (1) ▪ Yes, a little bit (2) ▪ Yes, I know quite a few things about

	information please click on the info button This button will be shown on each of the following pages	that (3) ▪ Yes, I know quite a lot about this subject (4)
Experience	Q7b. Have you ever got on a… • Hydrogen fuel cell car? • Hydrogen fuel cell bus?	▪ No, never (1) ▪ I had a ride once (2) ▪ I had a ride several times (3) ▪ I frequently use one (4).

Affect *items randomized*	Q8b. To what extent does thinking about hydrogen fuel cell vehicles evoke the following feelings to you? ▪ Worry ▪ Aversion ▪ Hope ▪ Interest	Scale 1 to 5 for each affect ▪ Not at all (1) ▪ Not really (2) ▪ A little (3) ▪ Somewhat (4) ▪ Very much (5)

Perceived costs, risks and benefits (perceived effects) *items randomized*	Q9b. What are your expectations with respect to hydrogen fuel cell cars? I expect that they would… ▪ be **environmentally friendly** – be **environmentally harmful** ▪ have **sufficient range** – **don't have** a **sufficient range** ▪ be **easy** – **not easy to refuel / recharge** ▪ be **safe** to drive – **not safe** to drive ▪ be **reliable** – **unreliable** ▪ be **economically affordable** – economically **not affordable** ▪ make my life **easier** – **wouldn't make** my life **easier**	Scale 1-5 Add don't know option

Evaluation of consequences *Q10b: items random*	The following pages will show few possible consequences of hydrogen and fuell cell technologies. It would be very interesting for us to know your opinion about these. (see text in Annex). Q10b. Do you consider this consequence as… Q11b. If you would you like to add any other potential advantage or disadvantage, please add it and indicate its importance:	For each consequence: Scale from 1 to 5 Very negative (1) — Not important (3) —Very positive (5)

Construct	Item	Scale
Global attitude	Q12b. Taking into account the information above, what is your overall evaluation of hydrogen fuel cell cars?	Scale 1 to 5. ▪ Very bad (1) ▪ Bad (2) ▪ Neutral (3) ▪ Good (4) ▪ Very good (5)

Preference over other technologies	Q13b. How would you rate the following types of cars compared to hydrogen fuel cell cars? Compared to think hydrogen full cell cars, I think … • Conventional cars are… • Hybrid cars are… • Full electric cars are… • Compressed natural gas (CNG) or liquefied natural gas (LNG) cars are…	(1-3 scale) ▪ a more negative option (1) ▪ about the same (2) ▪ a more positive option (3) Add don't know option

Acceptance and support	Q14b. Imagine that you are considering replacing your car or that you need to purchase a car. How likely, if at all, would you be to purchase a hydrogen fuel cell car?	Scale 1-5 (very unlikely - very likely) ▪ Very unlikely (1) ▪ Unlikely (2) ▪ Possible (3) ▪ Likely (4) ▪ Very likely (5)
	Q15b. [filter If answered very unlikely or unlikely] Why is this? Please check all that apply:	(*multiresponse*) ▪ I think conventional cars are for now a better option ▪ I think the price of purchasing a fuel cell car will be too high for my budget ▪ I think fuel cells vehicles are not yet a mature technology ▪ I think having a fuel cell vehicle will make my life more difficult ▪ I think full electric cars are a better option ▪ I can't imagine buying a car. ▪ other:

Intention to buy and support	Q16b. To what extent do you agree with the following statements? • All else equal (cost, range, etc.), I would like to purchase an hydrogen fuel cell car in the future • Local municipalities should promote the substitution of conventional buses for hydrogen fuel-cell buses	Scale 1-5 (totally disagree-totally agree) ▪ Strongly disagree (1) ▪ Disagree (2) ▪ Undecided (3) ▪ Agree (4) ▪ Strongly agree (5)

Across Europe, plans are being announced to build **hydrogen refueling stations**. A hydrogen station is a storage or filling station for hydrogen. Intended to power hydrogen vehicles, they are usually located along a road or highway. Hydrogen stations have several options. Some stations make their **fuel onsite**: via small reformers that use natural gas or biogas or via electrolyzers and solar panels to make hydrogen from water and electricity. Others have **hydrogen delivered** as a liquid and others have hydrogen delivered as a gas. In both cases, a tanker truck transfers the fuel to the retail site. Each type of station needs equipment for storing, compressing and dispensing hydrogen.

Photo: Hydrogen station in Höchst, district of Frankfurt am Main, Germany.

Construct	Item	Scale
Awareness/ familiarity	Q17b. Are you aware of any hydrogen refueling station in your region? If you would like to re-read the background information please click on the info button This button will be shown on each of the following pages	▪ Yes (1) ▪ No (2)

Construct	Items	Scale
Perceived costs, risks and benefits (perceived effects)	Q18b. What are your expectations with respect to this technology? I expect that hydrogen fueling stations would: • have **no use**--be very **useful** for people • have a very **negative**--very **positive** effect on the **environment**	Scale 1 to 5 + don't know option

Slider *Items randomized*	• be very **dangerous**--very **safe**, • be very **bad**--very **good** for the l**ocal economy** • have a very **negative**--very **positive** effect on the **health of people living nearby**.	

Acceptance	Q19b. If you could vote in your town on placing a hydrogen fuel station at your nearest petrol station, would you vote in favor of it, or against it?	Scale 1 to 5 1 - I would definitely vote **against** it to 5 - I would definitely vote **in favor of** it. Don't know

Other variables

Construct	Item	Scale
General trust	Q30. How much do you trust… …the industry in your country: • (1) to **make good decisions** about hydrogen technologies? • (2) to **solve possible problems** and **succeed in implementing** hydrogen technologies **safely** and in a **responsible** way? …the government in your country: • (1) to **make good decisions** about hydrogen technologies? • (2) to **solve possible problems** and **succeed in implementing** hydrogen technologies **safely** and in a **responsible** way?	Scale 1 to 5 1-not at all/5-very much

Pro-environmental self-identity scale: *Items randomized*	Q31. To what extent do you agree with the following statements? ▪ I think of myself as someone who is very concerned with environmental issues ▪ I think of myself as an environmentally- friendly consumer ▪ I would be embarrassed to be seen as having an environmentally- friendly lifestyle	Scale 1-5 (totally disagree-totally agree) ▪ Strongly disagree (1) ▪ Disagree (2) ▪ Undecided (3) ▪ Agree (4) ▪ Strongly agree (5)

Involvement with issues regarding energy technologies: *Items randomized*	Q32. To what extent do you agree with the following statements? ▪ I often read news/blogs, etc. about energy technology issues ▪ I am very interested in the field of new energy technologies ▪ Technology will solve many environmental problems	Scale 1-5 (totally disagree-totally agree) ▪ Strongly disagree (1) ▪ Disagree (2) ▪ Undecided (3) ▪ Agree (4) ▪ Strongly agree (5)

Lifestyles *Items randomized*	Q33. How often do you engage in each of the following activities? • Developing your career • Discussing or researching automobiles • Helping the environment • Home remodeling or "fix-it" projects • Nature and the outdoors	Scale 1 to 5 ▪ Never (1) ▪ Rarely (2) ▪ Occasionally (3) ▪ Frequently (4) ▪ Very frequently (5)

	• Playing sports, recreation or exercise • Religious or spiritual practices • Researching or trying new technology • School, lectures or other education • Shopping • Socializing with other • Taking care of/spending time with family • Using the internet for fun or leisure • Volunteering or giving to charity • Watching TV or movies	

[End text]

Many thanks for your time.

This questionnaire is part of the project HYACINTH - Hydrogen Acceptance in the Transition Phase, funded by the FP7 Fuel cell Hydrogen Joint Undertaking (FCH JU). For more information on the project, you can visit:

www.hyacinthproject.eu

Annex: For evaluation of consequences

Stationary applications for residential use

They would reduce the need to purchase electricity from a power company

Combining the production of on-site local heat with local electricity generation to meet on-site energy needs for both can save around 25% of the primary energy needed.

They would reduce CO_2 emissions

A typical fuel cell micro combined heat and power system, using natural gas as the hydrogen source and comprising a fuel cell unit and hot water tank, can reduce CO_2 emissions by up to 50% compared to the separate generation of heat and power.

High initial capital costs

As of December 2012, Panasonic and Tokyo Gas Co., Ltd. sold Ene-Farm units (full cell units that convert natural gas to heat and electricity) in Japan for a price of around 20.000 € before installation.

House space requirements

Installing a domestic fuel cell micro-CHP system requires around 0.65 m2 (about the size of fridge freezer).

It will reduce the cost of producing energy

Operating costs for home fuel cells can be as low as 10 cents per kWh for electricity. Residential systems are advertised by their manufacturers as reducing household bills by 450-1000 euros per year.

Similar risks to other fuels

Like any other fuel, hydrogen poses risks if not properly handled. Some of the properties of hydrogen make it potentially less hazardous than natural gas, petrol and diesel, while other characteristics make it more dangerous in particular situations. Specific precautions, such as good venting, need to be in place for hydrogen just as for many other fuels.

Hydrogen fuel cell vehicles

They would reduce the need for petroleum

Fuel cell vehicles use hydrogen gas and oxygen to power an electric motor. As hydrogen can be produced from a variety of domestic resources, hydrogen vehicles would reduce the need for petroleum.

Lower CO_2 emissions than conventional cars

When oxygen and hydrogen react, they produce only water and heat, making hydrogen vehicles "zero-emissions" vehicles (like battery-powered electric vehicles). Total CO_2 emissions depend on the source of energy used to produce the hydrogen. If solar, wind or other renewable resources generate the electricity, hydrogen could be produced without any carbon emissions at all. If the electricity used to produce hydrogen comes from natural gas, cars and buses cut emissions by over 30 percent when compared with their gasoline-powered counterparts.

Price of fuel cell material

The cost of the vehicles powered by hydrogen is still a key issue. Platinum is one of the most commonly used catalysts for fuel cells, but it is a very expensive and scarce resource. Initial pricing of Toyota Mirai, for instance, has been set at 53 231 € (state incentives in some countries could reduce the price).

Price of hydrogen

Hydrogen fuel cars are, on a simple per km basis, cheaper to run than regular gasoline engines. Right now, state-of-the-art hydrogen extraction from natural gas, pressurized and delivered to the customer, costs, before taxes, less than 1 euro for a liter of gasoline equivalent.

Infrastructure needed

New infrastructure will be needed for hydrogen refueling. Very few countries have more than 15 hydrogen filling stations operational and the network is only slowly growing. Interested drivers should ensure they live near hydrogen refueling stations.

Range

Current hydrogen cars have a range of around 450 km. This is a higher range than the majority of Electric Vehicles in the market and a lower range as compared to the performance of diesel vehicles.

Safety issues

Hydrogen poses risks of the same order of magnitude as other fuels. In a collision in an open space, an hydrogen fuel cell car should have less potential hazard than either natural gas or a gasoline vehicle. A potential risk is a release in an enclosed home garage, where an accumulation of hydrogen could lead to fire or explosion if no hydrogen detection or risk mitigation devices or measures are applied (such as passive or active ventilation).

9. Annex 2. Results by country and sociodemographics

SECTION 1 - GENERAL QUESTIONS

		Age				Gender		Education	
Country and characteristics	**Total**	**18-34**	**35-44**	**45-55**	**55+**	**Male**	**Female**	**Non-University degree**	**University degree**
BELGIUM N=1021									
Q1_ Need to improve energy security (Mean scale 1-5)	3,9	3,7	3,8	4,1	4,1	3,9	4,0	3,9	3,9
Q1_ Need to reduce greenhouse emissions (Mean scale 1-5)	4,0	3,8	4,0	4,0	4,1	3,9	4,0	4,0	4,0
Q1_ Need to reduce local air pollution (Mean scale 1-5)	4,0	3,9	4,0	3,9	4,2	4,0	4,0	4,0	4,0
Q1_ Need to create opportunities for industries (Mean scale 1-5)	3,6	3,4	3,5	3,7	3,9	3,7	3,6	3,6	3,6
Q2 Heard before of FCH technologies (% yes)	41	39	40	40	43	54	29	37	46
Q4. Initial evaluation of FCH as a solution for energy challenges (Mean scale 1-5)	3,7	3,6	3,6	3,8	3,8	3,8	3,6	3,7	3,8
GERMANY N=1011									
Q1_ Need to improve energy security (Mean scale 1-5)	3,4	3,3	3,4	3,5	3,5	3,4	3,5	3,4	3,5
Q1_ Need to reduce greenhouse emissions (Mean scale 1-5)	4,0	3,9	3,8	4,0	4,1	3,9	4,1	4,0	4,0
Q1_ Need to reduce local air pollution (Mean scale 1-5)	4,0	3,9	3,7	4,0	4,1	3,9	4,0	3,9	4,0
Q1_ Need to create opportunities for industries (Mean scale 1-5)	3,7	3,6	3,7	3,7	3,8	3,8	3,6	3,7	3,8
Q2. Heard before of FCH technologies (% yes)	49	53	52	50	45	65	34	42	70
Q4. Initial evaluation of FCH as a solution for energy challenges (Mean scale 1-5)	3,7	3,6	3,6	3,7	3,7	3,9	3,5	3,6	3,8
SPAIN N=1034									
Q1_ Need to improve en-	4,1	3,8	4,0	4,2	4,3	4,0	4,1	4,1	4,1

ergy security (Mean scale 1-5)									
Q1_ Need to reduce green-house emissions (Mean scale 1-5)	4,1	3,9	4,0	4,2	4,2	4,0	4,2	4,2	4,0
Q1_ Need to reduce local air pollution (Mean scale 1-5)	4,1	4,0	4,0	4,1	4,3	4,0	4,2	4,1	4,1
Q1_ Need to create oppor-tunities for industries (Mean scale 1-5)	4,0	3,7	3,9	4,0	4,3	4,0	4,0	4,0	4,0
Q2. Heard before of FCH technologies (% yes)	29	33	29	32	24	42	17	22	34
Q4. Initial evaluation of FCH as a solution for en-ergy challenges (Mean scale 1-5)	3,7	3,7	3,8	3,7	3,6	3,8	3,6	3,6	3,8
FRANCE N=1022									
Q1_ Need to improve en-ergy security (Mean scale 1-5)	4,0	3,8	3,8	4,1	4,1	4,0	4,0	4,0	3,9
Q1_ Need to reduce green-house emissions (Mean scale 1-5)	4,1	4,0	4,0	4,2	4,1	4,0	4,2	4,1	4,1
Q1_ Need to reduce local air pollution (Mean scale 1-5)	4,1	4,0	4,0	4,2	4,2	4,0	4,2	4,1	4,1
Q1_ Need to create oppor-tunities for industries (Mean scale 1-5)	4,0	3,8	3,9	4,1	4,2	4,1	4,0	4,1	4,0
Q2. Heard before of FCH technologies (% yes)	39	41	36	36	39	58	21	31	46
Q4. Initial evaluation of FCH as a solution for en-ergy challenges (Mean scale 1-5)	3,6	3,5	3,5	3,6	3,6	3,8	3,4	3,5	3,6
NORWAY N=1033									
Q1_ Need to improve en-ergy security (Mean scale 1-5)	3,6	3,3	3,6	3,9	3,9	3,6	3,7	3,8	3,5
Q1_ Need to reduce green-house emissions (Mean scale 1-5)	3,8	3,8	3,6	3,7	3,9	3,5	4,0	3,7	3,8
Q1_ Need to reduce local air pollution (Mean scale 1-5)	3,8	3,8	3,7	3,8	3,9	3,6	4,1	3,8	3,9
Q1_ Need to create oppor-tunities for industries (Mean scale 1-5)	3,8	3,6	3,8	3,9	4,1	3,9	3,8	3,8	3,9
Q2. Heard before of FCH	47	47	43	46	50	65	30	42	52

technologies (% yes)									
Q4. Initial evaluation of FCH as a solution for energy challenges (Mean scale 1-5)	3,7	3,7	3,6	3,7	3,7	3,8	3,6	3,6	3,7
SLOVENIA N=1014									
Q1_ Need to improve energy security (Mean scale 1-5)	4,2	4,0	4,1	4,2	4,4	4,1	4,3	4,2	4,2
Q1_ Need to reduce greenhouse emissions (Mean scale 1-5)	4,2	4,1	4,1	4,2	4,5	4,0	4,4	4,2	4,3
Q1_ Need to reduce local air pollution (Mean scale 1-5)	4,3	4,1	4,1	4,3	4,5	4,1	4,5	4,3	4,4
Q1_ Need to create opportunities for industries (Mean scale 1-5)	4,2	4,0	4,1	4,1	4,4	4,1	4,3	4,1	4,3
Q2. Heard before of FCH technologies (% yes)	41	38	39	44	44	58	25	38	47
Q4. Initial evaluation of FCH as a solution for energy challenges (Mean scale 1-5)	3,8	3,8	3,8	3,8	3,9	3,9	3,8	3,8	3,8
UK N=1013									
Q1_ Need to improve energy security (Mean scale 1-5)	3,9	3,7	3,8	3,9	4,1	3,9	3,9	3,9	3,9
Q1_ Need to reduce greenhouse emissions (Mean scale 1-5)	3,7	3,7	3,7	3,5	3,7	3,6	3,7	3,6	3,8
Q1_ Need to reduce local air pollution (Mean scale 1-5)	3,7	3,7	3,7	3,7	3,8	3,7	3,8	3,6	3,8
Q1_ Need to create opportunities for industries (Mean scale 1-5)	3,7	3,6	3,6	3,8	3,9	3,8	3,7	3,6	3,8
Q2. Heard before of FCH technologies (% yes)	39	42	38	43	37	56	22	30	45
Q4. Initial evaluation of FCH as a solution for energy challenges (Mean scale 1-5)	3,6	3,6	3,6	3,5	3,5	3,7	3,4	3,4	3,6

SECTION 2 - HOME HYDORGEN FUEL CELLS

		Age				Gender		Education	
Country and characteristics	**Total**	**18-34**	**35-44**	**45-55**	**55+**	**Male**	**Female**	**Non-University degree**	**University degree**
BELGIUM N=513									
Q8. Heard before of FCH for home use (%yes)	23	26	25	16	24	31	17	22	25
Q9_Worry (mean scale 1-5)	2,5	2,6	2,7	2,6	2,4	2,6	2,5	2,5	2,6
Q9_Aversion (mean scale 1-5)	2,1	2,3	2,2	1,9	2,0	2,2	2,1	2,2	2,0
Q9_Hope (mean scale 1-5)	3,4	3,3	3,6	3,4	3,5	3,5	3,3	3,4	3,5
Q9_Interest (mean scale 1-5)	3,5	3,4	3,6	3,5	3,6	3,7	3,4	3,4	3,6
Q10. Beliefs about costs/benefits (mean scale 1-5)	3,3	3,3	3,4	3,4	3,2	3,4	3,2	3,3	3,3
Q13. Evaluation of FCH for home use (mean scale 1-5)	3,7	3,6	3,6	3,7	3,7	3,7	3,7	3,7	3,7
Q14. Compared to FCH systems... solar thermal is a better option (% a better option)	36	34	33	32	40	34	38	35	36
Q14. Compared to FCH systems... gas boilers are a better option (% a better option)	15	14	15	19	14	17	13	14	16
Q15. Self-reported likelihood of installing a FCH system (% likely and very likely)	0,2	0,2	0,2	0,2	0,1	0,2	0,1	0,2	0,1
Q17. Acceptance of FCH at your building (% in favour of proposal)	0,5	0,4	0,3	0,6	0,6	0,5	0,5	0,5	0,4
Q18_1. I would be happy to have a fuel cell unit in my home (% agree and strongly agree)	60	66,2	60,4	57,3	56,7	63,1	57,4	59,3	61,0
Q18_2. Public funding should be used to subsidize fuel cell systems (% agree and strongly agree)	75	71	74	75	78	72	77	72	78
Q19. Are you aware of the existence of a fuel cell power plant in your region? (% yes)	6,0	9,4	14,3	2,1	1,6	8,7	3,7	5,3	7,0
Q21. Acceptance of a fuel cell power plant in your town (% in favour)	58	51	55	60	63	65	52	58	57
FRANCE N=510									
Q8. Heard before of FCH for home use (%yes)	25,0	38,0	24,0	20,0	18,0	36,0	15,0	26,0	24,0
Q9_Worry (mean scale 1-5)	2,5	2,6	2,6	2,6	2,4	2,5	2,6	2,6	2,5
Q9_Aversion (mean scale 1-5)	2,3	2,5	2,3	2,2	2,1	2,2	2,3	2,4	2,1
Q9_Hope (mean scale 1-5)	3,6	3,6	3,4	3,6	3,7	3,7	3,5	3,6	3,6
Q9_Interest (mean scale 1-5)	3,6	3,6	3,4	3,8	3,7	3,8	3,5	3,6	3,7
Q10. Beliefs about costs/benefits (mean scale 1-5)	3,5	3,4	3,5	3,6	3,4	3,5	3,4	3,5	3,5

Q13. Evaluation of FCH for home use (mean scale 1-5)	3,7	3,6	3,6	3,8	3,8	3,8	3,6	3,7	3,7
Q14. Compared to FCH systems... solar thermal is a better option (% a better option)	34,3	29,2	32,3	35,2	38,9	36,5	32,3	35,3	33,5
Q14. Compared to FCH systems... gas boilers are a better option (% a better option)	12,2	12,5	10,8	11,4	13,0	12,7	11,7	15,5	9,2
Q15. Self-reported likelihood of installing a FCH system (% likely and very likely)	20,0	25,0	23,0	22,0	14,0	27,0	13,0	19,0	21,0
Q17. Acceptance of FCH at your building (% in favour of proposal)	0,5	0,5	0,4	0,5	0,6	0,6	0,4	0,4	0,5
Q18_1. I would be happy to have a fuel cell unit in my home (% agree and strongly agree)	54,7	53,5	50,5	60,2	55,1	62,7	47,4	52,5	56,6
Q18_2. Public funding should be used to subsidize fuel cell systems (% agree and strongly agree)	73,9	68,8	68,8	80,7	77,3	76,6	71,4	72,7	75,0
Q19. Are you aware of the existence of a fuel cell power plant in your region? (% yes)	7,5	11,1	15,1	4,5	2,2	9,4	5,6	5,9	8,8
Q21. Acceptance of a fuel cell power plant in your town (% in favour)	52,9	53,5	45,2	55,7	55,1	61,5	45,1	49,2	56,3
GERMANY N=511									
Q8. Heard before of FCH for home use (%yes)	32,0	28,0	34,0	24,0	37,0	43,0	21,0	27,0	46,0
Q9_Worry (mean scale 1-5)	2,3	2,5	2,5	2,2	2,2	2,3	2,3	2,3	2,3
Q9_Aversion (mean scale 1-5)	1,9	2,1	2,0	1,7	1,9	1,9	2,0	2,0	1,8
Q9_Hope (mean scale 1-5)	3,6	3,6	3,5	3,5	3,6	3,6	3,5	3,5	3,6
Q9_Interest (mean scale 1-5)	3,7	3,8	3,6	3,7	3,7	3,9	3,5	3,7	3,9
Q10. Beliefs about costs/benefits (mean scale 1-5)	3,5	3,2	3,4	3,5	3,6	3,5	3,4	3,5	3,4
Q13. Evaluation of FCH for home use (mean scale 1-5)	3,8	3,7	3,6	3,8	3,9	3,9	3,7	3,8	3,9
Q14. Compared to FCH systems... solar thermal is a better option (% a better option)	38,6	42,9	48,4	32,3	34,6	39,2	37,9	38,5	38,8
Q14. Compared to FCH systems... gas boilers are a better option (% a better option)	14,9	16,8	20,9	11,5	12,7	16,4	13,4	16,2	11,2
Q15. Self-reported likelihood of installing a FCH system (% likely and very likely)	25,0	24,0	26,0	22,0	27,0	32,0	19,0	25,0	26,0
Q17. Acceptance of FCH at your building (% in favour of proposal)	0,5	0,5	0,3	0,5	0,7	0,6	0,5	0,5	0,6
Q18_1. I would be happy to have a fuel cell unit in my home (% agree and strongly agree)	71,4	78,2	62,6	74,0	70,2	76,4	66,7	69,5	76,9
Q18_2. Public funding should be used to subsidize fuel cell systems (% agree	78,7	80,7	68,1	85,4	79,0	80,8	76,6	79,8	75,4

and strongly agree)									
Q19. Are you aware of the existence of a fuel cell power plant in your region? (% yes)	5,3	9,2	6,6	5,2	2,4	6,0	4,6	5,0	6,0
Q21. Acceptance of a fuel cell power plant in your town (% in favour)	63,2	62,2	50,5	66,7	67,8	72,0	54,8	60,5	70,9
NORWAY N=521									
Q8. Heard before of FCH for home use (%yes)	20,0	24,0	20,0	18,0	19,0	25,0	15,0	17,0	23,0
Q9_Worry (mean scale 1-5)	2,2	2,3	2,1	2,3	2,1	2,2	2,2	2,2	2,2
Q9_Aversion (mean scale 1-5)	1,9	2,0	1,9	2,0	1,8	1,9	1,9	2,0	1,8
Q9_Hope (mean scale 1-5)	3,4	3,4	3,2	3,5	3,6	3,4	3,4	3,3	3,5
Q9_Interest (mean scale 1-5)	3,7	3,7	3,5	3,7	3,7	3,8	3,6	3,6	3,7
Q10. Beliefs about costs/benefits (mean scale 1-5)	3,3	3,1	3,2	3,2	3,5	3,3	3,3	3,3	3,3
Q13. Evaluation of FCH for home use (mean scale 1-5)	3,5	3,6	3,4	3,4	3,5	3,5	3,4	3,5	3,5
Q14. Compared to FCH systems... solar thermal is a better option (% a better option)	60,7	56,1	57,7	63,4	64,5	57,1	64,1	60,3	60,9
Q14. Compared to FCH systems... gas boilers are a better option (% a better option)	4,2	4,1	9,3	4,3	1,6	4,2	4,2	4,5	3,9
Q15. Self-reported likelihood of installing a FCH system (% likely and very likely)	13,0	14,0	13,0	11,0	13,0	17,0	8,0	11,0	14,0
Q17. Acceptance of FCH at your building (% in favour of proposal)	0,4	0,4	0,3	0,5	0,5	0,5	0,4	0,5	0,4
Q18_1. I would be happy to have a fuel cell unit in my home (% agree and strongly agree)	58,3	72,3	56,7	54,8	49,7	64,1	52,7	56,2	60,2
Q18_2. Public funding should be used to subsidize fuel cell systems (% agree and strongly agree)	67,9	73,0	66,0	67,7	65,0	68,3	67,6	74,0	62,7
Q19. Are you aware of the existence of a fuel cell power plant in your region? (% yes)	7,0	7,6	6,3	4,4	8,3	8,0	6,1	5,5	8,5
Q21. Acceptance of a fuel cell power plant in your town (% in favour)	46,6	45,3	39,2	50,5	49,7	51,7	41,6	45,0	48,0
SLOVENIA N=511									
Q8. Heard before of FCH for home use (%yes)	31,0	31,0	23,0	33,0	33,0	37,0	25,0	30,0	32,0
Q9_Worry (mean scale 1-5)	2,4	2,4	2,4	2,4	2,3	2,3	2,4	2,4	2,4
Q9_Aversion (mean scale 1-5)	2,0	2,1	1,8	2,0	2,0	2,0	1,9	2,0	1,8
Q9_Hope (mean scale 1-5)	3,8	3,6	3,5	3,7	4,2	3,9	3,7	3,8	3,9
Q9_Interest (mean scale 1-5)	4,0	3,7	3,6	4,1	4,4	4,0	4,0	4,0	4,1
Q10. Beliefs about costs/benefits (mean scale 1-5)	3,5	3,3	3,6	3,6	3,6	3,5	3,5	3,5	3,5

Q13. Evaluation of FCH for home use (mean scale 1-5)	3,8	3,7	3,7	3,9	4,0	3,9	3,8	3,8	3,8
Q14. Compared to FCH systems... solar thermal is a better option (% a better option)	51,9	52,6	49,0	47,4	55,2	48,2	55,4	52,2	51,2
Q14. Compared to FCH systems... gas boilers are a better option (% a better option)	11,4	9,5	14,3	7,4	13,3	13,4	9,3	12,1	9,9
Q15. Self-reported likelihood of installing a FCH system (% likely and very likely)	19,0	16,0	18,0	20,0	20,0	23,0	15,0	21,0	15,0
Q17. Acceptance of FCH at your building (% in favour of proposal)	0,6	0,4	0,5	0,6	0,7	0,6	0,6	0,6	0,5
Q18_1. I would be happy to have a fuel cell unit in my home (% agree and strongly agree)	70,8	72,3	61,2	72,6	74,0	71,9	69,8	70,2	72,1
Q18_2. Public funding should be used to subsidize fuel cell systems (% agree and strongly agree)	85,7	83,2	87,8	86,3	86,2	83,8	87,6	85,0	87,2
Q19. Are you aware of the existence of a fuel cell power plant in your region? (% yes)	2,9	5,8	3,1	3,2	0,6	4,3	1,6	3,5	1,7
Q21. Acceptance of a fuel cell power plant in your town (% in favour)	68,3	64,2	64,3	71,6	71,8	72,7	64,0	68,7	67,4
SPAIN N=517									
Q8. Heard before of FCH for home use (%yes)	23,0	29,0	25,0	18,0	18,0	26,0	19,0	18,0	25,0
Q9_Worry (mean scale 1-5)	2,6	2,7	2,6	2,5	2,6	2,6	2,6	2,7	2,6
Q9_Aversion (mean scale 1-5)	2,2	2,4	2,1	2,3	2,0	2,2	2,2	2,3	2,1
Q9_Hope (mean scale 1-5)	3,7	3,5	3,8	3,7	3,8	3,7	3,7	3,6	3,7
Q9_Interest (mean scale 1-5)	4,0	3,8	4,1	4,0	4,0	4,0	3,9	3,9	4,0
Q10. Beliefs about costs/benefits (mean scale 1-5)	3,3	3,3	3,3	3,3	3,4	3,3	3,3	3,5	3,3
Q13. Evaluation of FCH for home use (mean scale 1-5)	3,8	3,7	3,8	3,7	3,9	3,9	3,7	3,8	3,8
Q14. Compared to FCH systems... solar thermal is a better option (% a better option)	44,9	48,7	45,9	35,6	45,8	48,8	41,3	40,1	47,9
Q14. Compared to FCH systems... gas boilers are a better option (% a better option)	13,0	18,0	17,4	8,9	7,7	13,8	12,2	10,4	14,6
Q15. Self-reported likelihood of installing a FCH system (% likely and very likely)	22,0	23,0	25,0	12,0	24,0	24,0	20,0	22,0	22,0
Q17. Acceptance of FCH at your building (% in favour of proposal)	0,5	0,6	0,5	0,5	0,6	0,6	0,5	0,5	0,4
Q18_1. I would be happy to have a fuel cell unit in my home (% agree and strongly agree)	71,0	69,3	73,4	58,9	77,4	71,1	70,8	69,8	71,7
Q18_2. Public funding should be used to subsidize fuel cell systems (% agree	77,8	76,0	79,8	82,2	75,6	76,4	79,0	76,2	78,7

and strongly agree)									
Q19. Are you aware of the existence of a fuel cell power plant in your region? (% yes)	5,6	10,7	3,7	5,6	2,4	6,9	4,4	3,0	7,3
Q21. Acceptance of a fuel cell power plant in your town (% in favour)	59,6	61,3	56,9	53,3	63,1	65,0	54,6	56,4	61,6
UK N=509									
Q8. Heard before of FCH for home use (%yes)	23,0	39,0	26,0	20,0	11,0	31,0	15,0	13,0	30,0
Q9_Worry (mean scale 1-5)	2,4	2,7	2,4	2,3	2,2	2,3	2,4	2,4	2,4
Q9_Aversion (mean scale 1-5)	2,3	2,8	2,4	2,1	2,0	2,3	2,3	2,2	2,3
Q9_Hope (mean scale 1-5)	3,5	3,3	3,3	3,5	3,5	3,5	3,4	3,4	3,5
Q9_Interest (mean scale 1-5)	3,6	3,5	3,5	3,7	3,7	3,7	3,5	3,5	3,7
Q10. Beliefs about costs/benefits (mean scale 1-5)	3,4	3,4	3,3	3,5	3,4	3,4	3,3	3,3	3,4
Q13. Evaluation of FCH for home use (mean scale 1-5)	3,6	3,6	3,6	3,6	3,7	3,7	3,6	3,6	3,7
Q14. Compared to FCH systems... solar thermal is a better option (% a better option)	35,8	37,7	40,0	39,3	30,7	37,6	33,7	33,5	37,3
Q14. Compared to FCH systems... gas boilers are a better option (% a better option)	16,9	24,7	21,1	10,7	11,6	21,7	11,8	16,3	17,3
Q15. Self-reported likelihood of installing a FCH system (% likely and very likely)	20,0	32,0	26,0	18,0	10,0	26,0	14,0	12,0	26,0
Q17. Acceptance of FCH at your building (% in favour of proposal)	0,5	0,4	0,5	0,7	0,4	0,5	0,4	0,4	0,5
Q18_1. I would be happy to have a fuel cell unit in my home (% agree and strongly agree)	60,7	61,0	58,9	64,3	59,8	68,1	52,8	52,7	66,0
Q18_2. Public funding should be used to subsidize fuel cell systems (% agree and strongly agree)	61,1	56,2	64,4	69,0	59,8	66,5	55,3	56,7	64,1
Q19. Are you aware of the existence of a fuel cell power plant in your region? (% yes)	11,2	26,0	13,3	7,1	0,5	15,2	6,9	5,9	14,7
Q21. Acceptance of a fuel cell power plant in your town (% in favour)	53,0	51,4	52,2	59,5	51,9	62,4	43,1	45,8	57,8

SECTION 3 - FUEL CELL HYDROGEN VEHICLES

		Age				Gender		Education	
Country and characteristics	**Total**	**18-34**	**35-44**	**45-55**	**55+**	**Male**	**Female**	**Non-University degree**	**University degree**
BELGIUM N=513									
Q6. Heard before of FCH vehicles (%yes)	60,0	57,0	57,0	60,0	62,0	78,0	44,0	55,0	67,0
Q8_ Worry (mean scale 1-5)	2,3	2,4	2,4	2,3	2,1	2,3	2,2	2,2	2,4
Q8_Aversion (mean scale 1-5)	1,9	2,3	1,9	1,8	1,6	1,9	1,9	1,9	1,9
Q8_Hope (mean scale 1-5)	3,6	3,4	3,6	3,6	3,7	3,8	3,4	3,5	3,7
Q8_Interest (mean scale 1-5)	3,6	3,4	3,5	3,5	3,8	3,8	3,5	3,5	3,8
Q9_Beliefs about benefits/costs (mean scale 1-5)	2,2	2,3	2,1	2,1	2,1	2,2	2,1	2,1	2,2
Q12b. Evaluation of FCH vehicles (mean scale 1-5)	3,6	3,6	3,7	3,6	3,7	3,7	3,6	3,6	3,7
Q13b. Compared to FCH cars... Conventional care are a better option (% more positive option)	20,5	20,6	27,7	19,1	17,4	23,4	17,9	19,4	22,3
Q13b. Compared to FCH cars... Full electric are a better option (% more positive option)	26,8	21,3	26,6	28,7	29,9	29,4	24,5	24,7	30,3
Q14b. Self-reported likelihood of purchasing a FCEV (% likely and very likely)	13,4	16,9	16,0	14,9	8,7	17,4	9,9	11,6	16,5
Q16b1. Intention to buy an FCH car in the future (all else equal) (% agree)	54,5	53,7	58,5	53,2	53,8	58,3	51,3	50,0	62,2
Q16b2. Local municipalities should support FCH buses (% agree)	79,3	72,8	80,9	83,0	81,5	83,0	76,2	76,9	83,5
Q17b. Awareness of hydrogen refuelling stations in your region (% yes)	4,3	8,8	5,3	0,0	2,7	6,0	2,9	3,8	5,3
Q19b. Acceptance of an hydrogen fuel station nearest your petrol station (% in favour)	82,0	78,8	81,5	76,9	87,3	87,5	76,6	81,5	82,7
FRANCE N=510									
Q6. Heard before of FCH vehicles (%yes)	54,0	56,0	52,0	54,0	53,0	75,0	35,0	47,0	61,0
Q8_ Worry (mean scale 1-5)	2,4	2,5	2,4	2,3	2,4	2,3	2,5	2,4	2,3
Q8_Aversion (mean scale 1-5)	2,1	2,3	2,0	2,3	2,0	2,1	2,2	2,3	2,0
Q8_Hope (mean scale 1-5)	3,5	3,4	3,5	3,6	3,7	3,8	3,3	3,5	3,6
Q8_Interest (mean scale 1-5)	3,6	3,5	3,6	3,6	3,7	3,8	3,4	3,5	3,7
Q9_Beliefs about benefits/costs (mean scale 1-5)	2,1	2,4	2,3	2,0	1,9	2,1	2,2	2,1	2,1
Q12b. Evaluation of FCH vehicles (mean scale 1-5)	3,6	3,6	3,6	3,5	3,7	3,8	3,4	3,5	3,7

Q13b. Compared to FCH cars… Conventional care are a better option (% more positive option)	21,7	21,3	17,9	28,9	20,4	19,7	23,5	23,6	19,8
Q13b. Compared to FCH cars… Full electric are a better option (% more positive option)	31,1	34,0	29,5	34,4	28,0	32,8	29,5	30,5	31,6
Q14b. Self-reported likelihood of purchasing a FCEV (% likely and very likely)	13,5	21,3	14,7	14,4	6,5	18,4	9,0	9,7	17,4
Q16b1. Intention to buy an FCH car in the future (all else equal) (% agree)	57,6	65,2	63,2	51,1	52,2	68,0	48,1	51,4	64,0
Q16b2. Local municipalities should support FCH buses (% agree)	73,6	73,0	71,6	72,2	75,8	79,5	68,3	69,5	77,9
Q17b. Awareness of hydrogen refuelling stations in your region (% yes)	3,7	7,8	6,3	1,1	0,5	5,7	1,9	1,5	5,9
Q19b. Acceptance of an hydrogen fuel station nearest your petrol station (% in favour)	78,3	77,6	78,9	82,4	76,8	84,3	71,7	76,4	80,2
GERMANY N=511									
Q6. Heard before of FCH vehicles (%yes)	59,0	69,0	62,0	56,0	52,0	75,0	43,0	54,0	73,0
Q8_ Worry (mean scale 1-5)	2,2	2,2	2,2	2,2	2,2	2,1	2,4	2,3	2,1
Q8_Aversion (mean scale 1-5)	1,9	1,9	1,8	1,7	2,0	1,7	2,0	1,9	1,7
Q8_Hope (mean scale 1-5)	3,5	3,4	3,4	3,7	3,5	3,7	3,3	3,5	3,6
Q8_Interest (mean scale 1-5)	3,7	3,6	3,5	3,7	3,8	3,9	3,5	3,6	3,8
Q9_Beliefs about benefits/costs (mean scale 1-5)	2,2	2,4	2,3	2,1	2,0	2,1	2,3	2,2	2,3
Q12b. Evaluation of FCH vehicles (mean scale 1-5)	3,7	3,6	3,7	3,7	3,7	3,8	3,5	3,6	3,8
Q13b. Compared to FCH cars… Conventional care are a better option (% more positive option)	25,6	25,2	28,4	33,3	21,0	20,9	30,1	25,4	26,3
Q13b. Compared to FCH cars… Full electric are a better option (% more positive option)	20,8	25,2	27,3	16,1	17,5	21,7	19,9	21,5	18,4
Q14b. Self-reported likelihood of purchasing a FCEV (% likely and very likely)	8,4	10,9	9,1	5,4	8,0	9,4	7,4	8,8	7,0
Q16b1. Intention to buy an FCH car in the future (all else equal) (% agree)	66,2	68,1	64,8	71,0	63,5	76,6	56,3	63,7	74,6
Q16b2. Local municipalities should support FCH buses (% agree)	82,0	78,2	79,5	90,3	81,5	88,1	76,2	80,1	88,6
Q17b. Awareness of hydrogen refuelling stations in your region (% yes)	2,6	1,7	2,3	5,4	2,0	3,3	2,0	2,6	2,6
Q19b. Acceptance of an hydro-	78,3	75,2	76,6	75,9	82,0	87,4	68,4	77,0	82,7

gen fuel station nearest your petrol station (% in favour)									
NORWAY N=521									
Q6. Heard before of FCH vehicles (%yes)	85,0	87,0	81,0	79,0	89,0	93,0	78,0	82,0	88,0
Q8_ Worry (mean scale 1-5)	1,9	2,0	1,9	2,0	1,8	1,8	2,0	2,0	1,9
Q8_Aversion (mean scale 1-5)	1,7	1,8	1,7	1,9	1,6	1,7	1,8	1,7	1,8
Q8_Hope (mean scale 1-5)	3,4	3,4	3,4	3,2	3,6	3,4	3,4	3,4	3,5
Q8_Interest (mean scale 1-5)	3,6	3,6	3,5	3,5	3,8	3,7	3,6	3,5	3,7
Q9_Beliefs about benefits/costs (mean scale 1-5)	2,4	2,6	2,5	2,1	2,2	2,3	2,5	2,4	2,4
Q12b. Evaluation of FCH vehicles (mean scale 1-5)	3,8	3,8	3,8	3,7	3,8	3,9	3,7	3,7	3,8
Q13b. Compared to FCH cars… Conventional care are a better option (% more positive option)	12,1	10,3	15,6	17,8	8,8	12,7	11,5	13,0	11,2
Q13b. Compared to FCH cars… Full electric are a better option (% more positive option)	28,1	29,0	26,0	25,6	29,8	26,7	29,5	30,0	26,3
Q14b. Self-reported likelihood of purchasing a FCEV (% likely and very likely)	10,9	12,4	6,3	11,1	12,2	12,7	9,2	9,9	12,0
Q16b1. Intention to buy an FCH car in the future (all else equal) (% agree)	72,1	75,9	69,8	71,1	70,7	78,9	65,5	71,5	72,6
Q16b2. Local municipalities should support FCH buses (% agree)	80,3	82,1	78,1	81,1	79,6	78,5	82,0	78,7	81,9
Q17b. Awareness of hydrogen refuelling stations in your region (% yes)	7,0	7,6	6,3	4,4	8,3	8,0	6,1	5,5	8,5
Q19b. Acceptance of an hydrogen fuel station nearest your petrol station (% in favour)	82,4	82,8	73,8	89,5	83,3	85,9	78,6	81,6	83,3
SLOVENIA N=511									
Q6. Heard before of FCH vehicles (%yes)	63,0	62,0	66,0	57,0	65,0	80,0	47,0	61,0	66,0
Q8_ Worry (mean scale 1-5)	2,2	2,1	2,1	2,2	2,2	2,2	2,2	2,2	2,2
Q8_Aversion (mean scale 1-5)	1,8	1,7	1,9	1,9	1,8	1,7	1,8	1,8	1,8
Q8_Hope (mean scale 1-5)	3,7	3,6	3,6	3,6	3,9	3,8	3,6	3,7	3,8
Q8_Interest (mean scale 1-5)	3,9	3,7	3,7	4,1	4,0	4,0	3,7	3,8	4,0
Q9_Beliefs about benefits/costs (mean scale 1-5)	2,6	2,8	2,7	2,5	2,4	2,3	2,8	2,6	2,5
Q12b. Evaluation of FCH vehicles (mean scale 1-5)	3,8	3,7	3,8	3,6	3,8	3,8	3,7	3,8	3,7
Q13b. Compared to FCH cars… Conventional care are a better option (% more positive option)	21,7	25,9	26,5	24,4	14,2	24,8	18,7	23,7	18,3
Q13b. Compared to FCH cars…	25,4	20,9	19,4	24,4	33,0	26,8	24,1	24,9	26,3

Full electric are a better option (% more positive option)									
Q14b. Self-reported likelihood of purchasing a FCEV (% likely and very likely)	14,3	12,9	18,4	12,2	14,2	17,1	11,7	15,8	11,8
Q16b1. Intention to buy an FCH car in the future (all else equal) (% agree)	64,6	60,4	78,6	54,4	65,3	67,1	62,3	65,6	62,9
Q16b2. Local municipalities should support FCH buses (% agree)	82,1	79,1	90,8	81,1	80,1	85,4	79,0	80,1	85,5
Q17b. Awareness of hydrogen refuelling stations in your region (% yes)	4,4	3,6	8,2	2,2	4,0	4,9	3,9	4,1	4,8
Q19b. Acceptance of an hydrogen fuel station nearest your petrol station (% in favour)	84,4	81,9	85,9	78,6	88,8	89,7	79,2	84,5	84,3
SPAIN N=517									
Q6. Heard before of FCH vehicles (%yes)	47,0	49,0	53,0	48,0	40,0	60,0	33,0	43,0	49,0
Q8_ Worry (mean scale 1-5)	2,3	2,5	2,3	2,1	2,3	2,3	2,4	2,4	2,3
Q8_Aversion (mean scale 1-5)	2,0	2,3	2,0	1,9	1,9	2,1	2,0	2,1	1,9
Q8_Hope (mean scale 1-5)	3,8	3,8	3,8	3,9	3,6	3,9	3,7	3,7	3,8
Q8_Interest (mean scale 1-5)	3,9	3,9	3,9	4,0	3,9	3,8	4,0	3,8	4,0
Q9_Beliefs about benefits/costs (mean scale 1-5)	2,9	2,9	2,9	2,8	2,9	2,9	2,9	2,9	2,9
Q12b. Evaluation of FCH vehicles (mean scale 1-5)	3,7	3,9	3,7	3,7	3,6	3,8	3,7	3,7	3,8
Q13b. Compared to FCH cars… Conventional care are a better option (% more positive option)	21,3	21,1	23,4	13,0	24,7	20,2	22,3	22,6	20,4
Q13b. Compared to FCH cars… Full electric are a better option (% more positive option)	32,3	34,2	30,8	26,1	34,9	33,1	31,5	38,5	28,2
Q14b. Self-reported likelihood of purchasing a FCEV (% likely and very likely)	17,4	25,7	15,0	13,0	13,9	18,3	16,5	15,4	18,8
Q16b1. Intention to buy an FCH car in the future (all else equal) (% agree)	72,0	78,3	74,8	73,9	63,3	77,8	66,2	67,8	74,8
Q16b2. Local municipalities should support FCH buses (% agree)	81,0	84,2	80,4	80,4	78,9	83,3	78,8	80,3	81,6
Q17b. Awareness of hydrogen refuelling stations in your region (% yes)	5,8	8,6	11,2	2,2	1,8	7,0	4,6	6,7	5,2
Q19b. Acceptance of an hydrogen fuel station nearest your petrol station (% in favour)	82,9	87,4	81,1	80,5	81,0	84,8	80,7	81,9	83,5
UK N=509									

Q6. Heard before of FCH vehicles (%yes)	54,0	61,0	48,0	53,0	52,0	67,0	39,0	47,0	58,0
Q8_ Worry (mean scale 1-5)	2,2	2,4	2,3	2,1	2,2	2,2	2,3	2,2	2,3
Q8_Aversion (mean scale 1-5)	2,2	2,6	2,0	2,1	1,9	2,2	2,1	2,1	2,2
Q8_Hope (mean scale 1-5)	3,4	3,5	3,4	3,5	3,4	3,5	3,4	3,3	3,5
Q8_Interest (mean scale 1-5)	3,5	3,6	3,6	3,4	3,4	3,6	3,4	3,3	3,7
Q9_Beliefs about benefits/costs (mean scale 1-5)	2,5	2,6	2,6	2,6	2,4	2,5	2,7	2,5	2,5
Q12b. Evaluation of FCH vehicles (mean scale 1-5)	3,7	3,8	3,8	3,7	3,7	3,8	3,6	3,6	3,8
Q13b. Compared to FCH cars… Conventional care are a better option (% more positive option)	24,2	28,0	23,3	24,7	21,5	27,1	21,1	21,6	25,8
Q13b. Compared to FCH cars… Full electric are a better option (% more positive option)	27,6	30,8	30,0	31,8	22,0	28,2	26,9	25,3	29,0
Q14b. Self-reported likelihood of purchasing a FCEV (% likely and very likely)	19,0	32,2	23,3	14,1	9,1	26,7	10,7	12,1	23,2
Q16b1. Intention to buy an FCH car in the future (all else equal) (% agree)	55,8	62,2	63,3	50,6	49,5	60,7	50,4	44,7	62,4
Q16b2. Local municipalities should support FCH buses (% agree)	70,8	66,4	81,1	67,1	71,0	74,4	66,9	65,3	74,2
Q17b. Awareness of hydrogen refuelling stations in your region (% yes)	6,3	14,7	5,6	3,5	1,6	10,3	2,1	4,2	7,6
Q19b. Acceptance of an hydrogen fuel station nearest your petrol station (% in favour)	78,9	80,2	76,8	81,7	77,9	80,8	76,4	71,4	83,0

10. Annex 3. Answers to open questions

Other consequences/attributes of home hydrogen fuel cells raised by respondents

		N	Examples of quotes
Price and cost	Cost of purchasing the hydrogen fuel cell system	84	*"Seems far too expensive for domestic use currently - would take >20 years to save the cost of the unit" (German participant)* *"Capital cost far too high" (British participant)* *"The cost is prohibitive, so unlikely to take off in any great numbers." (British participant)* *"We simply cannot afford this, if we win the lottery then we will definitely buy one!" (Belgian participant)* *"It is too expensive start cost for the situation in which today's Slovenian households" (Slovenian participant)*
Danger and safety	Potential risks associated with the use of the hydrogen fuel cell unit	61	*"Hydrogen gas is highly explosive! it is difficult to detect leakage (colorless, odorless ...)" (Slovenian participant)* *"How explosive is fuel or? I've heard that they can go in the air as tnt if they are not treated incredibly careful." (Norwegian participant)* *"Fire and explosion hazards when installing fire compartment in the home?" (Norwegian participant)* *"I am seriously concerned about the explosive reaction of hydrogen that could lead to accidents". (British participant)*
Need of information and lack of experience	Lack of information to provide an evaluation	49	*"I don't know, I would need more and clearer information" (Spanish participant)* *"One would have to be adequately informed" (German participant)* *"Insufficient experience" (British participant)*
Environment, pollution and health	Environmental benefits and risks	33	*"Less electricity is less dependent on for example. nuclear power plants" (Belgian participant)* *"Less greenhouse gas" (French participant)* *"Alternative sources of energy are very important right now. We need to look to them to provide cleaner and more efficient" (British participant)* *"Compared to oil heating is still low and Environmentally-friendly" (German participant)*

Hydrogen production	Issues regarding the production of hydrogen	28	*"Natural gas is limited source , production should not be dependent on it" (British participant)* *"If it consumes natural gas, it is the same that electricity companies are doing" (Spanish participant)* *"Production of hydrogen is very energy intensive. A fuel cell is only 30% efficient. Electric motors is 90-99% effective" (Norweigan participant)* *"By operating with natural gas but unfortunately still dependency on gas producers" (German participant)* *"It will continue to require natural gas" (German participant)*
Maintenance, reparations and lifespan	Problems associated with the maintenance of the system	20	*"The concern is to find the right installer, who really knows" (French participant)* *"Lack of company for maintenance" (French participant)* *"It seems very complex" (Belgian participant)* *"Costs of maintenance and technical assistance" (Spanish participant)* *"Who would be able to repair it if broken" (British participant)*
Suitability for different type of homes	Questions regarding the suitability of the system for different types of homes	16	*"It depends on how big is the house" (German participant)* *"Only home owners would benefit, as community housing would not allow it" (British participant)* *"You'd have a lot of difficulty fitting these things into the average British house" (British participant)* *"It would be difficult for a conventional flat" (Spanish participant)*
Political issues and companies interests	The role of companies and governments	13	*"The monopoly of large manufacturers on the market" (Slovenian participant)* *"We would fight against energy companies as they would reduce their benefits" (Spanish participant)*
Delivery and installation	Doubts regarding the installation	11	*"Would it have to be installed in the house----could it be in a shed for example---would it be affected by temperature-" (British participant)*
Other disadvantages	Other	10	*"In Norway, it shall compete with cheap electricity and therefore would be uncompetitive" (Norweigan participant)*
Fuel cells recycling	The recycling of the fuel cells	5	*"Recycling needs" (French participant)* *"How is the recycling of spent cells?" (Slovenian participant)*

Other reasons for not purchasing a residential hydrogen fuel cell unit mentioned by respondents (in total number of mentions)

		N	Examples of quotes
Not the home owner/no decision power	Lack of decision making capacity due to not owning the house	53	*"I am a tenant" (German participant)* *"This decision must be taken by the owner, not the tenant" (French participant)* *"I'm not the owner" (Norwegian participant)* *"I'm the tenant and I haven't influence" (German participant)* *"I don't own the property" (British participant)* *"I live in a Council Flat and therefore I can't change it" (French participant)* *"I live in a rented flat" (Spanish participant)* *"We live in a block so we need quorum to make this change" (Slovenian participant)*
Other types of energy installed at home	Alternative types of energy	21	*"Collective fuel heater" (French participant)* *"I have firewood free" (Slovenian participant)* *"I've just received heat pump" (Norwegian participant)* *"We have district heating" (Norwegian participant)* *"Installed energy collector in rock in 2015" (Norwegian participant)* *"I invested in a high performance wood system but otherwise yes" (French participant)* *"I already have a photovoltaic system" (French participant)* *"We're connected to district heating" (Slovenian participant)* *"Chimney is ecological" (French participant)*
Suitability for different type of homes	Questions regarding the suitability of the system for different types of homes	18	*"I'm living in a condominium" (Norwegian participant)* *"Lack of space" (Spanish participant)* *"Even if I owned our house, we don't have the space for it" (Spanish participant)* *"Given the fact that I'm in a block, I don't currently see opportunities for installation" (Slovenian participant)* *"I haven't space" (Norwegian participant)* *"Too little house" (French participant)* *"I haven't space at home to install it" (Spanish participant)*
Price and cost	Cost of purchasing the hydrogen fuel cell system	18	*"I don't trust the data being provided both in terms of savings or safety" (British participant)* *"Cost of installation versus gain in conventional savings is out of balance" (British participant)*

			"The price is too high" (Dutch participant) *"The investment is too expensive" (German participant)* *"Much more expensive than electricity currently" (Norwegian participant)* *"Savings did not outweigh the investments" (Slovenian participant)*
Delivery, installation and infrastructure	Doubts regarding the installation	16	*"Haven't natural gas available" (Norwegian participant)* *"No gas available in the street" (German participant)* *"Anyway, this is not applicable in Norway because we haven't natural gas infrastructure" (Norwegian participant)* *"No natural gas at home" (French participant)*
Danger and safety	Potential risks associated with the use of the hydrogen fuel cell unit	12	*"Concerned about hazard" (British participant)* *"Explosion danger" (French participant)* *"Many dangers" (Norwegian participant)* *"Hazard caused by hydrogen" (Slovenian participant)* *"I have fear about hydrogen storage risks" (Spanish participant)* *"It seems dangerous to me" (Slovenian participant)*
Information and lack of awareness	Lack of information to provide an evaluation	11	*"This must be investigated thoroughly over years before we can come to any conclusion" (Norwegian participant)* *"Too much uncertainty" (Norwegian participant)* *"I don't know enough about it" (British participant)* *"I'm not sufficiently familiar with hydrogen cells and their functioning" (Slovenian participant)* *"Not interested" (British participant)* *"I prefer known technologies" (British participant)*
Other	Other	9	*"I won't do this kind of investment at my age" (French participant)* *"I'm not an early adopter" (British participant)*
Political and companies interest	The role of companies and governments	2	*"Run by greedy energy firms again" (British participant)*
Hydrogen production	Issues regarding the production of hydrogen	2	*"Producing hydrogen requires more energy than hydropower" (Norwegian participant)* *"Energy used for obtaining hydrogen" (Norwegian participant)*
Fuel cells recycling	The recycling of the fuel cells	1	*"Recycling of fuel cells?" (French participant)*
Maintenance, reparations and lifespan	Problems associated with the maintenance of the system	1	*"Unsure of the life expectancy of these units" (British participant)*

Environment, pollution and health	Environmental benefits and risks	1	*You don't know the consequences on the environment and global warming in 30 or 50 years" (French participant)*

Other consequences/attributes of Hydrogen Fuel Cell vehicles raised by respondents

		N	Examples of quotes
Price and cost	Cost of purchase and maintenance. Also the cost of building the infrastructure.	94	*"The initial cost of the car is worrying" (British participant)* *"The car would be too expensive to buy" (British participant)* *"The cost wouldn't be affordable to people living on the minimum wage" (British participant)* *"The price of the car needs to be more attractive" (British participant)* *"The price should be more affordable" (Slovenian participant)* *"It will cost time, resources and money to establish the necessary infrastructure" (Norwegian participant)* *"Tax benefit comparable to LPG vehicles" (German participant)* *"The price is too expensive" (French participant)* *"Is too expensive for a person with an average income" (Belgian participant)* *"The purchase price is still high despite subsidies" (Belgian participant)*
Environment and pollution	Environmental benefits and risks.	58	*"It would definitely reduce the pollution in the air" (British participant)* *"Urban living would be less polluted" (British participant)* *"Reduces other noxious emissions and particles, particularly important in cities"* *"Simply ecology" (Spanish participant)* *"Is not a clean energy" (Spanish participant)* *"Reduced emissions" (Slovenian participant)* *"Cleaner air" (German participant)* *"Hydrogen will reduce emissions" (Norwegian participant)*
Danger and safety	Perceived dangers and risks of FCEV's	43	*"I am serious concerned about the explosive reaction of hydrogen that could lead to accidents" (British participant)*

			"Presumably the vehicle is silent while running so not very safe for pedestrians or cyclists or horse riders" (British participant) *"Concerned about safety because of past problems with combustibility of hydrogen" (British participant)* *"I found dangerous that after an accident the fuel cell may explode" (Spanish participant)* *"I'm sceptical regarding security. Is impossible to deal with it" (Norwegian participant)* *"Norway is a cold country, so emissions (water) can lead to ice on the roads in winter" (Norwegian participant)* *"The only inconvenient is the danger of explosion" (French participant)* *"The explosion risk seems very negative" (Belgian participant)*
Fuel production	Advantages and disadvantages of fuel production	43	*"Less reliant on other countries" (British participant)* *"Fuel already in this country! No need to import!" (British participant)* *"I'm worried about the energy that must be spent in order to produce the hydrogen itself" (British participant)* *"That the manufacture could be in the country of use" (British participant)* *"We won't depend so much from the oil barrel price" (Spanish participant)* *"Dependency from natural gas" (Spanish participant)* *"To become a positive energy, hydrogen should be produced from renewal energies, not from oil" (Spanish participant)* *"Production of hydrogen is not cheap" (Slovenian participant)* *"Where does the hydrogen come from?" (Norwegian participant)* *"The use of natural gas for the production is an inconvenient" (French participant)* *"The production is cheap" (Belgian participant)* *"It's a miscalculation because the recovery of hydrogen has to be done by conventional energy" (German participant)*

Positive opinions	Positive opinions in general	42	*"Everything looks great" (British participant)* *"I feel these new technologies must definitely be developed" (British participant)* *"I think it's positive every kind of new energy" (Spanish participant)* *"I hope this come soon to the market" (Norwegian participant)* *"Very few disadvantages" (Norwegian participant)* *"Fuel cell vehicles are the future" (German participant)* *"New jobs will be created" (German participant)* *"Is the future" (French participant)* *"It's good to find new energy opportunities and also use them" (Belgian participant)*
Other	Other	35	*"I have always maintained that electric is not the answer" (British participant)* *"I hope that future technology will provide solutions" (Slovenian participant)* *"It will have both advantages and disadvantages" (Belgian participant)* *"Step towards free energy" (Belgian participant)* *"What about the insurances?" (French participant)*
Refuelling stations	Availability or lack of refuelling stations	33	*"It sounds very interesting but I would need more looking into the refuelling situation, especially for people like myself" (British participant)* *"We need to make the refuelling stations more available" (British participant)* *"The major disadvantages that I can think about is that hydrogen may not be available in rural areas" (British participant)* *"Lack of refill stations" (British participant)* *"House prices going up near refuelling stations" (British participant)* *"I live in the mountains for extended periods. How can I fill the tank?" (Norwegian participant)* *"It must be possible to refuel in the country not only in eastern Norway" (Norwegian participant)*

			"I live in a village and it will be difficult to refuel" (French participant)
Information	Information or lack of it	26	*"I feel the public need educating. Not much information available until I read this survey" (British participant)* *"I don't know too much this technology" (Spanish participant)* *"I'm worried about the power, if it's possible to drive it in the motorway, its maximum speed and acceleration" (Spanish participant)* *"There's always fear towards the unknown" (Spanish participant)* *"There's a lack of experience to see the real risks and advantages" (Spanish participant)* *"Still to many unknowns about the positive and negative effects" (Slovenian participant)* *"I don't know it well enough" (Slovenian participant)* *"Are there any options that are better than hydrogen based vehicles?" (Norwegian participant)* *"No information" (Norwegian participant)* *"I don't know this technology enough but I'm looking forward to test it" (French participant)*
Reliability	Perceived reliability and performance of these cars	19	*"Durability" (Spanish participant)* *"Garages and mechanics able to repair it" (Spanish participant)* *"I hope that this will be improved as soon as possible and begin mass use" (Slovenian participant)* *"Lack of experience with this fuel" (Slovenian participant)* *"There will be no change in the car's lifespan?" (Norwegian participant)* *"The technology is not mature" (German participant)* *"Very environmentally friendly but they are also durable?" (Belgian participant)*
Political interests	Governments and oil industry lack of involvement	17	*"I think it's not given more boom and they freeze it because there are too many interests in the oil industry" (Spanish participant)* *"Everything is very developed but the oil industries will allow it? I doubt it" (Spanish participant)*

			"Fight against the interests of oil industry" (Spanish participant) *"I don't see the will of auto companies to drive this development forward. And the policies have barely pressure" (German participant)*
General disadvantages	Disadvantages in general	15	*"The need to learn a new functioning" (Spanish participant)* *"Hydrogen is negative for the Norwegian economy" (Norwegian participant)* *"Possibly negative for Norwegian industry" (Norwegian participant)* *"The need to have a very high level of energy compared to the obtained results" (French participant)*
Car range	Maximum range of the car	7	*"The fuel range is too low" (Slovenian participant)* *"The disadvantages are the refuelling time and the autonomy for long trips" (Spanish participant)* *"The capacity to drive more kilometres" (French participant)* *"Only for local routes. Impossible for the people who travels" (French participant)* *"Too low autonomy" (French participant)*
Refuelling time	Time spent in refuelling	5	*"Time spent refuelling not good" (British participant)* *"Rather long time to refill with hydrogen" (British participant)* *"The refuelling time" (French participant)*
Noise pollution	Noise related advantages and disadvantages	4	*"Quite vehicles. Less engine noise" (British participant)* *"Much quieter" (British participant)* *"Quieter engine" (Slovenian participant)* *"I wonder if these cars were quieter than others, that would be extremely positive" (German participant)*
Attitude change		4	*"We must know what we want. Protect or not our planet" (French participant)* *"Change in the way of thinking, referring to a new fuel" (Spanish participant)* *"A rethinking by the population to take the environment more in consideration" (German participant)*

Other reasons for not purchasing a Hydrogen Fuel Cell vehicle mentioned by respondents

		N	Examples of quotes
Lack of refuelling stations	Availability or lack of refuelling stations	89	*"I live in a small village and I couldn't refuel during years." (Spanish participant)* *"There are not enough hydrogen refuelling stations." (Norwegian participant)* *"There aren't enough refuelling stations (French participant)* *"Too few refuelling stations" (Norwegian participant)* *"The stations network has to be expanded significantly" (German participant)* *"Don't live near a hydrogen refuelling station" (British participant)* *"Get charging stations outside cities" (Norwegian participant)* *"Lack of refuelling stations" (German participant)*
Other necessities or not driving	Other driving necessities	18	*"We are old and our car is quite new and has a low mileage" (Norwegian participant)* *"We need a car for a handicapped person" (French participant)* *"I do not drive or hold a valid driving license" (British participant)*
Range	Maximum range of the car	15	*"You can't drive a lot of kilometres away. 450 km is what little as you drive every day and driving long distance on weekends." (Belgian participant)* *"Limited capacity" (German participant)* *"For short range" (Norwegian participant)* *"For small range" (Norwegian participant)* *"They need better range" (Norwegian participant)*
Price, cost	Cost of purchase and maintenance	15	*"This is beyond my budget" (German participant)* *"The price is excessive" (Spanish participant)* *"They will be too expensive" (British participant)*
Safety	Perceived dangers and risks of FCEV's	7	*"Explosion danger" (French participant)* *"I wouldn't feel safe" (Slovenian participant)* *"Unsafe" (German participant)*

Preference for alternatives	Alternatives of ecological cars.	5	*"Electric, gas or hybrid cars have a better chance" (Slovenian participant)* *"I drive a LPG car. Is cheaper and less polluting" (French participant)* *"Electric cars are a good option to drive in cities" (Spanish participant)*
General disadvantages	Disadvantages in general	5	*"I believe that this technology isn't enough mature and would therefore bring more problems and troubles" (German participant)* *"I think we have to wait many years to use it" (Norwegian participant)* *"No progressed enough" (British participant)*
Reliability and performance	Perceived reliability and performance of these cars.	3	*"Untested" (Norwegian participant)* *"Nowadays there aren't garages where they can solve any breakdowns of these cars" (Spanish participant)* *"Would it be powerful enough to tow a caravan?" (British participant)*
Other	Other	3	*"Hydrogen is not an option. A large part of total emissions come from production of the vehicle. Almost no one talks about this" (Norwegian participant)* *"I like cars with engine noise" (Norwegian participant)*
Noise	Noise related advantages and disadvantages	1	*"Silent running" (British participant)*
Environment and pollution	Environmental benefits and risks.	1	*"Waste of important resources" (Belgian participant)*