This project has received funding from the Fuel Cells and Hydrogen Joint Undertaking (FCH-JU) under grant agreement Nº 621228
1. HYDROGEN TECHNOLOGIES IN EUROPE

2. THE CONTRIBUTION OF HYACINTH PROJECT

3. THE HYACINTH PROJECT DETAILS

4. THE STUDIES AND RESULTS

5. CONCLUSIONS
1. HYDROGEN TECHNOLOGIES IN EUROPE

- The **transition phase of FCH technologies** is expected to happen within the next decades.

**Implementacion process**

- **Challenges:** higher cost and less comfortable infrastructure or lower reliability.
- **Benefits:** energy efficiency and environmental benefits (no local emissions)

- Advanced **hydrogen support** (Germany, UK), medium support (Spain) and low support.
Among the alternative technologies: residential fuel cells and hydrogen fuel cell vehicles (FCEV).

Both applications have mass-market potential and will have a significant impact on reducing emissions and primary energy consumption.

Social acceptance will likely play a role in the successful adoption of hydrogen and fuel cell applications.
HYACINTH: HYdrogen ACceptance IN the Transition PHase

- Funded by the **FCH-JU** in call 2013 (SP1-JTI-FCH.2013.5.3 Social acceptance of FCH technologies throughout Europe). Total cost: 999,383 €; EU contribution: 661,584 €.

- Coordinator: Nacional Hydrogen Centre (CNH2), **11 main partners from 5 different European countries**.

- Started in September 2014 with a duration of **30 months**.

- Aims to gain a **deeper understanding of the social acceptance of hydrogen technologies across Europe**.
HYACINTH: Specific objectives

- Identify and understand awareness and acceptance of hydrogen energy and FCH technology and perceive potential benefits in the general public and at selected stakeholders.

- Identify the main drivers of social awareness and acceptance of FCH technologies in order to provide recommendations.

- Support stakeholders by providing a social acceptance research toolbox.
3. THE HYACINTH PROJECT DETAILS

PARTNERS

- Centro Nacional del Hidrógeno (CNH2) – Spain
- I PLUSF France – France
- Fraunhofer-Institut für System- und Innovationsforschung ISI– Germany
- Aberdeen City Council– United Kingdom
- University of Sunderland– United Kingdom
- Centre for Energy, Environment and Technology (CIEMAT) – Spain
- Sustainability Research Institute (SRI), University of Leeds - United Kingdom
- CIDAUT Foundation– Spain
- Razvojni Center za Vodikove Tehnologije (RCVT) – Slovenia
- NORSTAT Services GmbH (NORSTAT) – Germany
- I PLUSF España – Spain
3. THE HYACINTH PROJECT DETAILS

WORK PACKAGES

- **WP1 “Project management”** includes meetings, reporting, deliverables, day to day work. The webpage design and development is here included.

- **WP2 “Context analysis”** is aimed to gather information that could be useful for the rest of the WPs.

- **WP3 “Methodological design”** of the studies, one for the general public and two on stakeholders. This WP includes the design of the questionnaires and protocols to be implemented in the Data Collection (WP4).

- **WP4 “Data collection”**, with three parts: personal interviews with stakeholders, online questionnaires for selected stakeholders and a general public survey.

- **WP5 “Data analysis and interpretation”**, will analyse the information gathered from WP4 alongside with information from WP2 to obtain **two studies**: one for the general public awareness and acceptance of hydrogen and fuel cell technologies and the second one for the stakeholders awareness and acceptance. The information obtained will feed the information treated in the toolbox (WP6).

- **WP6 “Development of management toolbox”** is aimed to present the final results of the project: a social awareness report and a toolbox. The toolbox should help stakeholders to better communicate or target their products or services.

- **WP7 “Dissemination”**: to engage stakeholders in the project and in the use and spreading of the results of the project (the two studies and the toolbox).
3. THE HYACINTH PROJECT DETAILS

**DESIGN METHODS**

**Studies:**
1. Public awareness and acceptance of FCH technologies across Europe.
2. Stakeholder acceptance of FCH technologies across Europe.

**Toolbox:**
To help promoters and decision makers integrate issues related to social acceptance into their developments.

**HYACINTH project**
- **PUBLIC**
  - Public awareness and acceptance of FCH technologies across Europe:
    - Survey
      - 1000 participants
      - 7 European countries

- **STAKEHOLDERS**
  - Stakeholder acceptance of FCH technologies across Europe:
    - Survey
      - 333 participants
      - 5 European countries
    - Semi-structured interviews
      - 145 participants
      - 5 European countries

**Social Acceptance Management Toolbox (SAMT):**
To help promoters and decision makers integrate issues related to social acceptance into their developments.
### DESIGN METHODS

<table>
<thead>
<tr>
<th></th>
<th>PUBLIC SURVEY</th>
<th>STAKEHOLDERS SURVEY</th>
<th>SEMI- STRUCTURED INTERVIEWS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Participant countries</strong></td>
<td>Belgium, France, Germany, Norway, Slovenia, Spain and United Kingdom</td>
<td>France, Germany, Spain, Slovenia, and United Kingdom</td>
<td>France, Germany, Spain, Slovenia, and United Kingdom</td>
</tr>
<tr>
<td><strong>Data collection</strong></td>
<td>April 2016</td>
<td>March 2016 to June 2016</td>
<td>November 2015 to June 2016</td>
</tr>
<tr>
<td><strong>Total sample</strong></td>
<td>7148 participants</td>
<td>333 participants</td>
<td>145 interviews</td>
</tr>
<tr>
<td><strong>Recruitment</strong></td>
<td>Recruitment through Norstat panel.</td>
<td>Invitations sent out by the project partners</td>
<td>Interviews were conducted by the project partners</td>
</tr>
<tr>
<td><strong>Sampling</strong></td>
<td>General population (aged 16 and more)</td>
<td>Energy stakeholders and hydrogen experts</td>
<td>Professionals involved in hydrogen demonstration projects</td>
</tr>
<tr>
<td><strong>Procedure</strong></td>
<td>Online questionnaire provided by Norstat</td>
<td>Online questionnaire provided by Norstat</td>
<td>Conducted by phone or in person by project partners Duration ca. 30 min</td>
</tr>
<tr>
<td><strong>Data Analysis</strong></td>
<td>The data was analysed using SPSS software.</td>
<td>The data was analysed using SPSS software.</td>
<td>Qualitative data has been coded with MaxQDA.</td>
</tr>
</tbody>
</table>
PUBLIC ACCEPTANCE STUDY

Objectives of the public study:

- To examine public awareness, familiarity, perception of benefits and costs, global attitude and acceptance of FCH technologies.
- To identify key individual and social determinants of public awareness and acceptance of FCH technologies;
- To report on cross-country comparisons in public awareness, attitudes and acceptance towards FCH technologies.

Survey Method: Survey data collected in 7 European countries
Participants: around 1000 members of the general population aged 16 and over. Nationally-representative samples.

Studied applications:
1. Hydrogen fuel cell stationary residential applications
2. Hydrogen fuel cell transport applications and related infrastructures

This project has received funding from the Fuel Cells and Hydrogen Joint Undertaking (FCH-JU) under grant agreement Nº 621228
Awareness of residential hydrogen fuel cells

The level of public awareness about home HFCs is very low in the seven studied populations. **Only around 25% of respondents report having heard about residential fuel cell micro-CHP** (this is 15 percentage points lower than the level of awareness of HFCs in general). And less than 5% consider themselves knowledgeable about this application.
4. PUBLIC SURVEY - METHOD AND RESULTS

**Informed evaluation/global attitude of home HFCs**

- **Very good**: 14%
- **Acceptable**: 32%
- **Good**: 48%
- **Bad**: 5%
- **Very bad**: 1%

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%

**Acceptance of home HFCs**

The study shows: “I would be happy to have an hydrogen fuel cell unit in my home in future”. Around 6 out of 10 would be happy to have a residential HFC 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.** % of respondents in the total sample that would like to have a hydrogen fuel cell system in their home.

- **Belgium**: Disagree 15%, Strongly disagree 1%, Agree 50%, Strongly agree 34%
- **France**: Disagree 12%, Strongly disagree 3%, Agree 47%, Strongly agree 41%
- **Germany**: Disagree 13%, Strongly disagree 2%, Agree 49%, Strongly agree 36%
- **Norway**: Disagree 14%, Strongly disagree 3%, Agree 50%, Strongly agree 33%
- **Slovenia**: Disagree 16%, Strongly disagree 2%, Agree 48%, Strongly agree 34%
- **Spain**: Disagree 15%, Strongly disagree 2%, Agree 49%, Strongly agree 34%
- **United Kingdom**: Disagree 12%, Strongly disagree 3%, Agree 47%, Strongly agree 41%
Respondents’ reasons for not willing to buy a home HFC

- I think the price of installing a fuel cell will be too high for my budget
- I think fuel cells applications for residential use are not a yet mature technology
- I would prefer to invest in renewable forms of electricity and heat generation for my...
- The hydrogen fuel cells described here rely on fossil fuel
- I would prefer to invest in traditional systems of electricity and heat generation...
- Recycling of fuel cells
- Other disadvantages
- Delivery and installation
- Political and companies interests
- Suitability for different type of homes
- Maintenance, reparations and lifespan
- Hydrogen production
- Environment, pollution and health
- Need of information and lack of
- Danger and safety
- Price and cost
Awareness of FCEVs

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.
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%).

Acceptance of FCEVs

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 FCEV 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.
Respondents’ reasons for not willing to buy a FCEV

- I can’t imagine buying a car
- Full electric cars are a better option
- Having a fuel cell vehicle will make my life more difficult
- Fuel cells vehicles are not yet a mature technology
- The price of purchasing a fuel cell car will be too high for my budget
- Conventional cars are for now a better option

This project has received funding from the Fuel Cells and Hydrogen Joint Undertaking (FCH-JU) under grant agreement № 621228
STAKEHOLDER SURVEY-METHODS

- **Survey content:**
  - Innovation systems rationale: successful technologies require stakeholder alignment
  - Stakeholder perceptions of **hydrogen** technologies
  - In-depth evaluation of either
    - **Small static hydrogen fuel cell applications**
    - **Hydrogen fuel cell electric vehicles (FCEVs)**
  - Perception of other actors in the innovation system
  - Factors influencing future market development

- **Questionnaire survey** during **spring 2016**
- Population: **selected stakeholders** in 5 countries
- Implementation: **Online questionnaire** (by Norstat)

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This project has received funding from the Fuel Cells and Hydrogen Joint Undertaking (FCH-JU) under grant agreement Nº 621228
4. STAKEHOLDER SURVEY - METHOD AND RESULTS

STAKEHOLDER SURVEY - SAMPLE

Participants by country

- Heterogeneous affiliations:
  - Around 33% from private companies
  - Around 15% from public and government organisations, education and other non-profit

- Plenty of experience:
  - >25% have 11+ years of work experience
  - >21% 5-10 years of experience

- Different fields of expertise:
  - >50% work in research
  - 30% on H2 production
  - 25% in systems integration
4. STAKEHOLDER SURVEY - METHOD AND RESULTS

- 88% think that HFC are a good or a very good solution for energy and environmental challenges (no country differences)

- Most positive future expectations about H2-buses and H2 as a means of storage for renewable energy

- Respondents are in favour to further governmental support for FCH technologies

<table>
<thead>
<tr>
<th>Application</th>
<th>Very negative (1)</th>
<th>Very positive (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buses, with refuelling stations</td>
<td>DE</td>
<td>SI</td>
</tr>
<tr>
<td>Cars with refuelling stations</td>
<td>UK</td>
<td>ES</td>
</tr>
<tr>
<td>Portable power applications</td>
<td>FR</td>
<td>SI</td>
</tr>
<tr>
<td>Storage of renewable energy</td>
<td>SI</td>
<td>FR</td>
</tr>
<tr>
<td>Large-scale systems for prime power...</td>
<td>SI</td>
<td>FR</td>
</tr>
<tr>
<td>Back-up power systems</td>
<td>SI</td>
<td>FR</td>
</tr>
<tr>
<td>m-CHP for commerce/...</td>
<td>SI</td>
<td>FR</td>
</tr>
<tr>
<td>m-CHP for homes</td>
<td>SI</td>
<td>FR</td>
</tr>
</tbody>
</table>

What are your expectations regarding the medium-term (5-10 years) market implementation in your country?
4. STAKEHOLDER SURVEY- METHOD AND RESULTS

Mobile applications

- **Most challenging:** providing refuelling points followed by costs
- **Less challenging:** safety
- They favour FCEVs over other drivetrains / fuels. The highest competition → battery electric vehicles
- Public funding: Support for research and development and providing infrastructure is most important; demonstration project and subsidies for vehicles less relevant.
- Professionals from the same sector and researchers are perceived as most familiar, the public’s familiarity lowest. Attitudes are perceived similarly.

Static applications

- **Most challenging:** cost disadvantages
- **Less challenging:** safety issues and technological maturity
- Support for research and development is favoured over funding for demonstration project and subsidies on purchase prices.
- Professionals from the same sector and researchers are perceived as most familiar, the public’s familiarity lowest. Attitudes are perceived similarly.

This project has received funding from the Fuel Cells and Hydrogen Joint Undertaking (FCH-JU) under grant agreement Nº 621228
Factors influencing ratings of future market deployment

• For stationary applications:
  – Competition of renewable electricity and heat technologies
  – Implementation of air quality regulations
  – Development of business models for H2 distribution infrastructure

• For FCEVs:
  – Competition from alternative technologies
  – Competition from full electric cars as well as CNG / LNG cars
  – Perceived attitudes of professionals from the same sector and from actors from the automotive sector
4. STAKEHOLDER INTERVIEW- METHOD AND RESULTS

STAKEHOLDER ACCEPTANCE STUDY

- Interviews template
  - Project initiation and overview.
  - Evaluation of the hydrogen application, acceptance and support.
  - Expectations regarding the future adoption of the specific technology/application.
  - Recommendations for advancing use of the technology.

- Semi-structured interviews between November 2015 and June 2016
- Population: selected stakeholders in 5 countries
- Implementation: telephone or face-to-face interviews, recorded and summary transcripts

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Interviewee percentage by country

- Germany: 23%
- France: 26%
- Spain: 27%
- UK: 16%
- Slovenia: 8%

Interviewee percentage by affiliation

- Other non-profit organization: 24%
- Local government: 11%
- Multisector partnership: 6%
- University or state research organisation: 5%
- Multisector partnership: 8%
- Government Ministry or agency: 18%
- Public company: 28%

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Perceptions of hydrogen supply and use

**Strengths:**
- Environmental performance of hydrogen (despite the scepticism of the inefficiency of combining multiple conversion processes)
- Versatility: energy storage vector for renewable energy supply (per se and in relation to electrical grid balancing)

**Weaknesses:**
- Cost
- Limited awareness among regulators and government
- Inadequate or excessive regulation
- Competition from alternative technologies
- Lack of commercial support and lack of markets
- Immaturity and durability
- General lack of infrastructure
- Perceived safety issues

**Key expectations (mixed):**
- Positive view: market development expected by many in the relatively near term (albeit with national differences and specificities).
- Uncertain future for hydrogen and a high degree of conditionality on government policy support.

**Recommendations:**
- More government and political support is required
- Need to inform and engage stakeholders
- Additional R&D to reduce costs
Perceptions of static applications

**Strengths:**
- H2FCs for portable power (could also be bracketed with the potential for uninterruptible power)
- **Integration with existing infrastructure** (UK respondents only)
- Efficiency of fuel cells (reducing the pressure on the electrical network)
- **The capacity to offer domestic and non-domestic CHP, power and heat, including high power.**

**Weaknesses**
- Cost & Investment costs
- Complexity of the system and its components
- Perceived and ‘actual’ safety
- Competition from alternative technologies
- The challenge of finding commercial partners

**Key expectations (mixed):**
- Expectations expressing a positive inevitability for the technology
- Uninterruptible supply systems as one such niche (German respondents only)
- Stationary uses being more likely than mobile uses (UK respondents only)
- Hydrogen being used as a storage medium as key to the take-up of static applications (UK respondents only)

**Recommendations:**
- Government support
- Regulatory support particularly relating to issues of safety
4. STAKEHOLDER INTERVIEW - METHOD AND RESULTS

- Perceptions of mobile applications

**Strenghts:**
- Operational performance: long range, short refill times, high torque, strong performance generally and relative to alternatives
- Ease integration with existing infrastructure
- Suitability for specific fleets

**Expectations:**
- Specific vehicle fleets being the first to use H2FC technology
- Niche uses first or only
- Tighter emissions standards driving H2FC use
- Battery electric vehicle (BEV) with H2FC being the most likely option
- Transport corridors being first to support H2FCs

**Weaknesses:**
- Financial cost
- Perceived competition with other technologies
- Lack of infrastructure
- Limited awareness and support by regulators and government
- Inadequate or excessive regulations, codes or standards
- Safety

**Recommendations:**
- Governmental, political and regulatory support
- R&D to support cost reductions
- Commercial partner support
- More communication and engagement generally, including of publics
- Investment in refuelling infrastructure

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4. RESULTS. SOCIAL ACCEPTANCE MANAGEMENT TOOLBOX (SAMT)

**Objective:** Provide practical advice to developers and/or sponsors of HFC technologies that they now intend to progress from a completed demonstration project or phase to full market acceptance and wide public adoption.

**Inputs (7,000 EU general public and 250 industrial and government stakeholders)**

- Stakeholder Surveys
- Stakeholder Interviews
- Public Surveys
- Best Practice

**SAMT**

Generates

**Database of:**
- Attitudes
- Experiences
- Beliefs
- Funding Climate
- Political Support

**Quality Function Deployment:** technique used to understand:

- what is important to their customers,
- how well they are addressing those issues in order to adjust their designs/services accordingly and
- ensure that these vital issues are not lost during the product/service development process.

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As a result of the filters you selected, 4,291 out of 7,148 public responses and 114 out of 333 industry responses are included.

Responses have been mapped onto a model - the Technology Acceptance Framework - which provides several themes:

1. Knowledge and Experience
2. Trust
3. Positive and Negative Affects
4. Perceived Effects - Costs, Risks and Benefits
5. Perceived Consequences
6. Attitude
7. Initial Acceptance
8. Acceptance

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5. CONCLUSIONS

- **Less than 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 applications and higher for hydrogen fuel cell vehicles.
- The majority of **the population in the seven studied countries have a positive initial attitude towards HFC technologies**. The label associated to hydrogen and fuel cells seems to invoke positive feelings and thoughts among respondents.

- Variation across countries: **associated with differing levels of government investment in R&D programmes**.
- **R&D stakeholders have a strong positive appraisal of HFC technologies**, but with limitations:
  - **cost and limited regulatory**, political and commercial support;
  - **competition from other technologies** and inter-related obstacles.
- Stakeholders view: medium to long term rather than near term.
- **HFC technologies view**: realistic niche potential in the shorter term
  - **uninterruptible power, auxiliary power and high power demand such as fork lifts and heavy goods vehicles**.
It is increasingly understood that the success of innovative energy technologies is dependent not only upon the technical characteristics of those technologies, but equally on supportive social, political and economic contexts (EC, 2014 and 2015; OECD, 2014).
Thank you for your attention!

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- Project Coordinator maria.jaen@cnh2.es
- Social Networks
- Webinars & Workshops
- Digital mailing

https://www.youtube.com/watch?v=OJHyXGWxCzg

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