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CONTENTS

EXECUTIVE SUMMARY

This report addresses a series of fundamental issues related to the design and scope of the two main research tasks to be developed in HYACINTH and aimed at examining public and stakeholder attitudes towards fuel cell and hydrogen (FCH) technologies in various European countries. In particular, the report identifies the conceptual and methodological challenges underlying this research undertaking.

The report covers two sections:

- Study 1: Public awareness and acceptance of FCH technologies.
- Study 2: Stakeholder acceptance, expectations and views of FCH technologies.

The primary aim of the first study, based on a survey design, is to assess levels of awareness, understanding and acceptance of hydrogen and fuel cell technologies in the general public in seven European countries: Belgium, France, Germany, Norway, Spain, Slovenia, and United Kingdom. The survey will employ a self-reported questionnaire developed specifically for the objectives of the project to measure public attitudes towards FCH technologies across the EU. It will focus on two specific applications:

(1) Fuel cell stationary applications for heating and electricity

(2) Fuel cell transport applications and related infrastructures

The stakeholder study will use a mixed methods design based on qualitative interviews and a questionnaire survey with experts and members of the stakeholders groups in five EU countries: France, Germany, Spain, Slovenia, and United Kingdom. Specifically, this study will consist of:

- A survey to be implemented with energy stakeholders and hydrogen experts.
- Semi-structured interviews to be carried out with members of the stakeholders groups around selected hydrogen demonstration cases.

ABBREVIATIONS

CA	Consortium Agreement
CSA	Coordination and Support Action
CMO	Central Management Office
EC	European Commission
DX.Y	Deliverable X.Y
FCH	Fuel cell and hydrogen
FCH-JU	Fuel Cell and Hydrogen – Joint Undertaking
GA	Grant Agreement
IPR	Intellectual Property Rights
KET	Key Enabling Technologies
MI	Month I
MSI	Milestone I
PC	Project Coordinator
PO	Project Officer
RC	Regional Committee
SAMT	Social Acceptance Management Toolbox
SMC	Steering Management Committee
SMEs	Small and Medium Enterprises
TC	Technical Committee
WP	Work Package
WPL	Work Package Leader

1. INTRODUCTION

The overall purpose of HYACINTH is to gain a deeper understanding of the social acceptance of fuel cell and hydrogen (FCH) technologies in Europe as well as to develop a tool to assist hydrogen project developers in thinking about the social acceptance factors of their projects and products, with the objective of supporting a more widespread use of these technologies in the future. It is important to note that the social acceptance of FCH technologies emerges from a complex interaction of socio-technical elements that can be influenced to some extent, but that are always subject to factors beyond individual or organisational control.

This deliverable is part of WP3, which aims to outline the framework for the empirical work as well as to design the research and data collection instruments. It builds on the outcomes derived from WP2, which included the identification of hydrogen projects and policies (D2.1), lists of stakeholders (D2.2) as well as a report on methodologies and factors (D2.3). This deliverable starts from the conclusions of this report (D2.3) and specifies the research concept and design. This research concept will allow the collection and analyses of empirical data which are part of WP4 and WP5 and then feed into the Social Acceptance Management Toolbox (SAMT) to be developed in WP6.

Based on a literature review of previous social research, deliverable 2.3 concluded that a considerable degree of knowledge regarding the social acceptance of FCH technologies has accumulated over the last two decades. This research has generally focused on specific countries or regions and very few cross-country studies systematically comparing public attitudes to FCH applications have been found. For the public in the European countries studied (e.g. Germany, the Netherlands), studies tend to show that low levels of knowledge of - and interest in – FCH technologies coexist with relatively high levels of acceptance. However, the review of the literature suggests that public attitudes towards FCH technologies might vary depending on the type of application considered or the way hydrogen is produced. The majority of studies reviewed have focused on transport applications and very few studies have focused on the public or stakeholder reactions to FCH stationary residential applications. Regarding the stakeholders, previous studies suggest that they have more nuanced and varied views of the future for FCH technologies, given their greater knowledge of the challenges faced.

The empirical work foreseen in this project includes two studies:

- ***Study 1. Public awareness and acceptance of FCH technologies***. From a methodological point of view, this study will be based on a cross-sectional questionnaire survey with members of the general public in seven EU countries.
- ***Study 2. Stakeholder acceptance, expectations and views of FCH technologies***. This study will entail the collection of qualitative (semi-structured interviews) and quantitative data (via questionnaires) with members of the stakeholders groups in five EU countries.

In the following pages, the specific aims and approaches for the two studies will be outlined and discussed. Specifically, we will detail:

- The specific research questions and objectives.
- The methodologies and data collection methods to be used.
- The regions, projects, technologies and stakeholders to be included in the research.
- The sampling process and sample size.
- The data analysis procedures.

The final goal of the deliverable is to develop a research design that is applicable in a comparable way to all countries under study and that allows to study cross-country differences potentially due to national framework conditions, political support for FCH technologies and the specific technologies itself.

2. STUDY 1: PUBLIC AWARENESS AND ACCEPTANCE OF FCH TECHNOLOGIES

2.1. Study objectives

The findings in D2.3 pointed out that in the last two decades a growing concern over the issue of public awareness and acceptance regarding FCH technologies has emerged. A broad variety of studies from different countries based on various research methods and perspectives has been identified. From a technology perspective, previous studies have dealt with FCH technologies in general as well as with specific applications (mainly hydrogen vehicles). Overall, the reviewed studies tend to show that low levels of knowledge and interest about H2 technologies among the public coexist with fairly high levels of public acceptance. However, given the pace of technological development from pilots to marketable or near-market products, recent data on public knowledge and acceptance is needed as they develop in parallel.

Therefore, the primary aim of the study on *Public awareness and acceptance of FCH technologies* is to assess recent levels of awareness, understanding and acceptance of FCH technologies in the general public in seven EU countries (see Deliverable 2.1 for the selection of countries): Belgium, France, Germany, Norway, Spain, Slovenia, and United Kingdom. In order to be able to deduce specific advice from the data, the data collection will be designed around specific applications. The results from this study are supposed to feed into the SAMT (Social Acceptance Management Toolbox), to be developed in WP6. Beyond that, a secondary aim is to derive conclusions for policy makers and regulators.

The specific objectives of the study are:

1. To understand public attitudes and acceptance of FCH applications. More specifically, this includes:
    a. To estimate in the general population indicators for: awareness, familiarity, perception of benefits and costs, global attitude, acceptance and related attitudinal dimensions (affect, norms, trust) regarding the two hydrogen fuel cell applications, fuel cell stationary applications for heating and electricity and fuel cell transport applications and related infrastructures.
    b. To identify key individual and social determinants of public awareness and acceptance of FCH technologies; this also includes possible barriers for the diffusion of FCH technologies.
    c. To report on cross-country and cross-regional comparisons in public awareness, attitudes and acceptance towards FCH technologies.
2. To provide data-based input for the development of the tool-box SAMT.

3. To provide evidence to inform the development of programmes and interventions to improve public engagement with FCH technologies.

2.2.Design and methods

2.2.1. Research design and study scope

The study, based on a survey design, will be structured around two hydrogen fuel cell applications:

1. Hydrogen fuel cell stationary applications for heating and electricity
2. Hydrogen fuel cell transport applications and related infrastructures

These two applications are at the focus of the project given that, from a consumer perspective, it is most likely that citizens will be confronted with them sooner or later, i.e. these technologies are likely to become part of the portfolio of heating technologies or transport options about which consumers have to decide. Furthermore, the technology development for these two fields have reached an advanced stage, thus, they are about to be marketable. Additionally, the diffusion of these technologies depends on consumers' actively making decisions about them, i.e. to buy or lease them. Therefore, understanding consumer attitudes about these two applications is more important than for other applications that do not require active consumer engagement but only passive acceptance e.g. by nearby inhabitants. Examples for this category are applications that use H2 as a storage medium for excess electricity from renewable energies, although they would probably also need a minimum of citizen acceptance. As earlier work points out that attitudes towards FCH technologies are positive on a general level and given the need to limit the scope of the study, preference was given to the two applications outlined above.

The study aims to construct a predictive model for the (social) acceptance of FCH technologies based on segmented responses to FCH technologies, including factors known to be relevant in this context. Thus we take a socio-psychological perspective, 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 survey instrument mainly refers to the attitudinal path of the model, attitude formation being considered the most important process for influencing intention to act and finally acceptance. 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 appliances 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.

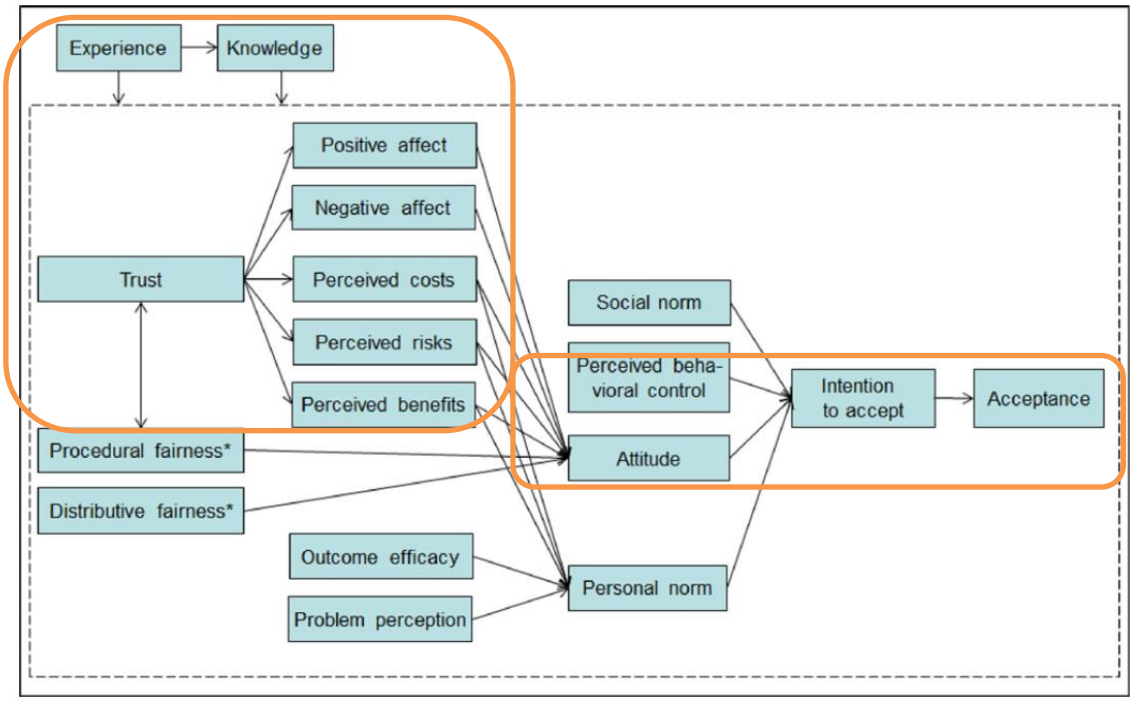

Figure 1 Technology acceptance model developed by Huijts et al., 2012; orange – constructs included in the questionnaire

As the study focuses on well-defined theoretical constructs and as the objective is to provide representative data, a quantitative survey design is indicated. Thus, nationally representative, self-administered cross-sectional surveys will be conducted in seven European countries. Furthermore, the questionnaire will focus on specific FCH technology applications for several reasons: first of all, measuring acceptance in relation to certain applications leads to a higher validity and reliability of the data collected. This is also important for feeding the SAMT. Secondly, as outlined above, current levels of knowledge on FCH technologies are low across the population in Europe. Choosing certain applications gives the possibility to include specific information into the questionnaire which, again, leads to the elicitation of more relevant and stable attitudes (see De Best Waldhober and Daamen, 2006 on details). The following sections will provide further details on the development of a specific questionnaire and the planned data collection via online panels in the relevant countries.

2.2.2. Questionnaire development

The survey questionnaire is developed specifically for the objectives of the project. The content of the questionnaire is based on items pertinent to issues around acceptance, support, affect, and trust and based on previous survey studies identified in the literature review (cf. D2.3) as well as questions developed specifically by the research team to meet the objectives

of the study. For each application, items will be incorporated in the questionnaire to measure a number of key variables (see Table 1). More details about the composition of the questionnaire will be given in D3.2.

Table 1. *Variables to be 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 and Daamen, 2006
Global attitude	Personal evaluation of the technology	De Best Waldhober and Daamen, 2006
Acceptance and support	Degree in which the individual accepts and supports (attitudinal and behavioural acceptance) further developments in the technology	Achterberg, 2014
Trust	Trust in industry and governments to make good decisions and to succeed	Midden and Huijts, 2009
Other variables	Involvement and identity in technology and environmental issues Lifestyles and identities Socio-demographic data	Axsen et al. (2012); Whitmarsh & O'Neill, (2010)

Prior to the questions referring to certain applications, information is provided to participants. As concluded from the review in D2.3, this is necessary due to the low levels of prior knowledge about these applications. The information will be developed based on existing information from websites and newspapers and be closely checked by all consortium partners in order to make sure that it is understandable as well as technically correct. The information provided to participants consists of two types of information: neutral information introducing the main characteristics of each hydrogen application under study and information on the potential consequences (including costs, risks and benefits) of each application. Information is presented at the beginning of each section of the questionnaire. The information is intended to be comparable to the type and level of information that a citizen might acquire through

media exposure, such that the responses elicited bear a resemblance to actuality. The information provided to the respondents will be reported in D.3.2 and D7.2.

2.2.3. Sample

The objective of the study is to survey the general public in seven EU countries in the terms described above in order to construct a predictive model of responses to FCH. In all countries, the universe of the respondents for the survey consists of non-institutionalized adults, aged 16 and over. Germany, France, UK, Spain, Belgium, Norway and Slovenia will be part of the survey. As specified in the description of work, a total of 7,000 participants will be recruited through nationally representative and validated panels with a sample size of 1000 per country. This sample size leads to about ± 3% margin of error with a 95% confidence[2]. In each country, after the baseline questions for the whole sample, participants will be split into Group A and Group B. Participants in Group A (around 500 participants) will evaluate stationary fuel cells for home use and fuel cell power plants. Participants in Group B (around 500 participants) will evaluate FCH vehicles and hydrogen refuelling stations.

The sample will be recruited from panels managed by Norstat. The members of these panels are recruited for market research purposes only by Norstat using diverse online and offline methods. Respondents can join on invitation only, which reduces the risk of panel overlap and of attracting "professional" respondents who are only taking part due to the incentives offered. Norstat's panels are actively managed to ensure survey feasibility and to keep members motivated.

In order to ensure a representative sample of the population, Norstat actively recruits members for the panel and has full control over the subscription of single target groups. Norstat defines the required targets thoroughly comparing the sociodemographic structure of the panels with the general population. Nonetheless, panel members are screened for this study with the aim of achieving representative samples for the age and gender groups according to the actual distribution in each relevant country and have an approximate distribution regarding region and education.

Invited panellists are told via email that they can take part in an interesting survey and, in doing so, have the chance to be involved in the development of future products and services, influence trends and decisions made by governments, companies, society or by consumer brands. They are also informed about how long the participation in the survey is likely to take and how many bonus points they will receive as an incentive. To avoid cheating in screening questions no information is usually given about the topic of the survey in the invitation e-mail. The final data analysis is made anonymously. However, unique IDs are assigned to each panellist, preventing repeated participation on the same survey.

[2] The margin of error has to be cautiously applied here given that, although proportional quotas for gender, age and education were established in order to represent the major characteristics of the population in each country, the selection of participants was not randomly sampled.

2.2.4. Implementation and procedure

Data collection will be conducted online. In an ever-growing internet-driven world it is of the utmost importance to ensure the safe transfer of data by implementing an SSL server. Under no circumstances Norstat, as the partner responsible for recruiting, ever passes on personal data to third parties, nor within the consortium, without the permission of the person involved. All gathered information is aggregated purely for scientific and market research purposes.

Norstat's panellists' data is stored on a separate server which is exclusively set up for this purpose. High security measures are taken, either through firewall protection or through the demilitarized zone (DMZ), in order to prevent trespassing of non-authorized staff. Data back-ups are made on a daily basis.

The questionnaire, which has been developed in English, will be translated into the respective national languages by professionals employed by Norstat. National partners from the project team will then check those translations. The questionnaire will be transferred to a programming concept for the online tool (developed by Norstat). The development of the online questionnaire will require the following activities

- Collecting and embedding media material.
- Finalising question types and order of questions.
- Programming of user friendly questionnaire.

The programming will be based on the following criteria, ensured by Norstat:

- Application of question types based on the latest social science findings and programming techniques.
- Focus on intuitive comprehension and usability of the surveys.
- Ongoing methodological review and optimisation.
- Modern survey techniques are required to ensure that respondents are engaged with the survey and enjoy the experience.
- Drawing on earlier experience on optimal survey design from numerous research-into-research projects.
- Survey layout – Visual support for the response options and their interpretation by the participants.
- Usability – Ensure that the usability does not affect the answer.

As pointed out above, participants will be recruited by Norstat. Invitations to take part in the survey will be sent out automatically via email through the access panel system. The first batch of invitations will be sent out in order to receive about 5% of the overall sample per country (soft launch). The responses of those will be checked to make sure that everything works from a technical point of view and that e.g. participants do not quit at a certain point during the interview. Once the data of the soft launch are checked, more invitations will be sent out. Data

will be collected and cleaned. Cleaning the data means selecting straight-liners, participants who only needed less than half of the time suggested, etc. and replacing the cheater in order to get the full 1, 000 interviews per country.

2.2.5. Approach for analyses

Descriptive analysis of the relevant variables will be performed for all the countries. Estimates of proportions, standard errors, and confidence limits for those estimates will be provided for each variable. Comparative, cross-tab or contingency tables analyses will be performed to study the relationship between responses on dependent variables (especially acceptance and support) and other (independent) variables such as age, gender, geographic region and demographic variables, as well as other theoretically-based profiles (cf. table 1).

Factor and multiple regression analyses will be conducted to investigate associations among various dependent and independent variables for each country, with difference tests used to make cross-country/-regional comparisons. According to the implemented design, differences between the studied fields of applications will be analysed as well. Cluster analysis will be also conducted to analyse whether meaningful subgroups emerge from the sample, e.g. country profiles in hydrogen awareness, understanding and acceptance or subgroups of individuals with different attitudes towards hydrogen technologies. This will be analysed for the whole sample as well as per country. Further analyses will check if meaningful regional results can be extracted.

Data analysis will be transferred to the SAMT, which on the one hand will consist of descriptive statistics for (geographic) subsamples and certain appliances. In addition to this, factors influencing acceptance will be identified and information about these relationships will inform the structure of the SAMT. The SAMT will map the inputs from FCH developers/funders to these factors and provide a useful output to guide them during the transition phase. It is felt that without an unbiased, neutral source of knowledge around the factors influencing social acceptance and the anticipated performance of a particular project/technology launch, many launches will be jeopardised due to them paying insufficient attention to these factors.

2.2.6. Reporting and output

Results will be described in a comparative report (D5.2). This report will focus on the findings from the analyses and especially document the results referring to the second objective, i.e. provide evidence to inform the development of programmes and interventions to improve public engagement with FCH technologies. The report will specifically address differences between applications and countries and relate them to the conclusions from D2.1. In addition to this, input to the SAMT will be provided tables and other suitable format to be agreed upon.

3. STUDY 2: STAKEHOLDER ACCEPTANCE, EXPECTATIONS AND VIEWS OF FCH TECHNOLOGIES

3.1. Study objectives

The study of public acceptance is complemented by a stakeholder-focussed study. The stakeholder study uses a mixed methods approach and consists of a standardised survey as well as an interview study. The objectives of this study are analogous to the ones of the public survey:

1. To understand stakeholder acceptance of FCH applications. More specifically, this includes:
    a. To assess the stakeholders' attitudes, evaluations, views and expectations regarding hydrogen and fuel cell technologies in general and (1) fuel cell transport applications and related infrastructures and (2) fuel cell stationary applications in particular.
    b. To report on cross-case and cross-country comparisons in stakeholder attitudes towards hydrogen technologies.
2. To provide data-based input for the development of the tool-box, the Social Acceptance Information Tool Box (SAMT);
3. To provide evidence to inform the development of programmes and interventions to improve public engagement with hydrogen technologies.

3.2.Design and methods

3.2.1. Research design and study scope

The stakeholder study draws on technological innovation systems (TIS) and socio-technical transitions perspectives, the rationale being not simply to understand stakeholder opinion per se, but to understand also the implications of that opinion for the success of hydrogen technologies. Innovation studies concepts are designed for the purpose of understanding such success factors and socio-technical transitions concepts are intended to contextualise these in terms of broader society-technology interactions (e.g. Geels and Schot, 2007). TIS proposes that market scale-up for a niche technology depends on the existence of aligned, mutually-reinforcing and supportive actors, networks and institutions (Carlsson & Stankiewicz, 1991; Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2008). This alignment in practice involves bringing to bear the wide variety of resources necessary to commercialise innovations and to catalyse the demand necessary to sustain them, as they struggle to compete with established technologies and practices.

The objective of the study is therefore to understand the innovation systems for selected mobile and static FCH technologies, particularly in terms of the expectations and perceptions of the actors involved, and particularly in terms of what stakeholders think is needed to change for FCH technologies to advance and how this relates to acceptance of the technology by different groups of stakeholders and the public. A special focus will be on the degree of alignment – in how far are all the key stakeholders pulling in the same direction on the development of FCH technologies? Where are there complementarities and where differences of opinion?

The stakeholder study will use a mixed methods design based on qualitative interviews and a questionnaire survey with experts and members of the stakeholders groups in various EU countries. Specifically, this study will consist of:

- A questionnaire survey to be implemented with energy stakeholders and hydrogen experts in five EU countries.
- Semi-structured interviews to be carried out with members of the stakeholders groups around selected hydrogen projects in five EU countries.

The combination of qualitative interviews with stakeholders around specific hydrogen projects with a survey with a larger sample of experts involved in hydrogen developments will allow the combination of both a good level of representation and an in-depth understanding of stakeholder perceptions of hydrogen and related fuel cell technologies. Surveys have the advantage of producing data that is easily comparable across participants and which can be used in a quantitative way. This allows for estimating values about distributions of characteristics and strengths of relationships between those characteristics. This type of information is assumed to be very helpful in this project in order to fill the SAMT as well as to compare findings from the stakeholder survey to findings from the public survey. However, quantitative studies often fall short in order to produce an in-depth understanding about

complex systems, like the innovation system for hydrogen. Therefore, the survey approach is complemented by an interview approach. For these interviews, we chose a project-based approach, i.e. potential interview partners are identified around specific projects.

Thus the two approaches are complementary to each other with slightly diverging objectives:

- Questionnaire-survey (stakeholders, QUANT):
  - investigate the state of acceptance and the acceptance process.
  - consider the different areas of application (transport, material handling, stationary energy supply/ backup power).
- Qualitative interviews (stakeholders, QUAL):
  - focus on questions regarding expectations and experiences with the technologies and the operation of hydrogen energy and FCH systems.
  - identify experiences, expectations, motivation and concerns of stakeholders in ongoing and former hydrogen energy and FCH technologies.
  - technological as well as regional aspects, leave time for individual focus.

3.2.2. Development of instruments

Stakeholder survey

The objectives of the survey are (a) to gain and collate a greater depth of insight into the current experience and views of professionals involved in the hydrogen innovation system; (b) to identify the expectations of the selected actors in the innovation system about the future in this context, particularly the policy signals that influence the propensity of firms to invest or not to invest and the decision-making of incumbents in the area; (c) to identify expectations about likely market development. The overall aim is thus to understand stakeholder perceptions of hydrogen technologies, including how actors in the innovation system perceive each other and the influence that this has on their decision-making. Hence social acceptance is here understood in the broad sense of societal embedding and adoption of technology, which involves many stakeholder groups and not simply the public. The knowledge gained thereby feeds directly through to the SAMT toolbox intended to help guide actors involved in hydrogen projects and initiatives in their consideration of the broader issues.

Similarly to the study on public attitudes and to be able to compare findings across those two studies, the study with stakeholders focuses specifically on two hydrogen fuel cell applications:

- Hydrogen Fuel Cell stationary applications for commercial and residential use.
- Fuel cell transport applications and related infrastructures.

The questionnaire for the survey is made up of 16 questions. Through the questionnaire, participants are asked to provide their expectations about FCH applications, their perception of the main challenges facing these applications and their overall attitude towards these

applications. Stakeholders are also asked about their views and expectations of other actors, i.e. anticipated societal responses (including other stakeholders and the public). This includes measures of expected familiarity and acceptance for FCH technologies. Some of the dimensions and items included in the questionnaire were drawn from the studies reviewed in D2.3. Additional dimensions and items were specifically generated by the research team based on previous knowledge on the state of the applications and on the specific research objectives. As a check on face validity, survey items were sent to researchers and experts within the consortium to obtain suggestions for modification. Thus, findings from this part can be compared to results from the public survey.

Overall, strong emphasis was put on creating a short and concise measurement instrument as stakeholders do not receive rewards for filling in the questionnaire and are often under time pressure due to other professional obligations. Thus, to secure sufficient response rates and a high data quality, it was important to focus on the most relevant issues.

The questionnaire is prepared in English and will be translated into German, French, Spanish and Slovenian, thus, interviews will be conducted in the respective national language. Interviews will be carried out in each country by a researcher from the project team.

Stakeholder interviews

The objective of the qualitative study is to examine stakeholders' views on hydrogen and fuel cell applications with a focus on transport and stationary applications. The main goal of the study is to get a deeper understanding of the broader context of the market acceptance of these applications. A semi-structured interview guideline was developed to gather data regarding the specific research objectives of the study. The interview guideline is supposed to ensure comparability across interviews, especially across countries and projects. However, the questions which are part of the guideline are open questions, i.e. interview partners do not have fixed options for answering them. This gives the interview partners the possibility to freely choose on which aspect they want to put an emphasis or which aspects they want to mention. Furthermore, the interviewer is also asked to spontaneously rephrase or add questions if the answers provided by the interview partner leave too much room for interpretation or are not fully clear. The following table gives an overview of the topics which were part of the interview guideline, the full guideline is provided as part of D3.2.

1. Project initiation and overview
   1.1. Why was this project developed?
   1.2. Who led the project?
   1.3. Brief summary of its development
2. Evaluation of the hydrogen and fuel cell application
   2.1. Benefits and opportunities
   2.2. Costs and threats
   2.3. Comparison with alternative technologies
3. Expectations regarding the future adoption of the specific technology/application
4. Recommendations for advancing the use of the technology

Figure 2 Initial dimensions to be covered in the interview

The interview guide is prepared in English and will be translated into German, French, Spanish and Slovenian.

3.2.3. Study participants

Conducting studies with stakeholders require more effort in recruiting participants than studying the public opinion. This is due to the fact that for surveying the public all relevant information for identifying a representative sample is available through public sources like official statistics. In contrast, the stakeholder population for a topic or an issue is not officially filed, thus, it is not known how many individuals belong to that population and how it is composed. Our sampling will be deliberate and systematic rather than representative in a statistical sense. First, interviewees and organisations were selected to reflect a range of positions in the relevant innovation systems, though with an emphasis on demonstration projects (on stationary and transport applications) and networks. This stratification and systematisation reflect project objectives and aim at understanding the variety of experiences and views of individuals working in a range of projects, differentiated by project objective, type, scale and country. Second, we also recruited stakeholders by snowball sampling. With the help of some interviewees additional interviewees not identified earlier will be added. Again, respondents will only be selected if they fit with the relevant criteria and add value to the sample.

This means that it is not possible to make judgements about the representativeness of a sample as it is e.g. not know to which degree the FCH community consists of engineers or scientists, professionals in marketing or research & development. Furthermore the number of members of the public is much higher than the number of stakeholders. Thus, more time and effort is needed to identify and recruit possible study participants. Preparatory steps for this have been undertaken during WP2 by identifying stakeholders, policies and projects. From this work some conclusions about the situation and the market stage of FCH technologies in the

different countries were developed. More generally, what became also obvious in this stage, to conduct a high quality stakeholder study a good knowledge about FCH technologies in each country, especially including some contacts to relevant people, would be necessary. Therefore, the stakeholder study will only be conducted in the five countries where one of our partners is located, i.e. ES, DE, FR, SL, UK.

Stakeholder survey

In WP2 extensive lists of stakeholders were collected for each country and served as a basis for potential survey respondents. The overall aim is to achieve at least 280 completed responses to the survey, preferably evenly distributed among the studied countries. However, this is not to be expected due to the different size of the countries and the stage of market development of FCH technologies (e.g. Germany vs. Slovenia). Thus the minimum goal for respondents per country is 40 participants and exceeding 280 overall. The process will be organised in a way that an ambitious goal of 60 participants per country is set, while acknowledging that significant variation in numbers is likely.

Besides reaching a relevant sample size, the consistency of the sample is also relevant. Therefore two questions in the survey will ask about background information of the respondent (see table below). As outlined above, the distributions of these characteristics in the countries are not known, nevertheless, it is to be expected that stakeholder from all these categories exist. Therefore, it is the aim to gain national samples which include a mixture of these categories.

Table 2 Items describing stakeholder categories

Organization type	Q2. Please indicate the type of organization in which you work	Private company Public company Government organization Education organization Other non-profit organization Other category:___
Areas of Expertise	Q4. Which of the following best describes your field of work or expertise? *(Please check all that apply)*	Research on hydrogen and/or fuel cells Fuel cell developer or manufacturer Hydrogen production Professional services provider Policy development and programme administration Car manufacturer / OEM Systems integrator Education, safety and training Fuel cell user Hydrogen storage Service station operator Supplier to developer or manufacturer Commercialization support Fuel cell distributor or agent Hydrogen distribution Other _____

Stakeholder interviews

The study on stakeholder acceptance of hydrogen fuel-cell technologies also involves conducting semi-structured individual interviews with a large number of stakeholders to explore their perspectives on particular hydrogen fuel-cell projects and applications. In each country around 35 interviews have to be conducted resulting in 175 interviews overall.

The interviews focus around *ongoing and former* hydrogen projects. Thus, as a first step hydrogen projects are to be selected in each country. The idea is to cover around 3-5 projects through the interviews per country, i.e. having several interviews per project. However, these numbers may vary depending on the number of organisations involved in a project / the project scope as well as the project structure in the different countries (cf. D2.1 and D5.1 for details).

The projects are supposed to be chosen preferably in line with the following criteria; where possible a heterogeneous selection of projects is advised (e.g. different technological fields):

- Objective of the project: demonstration resp. implementation projects (no sole research/basic research projects).
- Hydrogen technology: transport (fuel cell hydrogen cars, trains and buses) and stationary applications (incl. power-to-gas, heating, cooling, power plants); projects around (conventional) hydrogen production are less interesting due to a lower relevance for studying social acceptance but might also be included
- Focus: priority is on projects focusing on the respective country, a specific location in this country, e.g. national funded projects
- Project period: priority is on ongoing projects, followed by past projects - projects should be as recent as possible

Once the projects are identified, relevant stakeholders, preferably project leaders from participating organisations or communication representatives for the projects, are to be identified. For this step, it will also be drawn on the stakeholder lists from D2.2. The following figure gives an overview on this step.

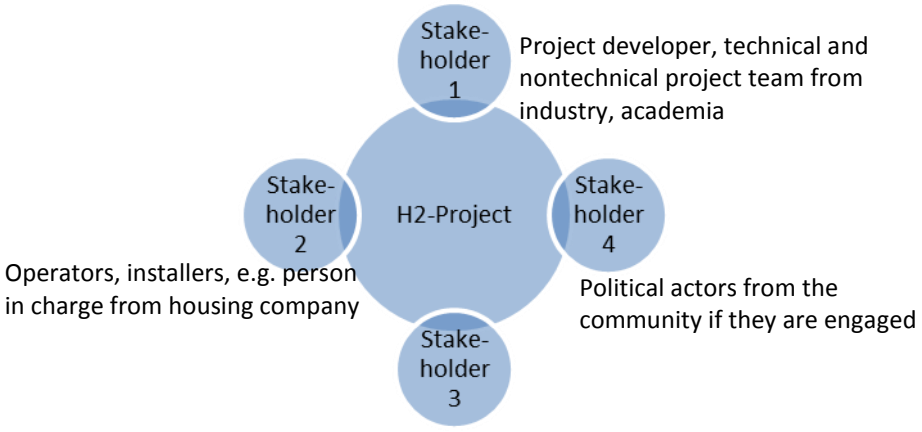

Figure 3 Overview with examples for stakeholder attachment to projects

It is the idea to recruit so many stakeholders from one project for the interviews such that a complete picture of the project resp. of the situation of hydrogen in the country is possible. The figure above provides an overview over possible interview partners.

Additionally, stakeholders not belonging to any specific projects could be interviewed to increase the number of participants in the final sample. This should include professionals in academia, regional agencies, companies, financing organizations and any other organization that might influence somehow the development of hydrogen applications.

Table 3 gives an overview on the methodological approaches for the two stakeholder studies.

Table 3 Overview of the study design for the two stakeholder studies

	Survey (QUANT)	*Interviews (QUAL)*
Target group	Different stakeholder groups (e.g. research bodies, professionals in the industry, fork lift users, public administration, interest groups, project partners etc.)	Stakeholders in ongoing and former hydrogen energy and FCH technologies
Sample size per country	280 respondents ca. 60	175 interviews ca. 35
Method	Material developed by CIEMAT, Leeds & Fraunhofer	
	Online survey of about 10 min Internet questionnaire provided by Norstat, participant recruitment by partners	Telephone interviews of about 30 min Conducted by partners. Interviews recorded and documented via written summaries
Countries	Germany, UK, Spain, Slovenia, France	

3.2.4. Implementation and procedure

Stakeholder survey

Recruitment of participants will be carried out online. An email will be sent to each potential participant personally inviting him or her to take part in the survey via a link that is provided. Participants will also be asked to forward this link to their colleagues. After 5-7 days a first reminder will be sent to invited respondents, a second reminder will be sent after another 5-7 days. Ideally the data collection should be finished within three weeks.

Stakeholder interviews

Arranging the interviews will be done following the steps outlined below:

1. At first, the stakeholder is contacted by sending him/her an e-mail. In this e-mail, the interviewer informs the (potential) interviewee on the objective of the study and on the interviews planned (duration, conducted face-to-face/by phone, confidentiality), explains to him or her why their participation in the study is essential, the potential benefits for him/her (results etc.) and asks him/her on his/her willingness to take part. A template for this will be provided.
2. If he/she is not responding, the interviewer should phone the (potential) interviewee in order to encourage him/her to participate in the study, to clarify any open questions and to fix the time and date of the interview. It is advised to do this about 7-10 days after sending out the email.
3. If the interviewer does not achieve an appointment or the stakeholder refuses participating in oral interviews, the interviewer may propose a written interview to him/her. For this, the interviewer informs the (potential) interviewee on the effort required from him and sends him the relevant document to fill in the answers. Please provide a timeframe when to return the document and remind him/her once or twice (but not more often).
4. Prior to the start of the interview, the interviewer explains briefly the aim of the interview, confidentiality, and recording and documentation process again.

Interviews should be recorded to ensure quality and preciseness. This allows taking notes and writing an interview summary while listening to the recording. This also enables the interviewer to focus on questioning and listening during the interview while nothing gets lost. If the interview partner is unsure if he/she wants to agree to a recording of the interview, the following line of argument has proved to be helpful:

- that recording is for his/her benefit in terms of accuracy, as it is usually not possible to take note as extensively as necessary and that the audio record ensures the information provided will be complete.
- that the audio record will be used for no other purpose than creating an interview protocol and that it will be deleted as soon as this is completed.
- that anonymity and confidentiality are guaranteed.
- that the interview partner may of course have a look at the interview protocol.
- that recording is state of the art in scientific projects to ensure data quality.

If recording is not possible, as many notes as possible should be taken during the interview and completed directly afterwards.

Interviews will be documented using an interview summary template that will be provided to all interviewers. The structure of this document follows the interview guideline. The main answers on the relevant topics are to be summarised; direct quotes are to be added on interesting or important parts.

3.2.5. Approach and analysis

Stakeholder survey

For the survey study, descriptive analysis will initially be conducted to estimate the proportion of individuals per country in each of the variables. Estimates of proportions, standard errors, and confidence limits for those estimates will be provided for each variable. Regression models and cluster analysis will provide information on acceptance and support factors. Comparative analyses with difference tests will be also performed to study the relationship between responses on dependent variables and other independent variables; this includes cross-national/-regional comparisons as well as a comparison across applications studied. The results will be set in the context of the TIS and socio-technical transitions literature, particularly regarding the uptake of other sustainable technologies.

Stakeholder interviews

For the qualitative study, each interview will be summarised and partly transcribed as described above for post-hoc thematic analysis. The qualitative data will be analysed at the case level initially and then an integrative report will synthesize the main findings across cases, organised by themes within the three main sections of hydrogen supply, static applications and mobile applications. The results will be set in the context of the technology innovation systems literature, particularly more recent work on the role of incumbent actors in advancing and hindering new technologies.

The *thematic coding* is planned along the following lines:

1. Basic information - country, interviewee affiliation and project type is coded once per sub-code. In general, coding consists of selecting text and allocating to one or more themes (in MaxQDA via drag and drop), providing links to the associated text that can be qualitatively and quantitatively represented. Based on this, systematic comparisons across countries and applications will be possible.
2. Other information may be coded more than once, regardless of whether it duplicates on a per interviewee basis. For example, if an interviewee mentions an issue twice, separately, it is coded twice. Quantitatively this will give us an indication of the density and salience of issues for the interviewee set as a whole. It also enables the identification of supporting text. The disadvantage is that the coding can be disproportionately influenced - on a per interviewee basis - by individuals, reflecting their speech style and the transcription style.
3. Accordingly, the basic codes can be used to reliably indicate the incidence of interviewee attributes in proportion to the sample population while the other codes indicate the characteristics of the discourse as well as the 'substance' of the total set.
4. Coding criteria: as it is neither possible nor desirable to include a code for every comment, all coding is inevitably selective and normative. That is, it involves a judgement regarding what is important and hence worth coding. Here, the codes are chosen so as to contribute at least beyond basic knowledge. For example, it is assumed to be basic knowledge that H2FCs have zero local emissions other than H2O and that

costs are an issue, so these are only coded once per interview summary unless in association with supplementary, qualifying information (for example, specifics such as information on which parts of the supply chain have been found to be costly, or how a surfeit of natural gas is being directed to LPG for cost reasons).

5. Overall, the purpose of the exercise is to add detail to the surface-level opinion gained via the stakeholder survey. Claims of statistical representativeness are made neither for that survey nor for the qualitative coding, though some degree of comparison of the samples and the total population is possible and also noting that the number of interviews is substantial relative to typical qualitative studies. Rather the purpose of the stakeholder survey and interviews is to systematically illustrate and reveal some of the issues and opinions held.

3.2.6. Reporting and output

This step will be analogous to the parallel step for the public survey. Results will be described in a report (D5.1). This report will focus on the findings from the analyses and especially document the results referring to the second objective, i.e. provide evidence to inform the development of programmes and interventions to improve public engagement with FCH technologies. The report will specifically address differences between applications and on a regional / national level and relate them to the conclusions from D2.1. In addition to this, input to the SAMT will be provided as tables and in other suitable formats to be agreed upon.

4. CONCLUSIONS

Based on the findings from WP2, this report has addressed a series of fundamental issues related to the design and scope of the two main research tasks to be developed in WP4 and aimed at examining public and stakeholder attitudes towards fuel cell and hydrogen (FCH) technologies in various European countries.

The report has first identified the conceptual and methodological challenges underlying the study on public awareness and acceptance of FCH technologies. The primary aim of this study is to assess levels of awareness, understanding and acceptance of hydrogen and fuel cell technologies in the general public in seven European countries: Belgium, France, Germany, Norway, Spain, Slovenia, and United Kingdom. A cross-sectional survey design has been proposed. The survey will employ a self-reported questionnaire developed specifically for the objectives of the project to measure public attitudes towards FCH technologies and partially based on the technology acceptance model. It will focus on two specific applications: i) fuel cell stationary applications for heating and electricity; ii) fuel cell transport applications and related infrastructures.

The report has also specified the design of the study on stakeholder acceptance, expectations and views of FCH technologies. The stakeholder study will use a mixed methods design based on qualitative interviews and a questionnaire survey with experts and members of the stakeholders groups in five EU countries: France, Germany, Spain, Slovenia, and United Kingdom. Specifically, this study will consist of a survey to be implemented with energy stakeholders and hydrogen experts and semi-structured interviews to be carried out with members of the stakeholders groups around selected hydrogen demonstration cases.

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