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HYFLEET:CUTE

**HYDROGEN MOVES FROM A SOCIETAL NICHE TO A SYSTEMIC
INTEGRATION**

Deliverable No. 5.4

**Social implications of introducing hydrogen as fuel in
Reykjavik;**

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1 Executive Summary

During the HyFLEET:CUTE bus demonstration the FC buses were only operated ¼ of the project time in Reykjavik, Iceland and the 9 other locations across Europe. But different hydrogen equipment and the hydrogen production station was kept in use throughout the project period. Fuel cell buses were the publicly best known appearance of hydrogen vehicles and therefore they were used as the blueprint for the idea of introducing hydrogen technology and electrolytic hydrogen made locally as the main fuel for transportation before engaging various groups and representatives in the society to discuss fuel futures and outline public preferences.

During the project time modules that had been established in the first hydrogen demonstrations shifted owners or operators, the maintenance workshop was moved, new car retailers became involved in hydrogen vehicles and public niches supporting other new alternative fuels had their rise (and fall). All of these changes took place first in an economic surge but towards the end a severe economic recess, a liftoff of international consensus that climate change is due to human activities and that sharp prevention measures now would be less costly than the decrease in natural services provided by healthy global ecosystems (Stern report) rapid price increase and decrease of oil and therefore fuel, rise of the Icelandic currency and later total collapse and stagnation in the Icelandic economy. It is quite evident that the shift to a new fuel will have to survive such economic floods and tides in a very dynamic environment where public goods, such as clean air and less noise are set as benefits and monetary costs are the parameters set to either drive or slow down technical and systemic development.

An Ariadne's thread through the themes in the report can be listed in the following way:

Settings: Indicators from surveys in 2001, 2004, 2005

Methods in social research

Screening:

Comparison of early social surveys in Europe: the study matrix

Social maps: Actor groups and societal positioning

Comparison of staff in the fuel delivery chain; oil versus hydrogen

Justifications of selecting interviewees and participants in the social dialogue

From masses to the personal interaction;

**Survey with multiple choices,
Questionnaire, suggested comments,
Focus groups, interview,
Semi-constructed interviews,
Workshops, discussions with staff
Media discourse**

Systemic budding, where do the growth shoots appear

Educational efforts and the effects

Suggested further actions

Conclusions

The report comes to the conclusion that more comparable studies for other types of fuel are important to the public, that a gap in demonstration is interpreted rather as failure of the technology rather than lack of support, also that any latest news is taken as the most reliable one, and that a clear policy for environmental benign transport systems as well as goals for total efficiency and environmental effectiveness are important guidelines for an ideal implementation plan. Thus hydrogen and fuel cells are rather discussed in context with other synthetic fuel types rather than in comparison with the fossil fuel and the current drive – technology. The benefits of using hydrogen and fuel cells are not highlighted enough and media rarely puts new pieces of news onto context with older announcements. Still the drawbacks rather than benefits are listed for all new technology.

The objective of this report

is to summarize and give an overview of the 7 exercises that have been carried out within the social research of HyFleetCute Bus demonstration projects using the introduction of hydrogen into Icelandic energy matrix as the study platform. First a short report is given on former surveys and public responses, then a matrix is compiled for similar European social studies connected to the uptake of hydrogen as fuel. Various methods for mapping preferences are introduced and the outcomes interpreted using different screening tools. An attempt is made to follow the creation of jobs linked to the hydrogen tests in Iceland between 2001 and 2008 and foretell the development in the future. The studies link Hydrogen applications in bus transport and later cars, public opinion discussions on fuel road maps and acceptance aspects. The report also outlines the successfulness of different research approaches. The report highlights how hydrogen is observed sieving into the public consciousness as one of the future fuel opportunities..

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Introduction

The introduction of hydrogen fuel and new drive-technology in public buses (and later in personal vehicles and boats) has been supported by numerous studies and outreach that can describe how these novelties hit the public in the daily lives, their acceptance, preferences, questions and influential factors to form public discourse. Figure 1 gives an overview of the continued demonstrations with hydrogen equipment in Iceland during the years 2001 – 2009. The public has perceived these H₂- activities and FC demonstrations as one and the same fuel experiment. Therefore the research that is described in the following document is presented in a holistic fashion that connects HyFLEET:CUTE, WP5, with other hydrogen related social research undertaking by University of Iceland.

Hydrogen projects 2001 - 2010

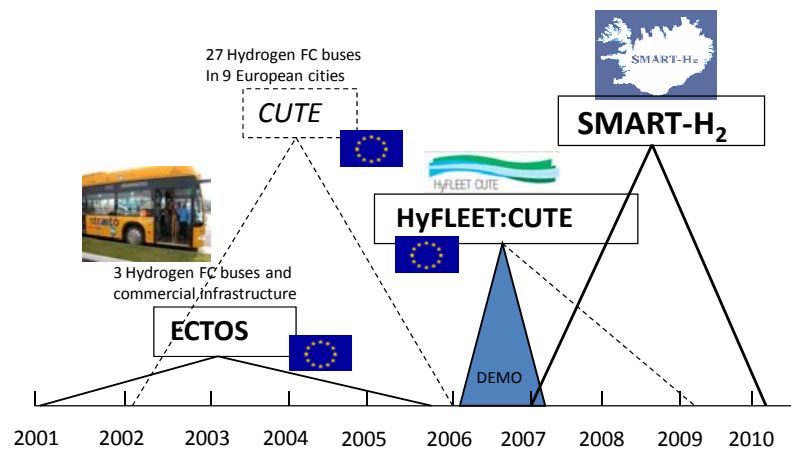


Figure 1 Hydrogen demonstrations in Reykjavik, 2001 – 2008 are perceived as one Hydrogen projects

These observations can help to establish a communication platform for those who believe that Hydrogen and electric drive is a sound response to oil shortage, price variations and environmental threats, without compromising much of the freedom that modern man associates with good transport. The down sides are left out of the narration but somehow the public and the media avoid looking at the needed changes in the transport service in a holistic way. The overall goal of the exercises that are described in the following sections is an attempt to engage people that adhere to niches in society to discuss the complicated

fuel and energy questions within the national context and help researchers to establish an understanding of preferences, conflicts and opinion forming, using the Icelandic society for a case study. Iceland is an island and therefore makes all settings and boundaries clear. The outcome should be recommendations to the government and municipal administration.

During the era of neo-classic economy the public has learned to trust the market to promote the best bargain. But now that external costs and scarcity of resources suddenly weigh more than the individual choice and market performance, other aspects must be considered in the equation, and societal costs must be included in the price tag. .

The society needs supportive measures to shift to a more sustainable solution– whichever type of fuel will become the main energy carrier, societal systems and patterns of cooperation need to be established to move in a coherent way towards the selected options, whether that will be biofuels from agricultural waste, biofuels from anaerobic fermentation in land fillings, bio ethanol from sugarcane or other options. Actors in this shift will preferably come both from public and private sector and from all layers of society. In order to promote and start such shift a common understanding would be helpful to steer the actions towards the set goal. Therefore the University of Iceland decided to try and use several social research methods to establish an understanding of the interactions between people, their views on the end of the oil era and facilitate a dialogue between Icelandic New Energy, who runs the hydrogen equipment and the public. The discussion is on the pros and cons of the opportunities of introducing integrated hydrogen systems with the established infrastructure in Iceland, using all its operational components. The University is a partner within HyFLEET:CUTE but also worked with Icelandic New Energy within the ECTOS and CUTE projects (FP5) closely cooperating with the technical staff and is currently continuing research in a similar field within the nationally funded project SMART-H2.

Icelandic transport and energy system

The current transport system (and the vast fishing fleet) is fuelled by imported oil products. A comparison the two systems reveals that types of staffs and their tasks that are needed to operate these two systems are quite different. Hydrogen is not transported

to the market, along roads but as electricity along the national grid; Hydrogen is made on refuelling stations with electrolysis from water.

Thus heavy vehicle-drivers will decrease in number. Specialized personnel that recognizes the characteristics of electric systems; power generation, transmission, operation and maintenance of grid, gas-pressure systems and strict security plans will be essential actors in the hydrogen delivery system. Only in a few places a third option, based methane-gas made locally from landfill could also be viable.

Table 1 A short comparison of the type of staff operating an oil fuel chain and hydrogen fuel chain within national boundaries

Aspects	Hydrogen fuel system; 20 Peta Joule/Year	Type of staff for H2	Oil fuel system 35-40 Peta Joule/year	Type of staff for oil
Import / Production	From local water and hydro-power electricity	Electricians Engineers technicians	Import in quarterly oil batches, transport from Rotterdam or other oil markets	Staff of oil tankers specially trained fire workers and inspectors, customs service, other civil servants
Transport from source to depot	Grid with needed capacity, water pipes,	Specialized workers for grid construction and maintenance	Oil and gas pipes, tankers, trucks security staff	Crew of tankers, trained staff to attend tanks and pumps, security inspectors
Transport from depot to station to users	GH2 in pressure cylinders from production sites to industrial plants or small depots	Trained truck drivers	105 specialized oil trucks to 55 gasoline filling stations in Reykjavik and 55 rural stations	150 truck drivers trained in EHS procedures. Inspectors for legal scaling and pumping.
Storage	High pressure tanks, specialized dispensers	Staff trained in Envir, Health and Safety procedures, and pressure systems	Underground tanks filled weekly during summer, once a month in winter, 3 types of fuel: gasoline, diesel	Automated self service or servants on fuel stations.

Distributional systems to diffuse electrolytic hydrogen and imported oil from a single import point are the options that present the most difference in the societal context and mark the main features of an eventual fuel shift. In Table 1 these systems are compared side by side for various aspects. The goal is to set a frame to compare the quantity and

quality of staff that is needed for each of these fuel systems during the upcoming phase of HyFLEET:CUTE.

The text in the table refers to the Icelandic system where there are 300.000 inhabitants and gasoline is transported with an oil tanker to Reykjavik and trucked from there to all other sites. Hydrogen is currently produced with electricity that is derived from renewable geothermal and hydropower sources. Water is abundant. Bio-mass is very scarce and productivity within natural or agricultural habitats low.

During the project time fuel cost and discourse about the price, the environmental effects and the size of fossil fuel stock has been more vivid than ever. Historically this four year period may be remembered for the war in Iraq, fast market introduction then growing sceptism towards biofuels in the EU, integration of several Eastern European countries into the European community, fluctuating gas import from Russia to the EU market, and the rise of financial transitions plus a financial crash towards the end of the period. All of these issues have had effect on the opinion of the public towards any fuel mix on the market and led to political consideration of the shift to a more environmentally benign fuel types; Hydrogen has been a major option in this fuel matrix. Vehicles that run on methane, ethanol, biodiesel, cooking oil, palm oil, batteries, and buses that use hydrogen in internal combustion engines or fuel cells, and hybrid technology is also available.

As the first paragraph indicates it should be evident that the social studies that are conducted in a few of the places that participate in the technology demonstrations cannot be used to generalize anything for any other locations, due to very different status of all dimensions. Instead this report conveys a message on research approach and work effort that can be used as blueprints for other sites.

1.1 Methods

Within HyFLEET:CUTE WP5, task 5.4, the social studies applied several different research approaches. These methods were:

- Acceptance surveys using questionnaire with preset multiple choices
- Mapping of actors in hydrogen projects
- Societal maps of stakeholder interactions and influential synergies and conflicts
- Focus group discussions about energy preferences (students)
- In dept interviews with two societal niche groups

- Workshops with invited participants; collection of ideas for fuel transitions in Iceland
- Workshop with same participants to outline a list of actions according to set preferences

Overall goals for WP5.4

1. To map the social dimensions and public views about shifting to hydrogen as fuel and the acceptance of new drive technologies in the participating countries.
 - i. Outline the public opinions, how they develop, which factors influence the views and future visions and what various target groups perceive to be important influential factors towards a decarbonised transport system. Hydrogen is put in context with other eventual options.
 - ii. Analyse which and how social information has been collected in context with hydrogen demonstrations
 - iii. Use this knowledge to understand what has been presented to the public to facilitate and understanding the underlying grounds for shifting to a new fuel type
2. Deploy various study methods and cover gaps found and in the acceptance matrix.
3. To establish a dialogue and support public engagement
4. To shape a working strategy for dissemination that is needed / helpful
5. To formulate information that the public asks for
6. Compare the acceptance of hydrogen to that of different types of fuel
7. Disseminate outcomes and needed information

2 Research methods and strategic approach

There are several accepted ways to collect and analyse qualitative issues. The methods of analysis are still in theoretical discussion and development, and all of them have been subject to criticism. An excellent insight into this research type is Reflexive Methodology¹ by Mats Alvesson and Kaj Sköldbörg. They insist that there is no such thing as passive information and all issues have meaning according to their context and interpretation, which focuses again on the culture of the researcher himself. None of the researchers or teams state their taken – for – granted assumptions, blind spots in their social culture, research community and language.

On the basis of this, a similar matrix should perhaps be composed only on the background of those who made the research.

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¹ Alvesson Mats, Kaj Sköldbörg (2000): Reflexive methodology, New Vistas for Qualitative research, Sage Publications Inc

Lessons learned from qualitative studies are very much linked to the methods that are used to collect the information and the target groups that are used as reference sample of individuals. Bus drivers (Figure 2) will insert different piece of information than a flight captain that has never tried to ride on a public bus in Reykjavik. Which of these pieces are more relevant or truer? Such qualitative differences are found and evaluated by set screening methods.

The following factors can influence the outcome: Phrasing in questionnaires, selection of sample of population, the context in which questionnaires or discussions are carried out, former events that may colour the momentous opinion of the respondents, their cultural background, educational and economic status, mood etc. On top of that the recorder and the interpreter read into the replies according to own background. Therefore the “outcomes” of the studies will only apply to the situation in which these studies were made. Generalising about the “opinions of Europeans” of hydrogen as fuel from these studies is impossible.

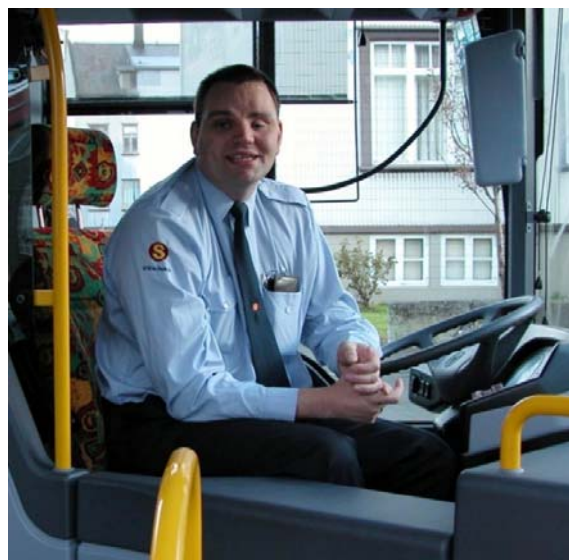


Figure 2 Bus drivers were considered an important social actor in the ECTOS bus test

The description of results, methods and approaches can give a contextual view on what has been undertaken. Because of the variety of questions, discussion issues, the varying size and culture of the sample then the outcomes are more than often not comparable.

Again according to Alvesson and Skjöldberg, interpretation schools have been called: Empiricist techniques that focus on the quantitative data, counting and proportions. Hermeneutics look for interpretation of texts also using insight. Critical theory seeks to find the truth according to politic and ideology dimensions. There is also the attempt to take all data out of cultural context in a poststructuralist approach and finally information can be interpreted according to discourse analysis, for example from a feministic point of view.

The overall advice is to use a more reflective approach and allow the applied methods to adapt to what happens during the study. Researchers should not hesitate to use the experience in a positive feedback-loop to adopt reflexive or a flexible approach to the data collection and interpretation in context with the first observed results.



Figure 3 Elderly people take a ride in a Hydrogen bus. In many surveys the oldest age group shows high interest in environmental and energy affairs.

The following descriptions only describe the various ways of collecting the data or material for further processing.

Surveys or telephone interviews propose fixed questions and usually offer a range of options that the interviewee can choose from. It is very important that questions are phrased correctly so that the responses fit the set goals. In this approach the interviewer (or the questionnaire) has built in presumptions about the knowledge or social background of the respondent. Selected vocabulary may fit for teenagers, but a similarly



frequent bus rider category is retired people, see Figure 3. If these factors vary across the sample then the results may not be comparable. For example in the first version of the Hy:FLEET:CUTE questionnaire from 2006m, that was supposed to be presented to bus riders all across Europe, it was suggested to give the option of connecting hydrogen with hair colouring (“Hydrogen blonde”). Some respondents may seize the opportunity to link this gas with use for cosmetic reasons. But in other cultures the name for the same phenomena is connected to the peroxide part of the same cosmetic product (Hydrogen peroxide) and the effect called “Peroxide blonde”. For them hydrogen blonde has no meaning at all and this option was discarded. The question would therefore miss the point. Because the researchers that formulate the questions will inevitably set their nuance on the questions with their own perception of the world, it is essential that a team scrutinizes the questions and that the lists is tested before its broader use. The hermeneutics (interpretation of text from cultural, historical and literary context²) therefore plays a role in this context while constructing the questions.

Focus groups can be good to form hypotheses rather than give insight into general public opinions. This method is at the heart of Empirical studies; groups of people are observed while discussing issues and questions that are put to them by the researcher. The discussion and behaviour is reported. When the goal is to find out which issues are of interest to the public, how opinions form or to pinpoint open issues in the context then focus group discussions can be helpful. Open issues are those that are suggested by the participants in an exercise opposite to questionnaires that only offer closed issues; a range of options that are given for each question. Focus groups are also good to find gaps in knowledge.

If more than one focus group is invited for discussion then either they can be representatives of a very similar background or from various social sectors in society. Those who have a monotonous background can bring in issues in discussion that are of interest within that social niche; smaller nuances can be detected in the discussions. Representatives from many societal categories can suggest broader ideas as if in a brainstorming exercise, but the risk is that they don’t engage in a dialogue because they use concepts from different levels of society. For example: In a focus group composed of

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² The simple explanations of concepts are from Wikipedia, www.en.wikipedia.org/wiki/

young energy experts, the official one year old information package was deemed to be old fashioned because it left out explanations of what is external costs. In the next group, composed of politicians in the same age group then this information package was entirely new, but still the question of cost-benefit analysis became a major issue for discussion. If individuals understand the same information material in a completely different way then the discussion may be loaded with misinterpreted concepts and lead to misunderstanding.

Constructed interviews are used to both collect opinions from individuals on pre-set issues but also leave space for open ended questions that may arise during the interview. Such interviews are used to get opinions on specified subjects from various angles or stakeholders.



Figure 4 A workshop at Icelandic New Energy. The group consists of stakeholders, specialist in social aspects of project management and key people in the project as well as representatives of competitors. The results are used to fine tune the implementation of the project and set a dissemination plan.

Workshops are used rather as a panel of experts or stakeholders to collect various aspects and feedback or check acceptance of ideas or plans before they are undertaken. Workshops can be helpful to formulate a strategic approach to launch the ideas into public domain see Figure 4.

Researchers and their assistants, who also conduct educational sessions, have an opportunity to influence the formation of understanding, perceptions and opinions whereas they are involved in dissemination activities, training or education (see Figure 5 and Figure 9).



Figure 5 The Icelandic Summer-University for Children was a successful dissemination activity carried out in 2003 and 2004 during the ECTOS project.

During the period 2001 – 2008 education was offered for children, university students, students of technology, trainers and vocational teachers. For example about one hundred interested youngsters in the age of 10 – 14 followed a week’s course on hydrogen and energy technology and got to see all the components of a hydrogen energy chain and their functions. The teachers were university students. Another group of 15 teachers participated in a 14 days training course in the Aalen centre for technology (<http://www.eaz-aalen.de/>). These target groups follow their interests and will therefore have a rather positive stand towards the issues of hydrogen and eventually other types of new fuel.

2.1 Target groups and societal positioning

Often new patterns are discovered when interest groups and their connection to each other or their position to influence development are expressed in a graphical way. Participants in projects can simply be listed along with their roles in the project as well as their importance in the project context plus their ability either to carry out their role or influence the failure of a project. One key instrument to catch actor’s visions of the project is called a ‘social network map’. This tool has been elaborated by social scientists to help actor’s elicit their views about the socio-political context of their projects (Laredo et al 1996, de LAAT 1999).

It consist in poles and axes between them (policy, technology, science, partners/investors, society, markets) along which key actor's can be positioned according to their societal niche. Arrows indicate the nature of links between them. The poles can slightly differ across projects to fit, but should remain the same within a project to ensure compatibility. The actors involved in a social network can then be mapped in this societal context as collaborators, opponents, influential, needed allies etc. When relevant, non-human items might be included in a network map, such as for example high energy prices, law, subsidies or technological efficiency improvements or networks attached to one hydrogen production facility. These issues will be discussed further in section 2.1 on the justification of selecting target groups. For clearer approach lets first consider a simpler approach where actors are indicated by their company logos.

Figure 6 displays for example the grouping of partners in the hydrogen project that tests hydrogen equipment on board the first sea going vessel in Iceland (see SMART-H2, www.newenergy.is/en/projects/current_projects/smart_h2/). Most of these companies and associations were also involved in the Hy:FLEET:CUTE project during the demonstration phase until 2007. These stakeholders act as providers, for example of technology, funding, service, energy, or maintenance. They must be active and supportive but individuals in their staff can hold a different position and may act as opponents and create friction against the project flow. Collaboration groups will form during the project design, organisation or implementation, but for the project manager it is essential to realise the dynamics within subgroups and how they influence the project and opinion forming. A good project managing effort begins by outlining the groups, who stick together and who are hubs for realizing the project steps. If such things occur during a project then their role may be even more relevant in later and larger system stages. Their roles can be promoters or welcome free riders, sceptics, or working equally well in competing systems.

In comparison Figure 7 positions these actors into stakeholders with different interests such as research supporters, administrative bodies, providers, competitors etc. These can have access to various media and lobby groups and varying capacity to hire staff that can fit the purpose of carrying out the tasks within the project. Such mapping can help the project manager to establish eventual conflicts or synergies during the project work.



Figure 6 Participating companies form isolated networks

These micro-cosmos can effect how support systems form and infrastructure unfolds. It should be noted that in larger markets, there might be grounds to built up infrastructure for several options of fuel simultaneously, but in a total population of 300.000 people options should be carefully selected to avoid wasteful investment.

2.1 Justification of selecting interviewees and participants in the social dialogue

During the research within WP5.4 it was decided to select individuals from the groups represented in the socio-gram displayed in figure 7. These groups, or governance bodies, even powerful individuals, can influence the early development of hydrogen systems or other fuel system options. Therefore the justification for selecting these as target groups for interviews and other involvement in the early discussion is simple: During the early stages of the integration of hydrogen (or other types of fuel) into society, these actors hold key positions in the energy and transport sector and are more influential than the general public and therefore may have more relevant comments about the upcoming effort to shift to a new fuel in the societal context.

The list of actors was collected with interviews with project managers, people on the board of directors and the owners of Icelandic New Energy, the hydrogen promoter in Iceland.

Secondly it was considered to be important to involve younger people who do not hold a strategic position in the fuel sector, but may become influential within 10 years given their education background, their participation in political work or because they have just started a carrier either in the energy or investment sectors. A general tendency in Iceland since the 1980s is that young people show little interest in voluntary work in social networks but are more preoccupied in working to earn salaries.

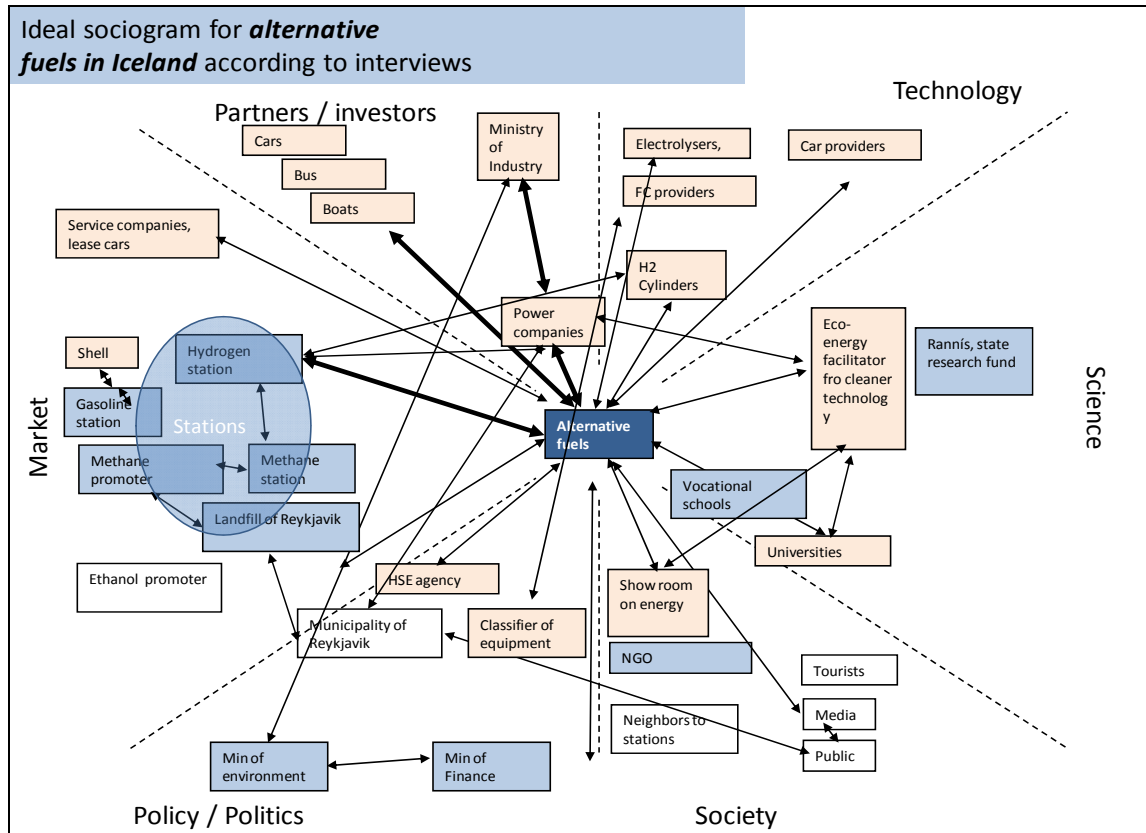


Figure 7 Example of a social map: The actors represented in beige boxes are involved in hydrogen projects, the white ones are neutral actors but relevant for the success. Blue boxes are stakeholders that are considered influential actors in the overall fuel business but are not involved in the hydrogen projects.

In a few instances a random sample was picked out, but only those who have a registered phone number are included in the population. In those instances that discussions were conducted with guests from abroad then the participants had to master the English language plus having an interest in the topic. The sampling is explained in each case in the Icelandic



reports, but all exercises have been compiled in reports that belong to the students, their tutors and have been delivered to Icelandic New Energy³.

1.1 _____

³ These tutors were: Karl Benediktsson, dep of human geography, Brynhildur Davíðsdóttir, department of natural resources, Maria Maack Institute of natural science. See authors list at the beginning of the report

3 Studies 2001 – 2006; earlier outcomes

The ECTOS project (EVK4-CT-2000-00033) started officially 1st of March 2001. The first months were used to plan and organise the upcoming work before the tangible milestones were erected.

One of the tasks was an extensive survey made by the Institute of applied Social Science at the University of Iceland to map the public opinion and acceptance of hydrogen before the first FC-buses were introduced in the traffic.

3.1 2001 First survey

The title of the first public poll on hydrogen, conducted via telephone, was: “The opinion of Icelanders on hydrogen in Dec 2001.”; notably two years before the H₂FC-buses arrived on the streets.

The purpose was to find out if public opinion or sceptics might become an obstacle to the general introduction of hydrogen as fuel in Iceland. In the case that the public opinion would act as a barrier in the implementation then the ECTOS team had planned a strategic launch of information about the emerging hydrogen technology.

The outcomes were very informative: The public opinion was very positive and therefore no barriers raised by the public; Fear or reluctance were not detected. This outcome made it possible to go ahead with the execution of the project and use it as the source of accurate information from first hand experience. Information was always fed back to those who showed interest but no „propaganda material” was launched at the onset of the tests; only short information in booklets that were on display in the buses, short newspaper articles, interviews on the public radio and an animated film was created for the public schools. Time and money was saved and yet sound information went to the public through channels that disseminated the material even further such as teachers, newsagents and interest groups that asked for information during the whole project period.

3.2 2004 survey (ECTOS)

A second survey was undertaken with commuters at the mid term of the ECTOS project. Short questionnaires were put to the drivers of the buses two times during the



project. Only very short examples of the processed outcomes are given in the appendices to this report but the whole document appears as ECTOS Del 12 – [\(\[http://www.newenergy.is/newenergy/upload/files/utgefid_efni/ectos_12-assesment_of_socio-eco.pdf\]\(http://www.newenergy.is/newenergy/upload/files/utgefid_efni/ectos_12-<u>assesment_of_socio-eco.pdf</u>\)\) is to be found online. But for the purposes of this report a list of issues is given below that respondents \(their number in brackets\) wanted to know more about:](http://www.newenergy.is/newenergy/upload/files/utgefid_efni/ectos_12-<u>assesment_of_socio-eco.pdf</u>)

- * More information should be available (14)
- * When is hydrogen due to arrive on the public market? (8)
- * Which risk factors are associated with using hydrogen? (7)
- * What is the price of hydrogen? (6)
- * How is hydrogen made (4)?
- * Worried that the speed and driving range would be less than for conventional cars (3)
- * Wanted to know more about the usefulness of hydrogen (3)
- * Wanted to be updated on the development and the hydrogen tests (3)
- * Wanted to know more about the development of costs (2)
- * Wanted to know about the feasibility of the idea of hydrogen taking over the services of oil (2)
- * Wanted to know if hydrogen would be produced in Iceland or imported (1)
- * Wanted more information directed to the public schools (1)

Not only was it possible to reveal a general support for the hydrogen initiatives, but also to reply to the issues that the public found relevant. The fact that people used the opportunity to send messages back to the interviewers was also a learning moment. Other outcomes are best described in the full document, but according to the reflexive methodology it should be stated that the questionnaires were carried out by students in geography and bio-chemistry and the replies were interpreted by engineers or other specialists of natural sciences (see Figure 8).



Figure 8 German, Swedish and Icelandic experts, attending the first organisation meeting on social aspects.

3.3 Feedback from the bus drivers' group

In April 2004, fifteen H₂fc-bus drivers, were asked about their experience from driving the FC-buses. The survey was an initiative taken by the CUTE project in Luxemburg. The results show that bus drivers in Reykjavik evaluated the test as an important step towards „What eventually has to become”.

The bus drivers as a whole described the tests as a pleasant experience, the buses are quicker, more silent and are met with more positive reactions from the passengers than then they had expected.

4 The HyFLEET:CUTE social studies

In the following sections a description is given for other studies that attempted to involve the public and selected target groups in dialogues that reveal more than accounts of standardised replies to standardized questions. These methods are focus group discussions with preset discussion issues, questions and provoking statements; the workshops with selected representatives according to the outlined stakeholders' societal positioning and semi constructed interviews that are addressed one side to a group of environmentally interested people and on the other the same number of energy experts.



Figure 9 First training session with bus drivers of hydrogen buses

HyFLEET:CUTE demonstration was the second major hydrogen demonstration in Iceland and opportunity arrived to build upon the repeated studies from 2001 – 2006. And according to the acceptance matrix specific target groups were selected to be invited in more qualitative studies that can give more freedom to the respondents and recognises their will to consult with peers or take initiatives to suggest topics that they find individually or collectively important in the context. But qualitative research differs from quantitative measures and therefore the section begins to outline basic parameters that should be noticed in social studies.

Lessons learned from qualitative studies are very much linked to the methods that are used to collect the information. The following factors can influence the outcome: Phrasing in questionnaires, selection of sample or population, the context in which questionnaires or discussions are carried out, former events that may colour the momentous opinion of the respondents, their cultural background, educational and economic status, mood etc. On top of that the recorder and the interpreter read into the replies according to own background. Therefore the “outcomes” of the studies will only apply to the situation in which these studies were made. Generalising about the “opinions of Europeans” of hydrogen as fuel from these studies is impossible. The description of results, methods and approaches can give a contextual view on what has been undertaken. Because of the variety of questions, discussion issues, the varying size and culture of the sample then the outcomes are more than often not comparable.

It can be imputed from the social acceptance studies that the public seems to be interested in hydrogen deployment. A minority reports fear this new fuel type, many ask for more information, some people think that this technology will enter the markets in 20 – 30 years earliest, while others are more optimistic and believe that hydrogen economy is just around the corner. But whereas completed studies are often not comparable a more systematic approach to the studies can give different insights.

4.1 2006 survey (HyFLEET:CUTE)

A questionnaire (Deliverable No. 5.6 Study of Customer Acceptance) was presented to bus passengers simultaneously in Berlin, Reykjavik, Madrid, Luxemburg and London within the HyFLEET:CUTE. A few of the questions were the same as in earlier surveys. The outcomes in Reykjavik were quite compatible with earlier findings, people are positive and 20% of the respondents actually thought that the number of hydrogen buses in Reykjavik had reached 10 when indeed the fuel cell bus test was nearing its end. The figures 11-13 reveal responses to three of the questions.

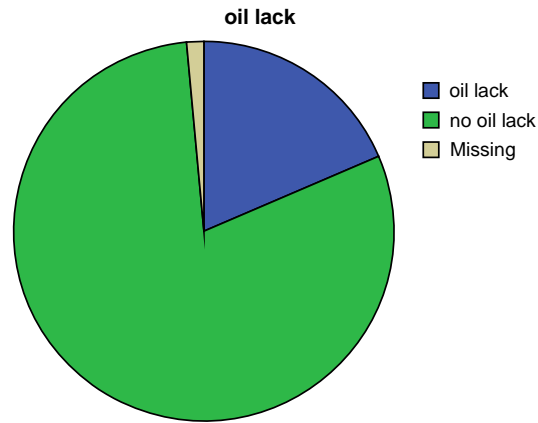


Figure 10 Replies in Reykjavik to the questions: will oil be lacking during your life time.

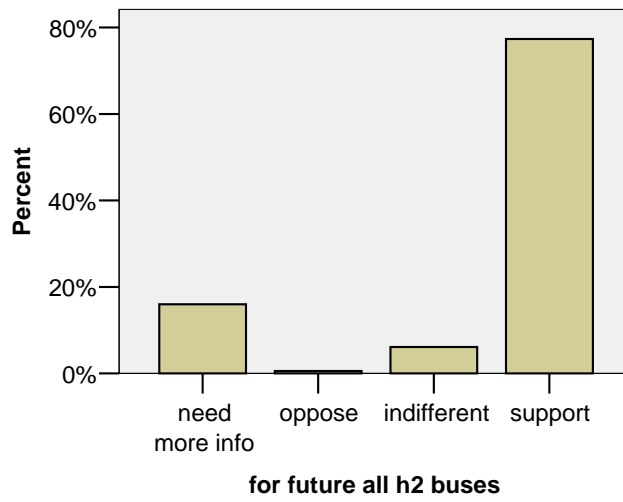


Figure 11 In Reykjavik a majority supports the idea to run all buses on hydrogen.

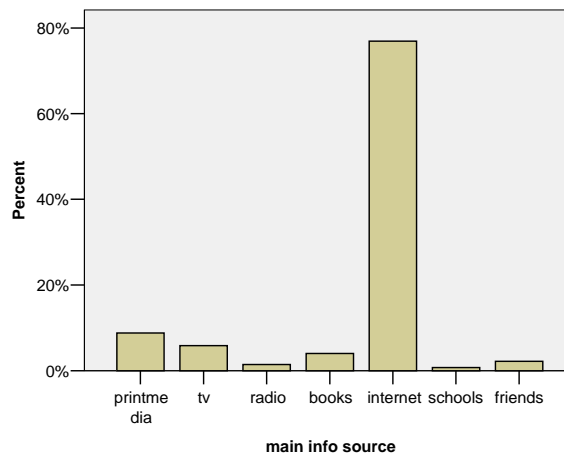


Figure 12 Which information source is used the most by respondents in Reykjavik

4.1 The acceptance matrix

Before undertaking any further social research it was decided to start by analysing former social studies that had been conducted for the last decade on public perception of hydrogen in a more international context. Eventually gaps in these studies were to be discovered but the lessons from these were to be used as basis for added value. Could former studies broaden our understanding of the socio-technical dimensions or factors be found (integrated criteria of the vehicle or of the fuel stations, for example fear of explosions, fear of high pressure, scepticism of lower range or other performance) that might prevent the smooth introduction of H₂ into our regulated European society.

For the purpose of finding a gap in public acceptance studies, 13 European and American studies were analyzed for concurrency, overlaps or missing pieces in the research agenda. The entire analysis is given in the appendix to this report and the studies are listed in the reference list.

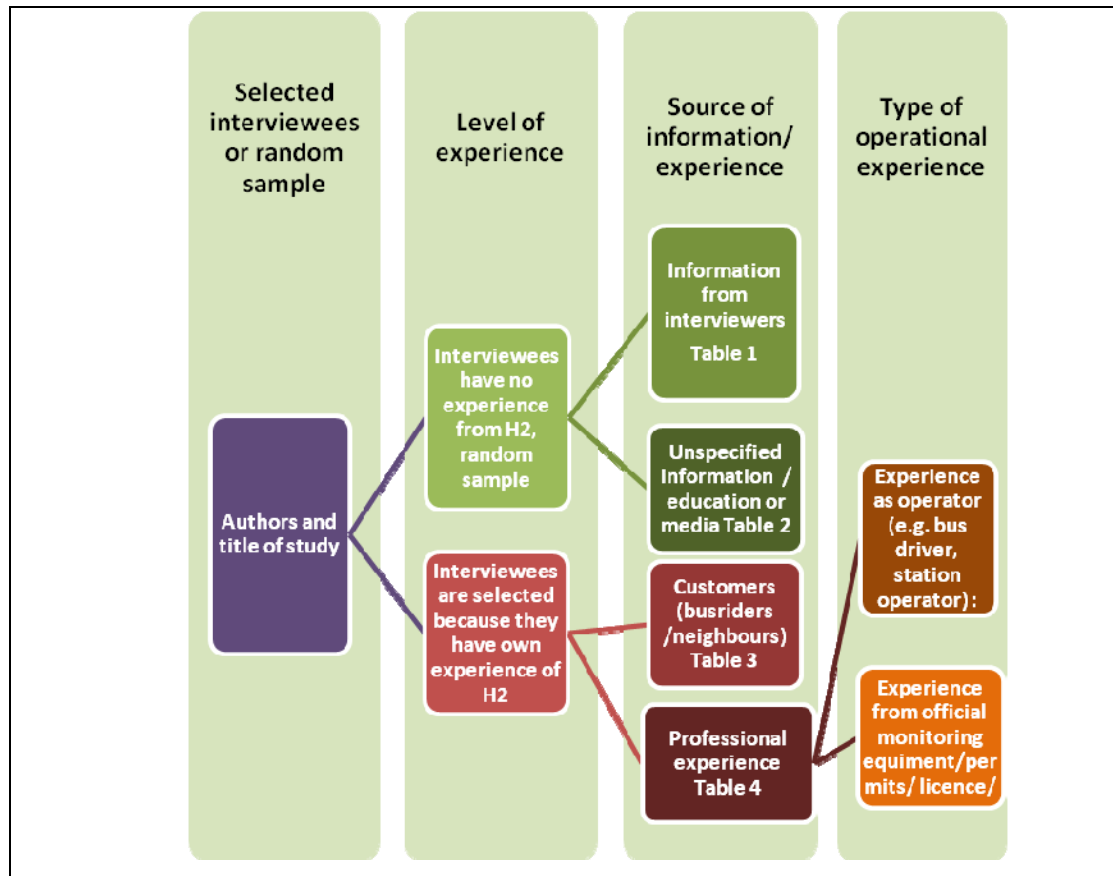


Figure 13 Overview of the classification of hydrogen acceptance studies.

Figure 13 shows how the tables 1 – 4 are organised to the extent of experience that the respondents have at the time of the study in question.. The most important studies are analysed according to their goals, issues of group-discussion or questionnaires, and key words in their results. These factors are presented in tables 1 through 4 in the Appendix B, which is attached to this report.

The main criterion in the classification is the level of experience within the selected sample of respondents. The colour code in Figure 13 is used further in tables 1 – 4 in Appendix B to emphasise the classification criteria. The most important background of the respondents is assumed to be their level of personal experience from using Hydrogen equipment at the time of study. This category is then split into two groups; those who have experience of using hydrogen technology as a customer, on a bus for example, or as an operator, perhaps a bus driver. These types of experience are considered to give different insights but still can give valuable information about how the experienced people view this novel technology.

The other group of respondents has no personal experience but has either had access to known information material on the subject or may only have learned about hydrogen technology in the media. It is generally assumed that the public uses different information sources according to their background, education level or discipline. But in some of the studies, the respondents were fed specific information before they were interviewed or participated in discussion on hydrogen.

4.2 Analysis of the acceptance matrix

This section lists and explains the issues that appear most often in the Acceptance matrices (Tables 1 -4). Specified issues appear more often in the studies and are used here as headings for the columns. In this section only the studies' acronyms are given in brackets for quick reference.

In the attached tables that are referred to as the acceptance matrix, the first column in each indicates the short title of each study; the precise title is to be found in the reference list.

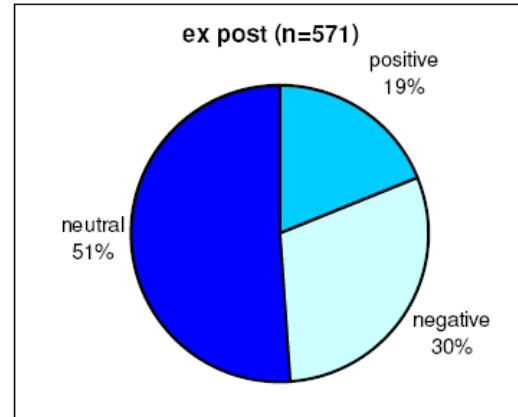
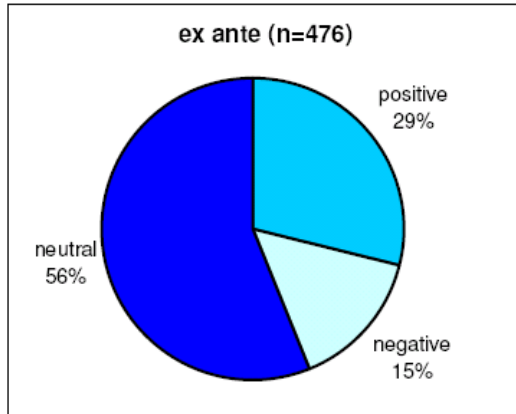
The method used to select the sample is given in the second column. In telephone surveys the sample is kept large and usually selected ‘randomly’. But the sample can easily exclude those who do not possess a fixed telephone line, ages beneath 18 years those who have not registered a new address etc. These studies are made to give insight into general views on rather unspecific issues, such as first impressions. The sample should be large as if to represent the public in general within security margins. A few of the studies (DOE, Cooper) are directed at several target groups in the same geographical area while others select similar target groups in different countries (Imperial College, Garreth).

The goals (see third column) of the social studies may vary. All qualitative research should follow some well reasoned logic and a clear **goal** is of fundamental importance. Some studies intend to find out general views before the introduction on hydrogen demonstrations, with the goal to clarify good options for information campaigns (See figure 3 ECTOS, 2001) or frame educational efforts (DOE, 2005). It is recommended in the methodological approach for this type of research that goals should be clear from the beginning and questions should aim at finding answers to set research question(s). Questionnaires should be tested for accuracy and precision before the surveys are launched; sometimes they are used repeatedly to estimate changes with time (H2Acceptance, ex-ante and ex-post).

Information sources or background experience of the respondents is used in the acceptance matrix as the fourth criteria for categorisation, set out in the fourth column.

Bad reputation, shocking images or negative experience can act against acceptance. Mature generations at least can link Hydrogen with influential news-release images but younger generations with lab-experiments that leave blueprints of hydrogen knocks. Therefore many studies link the frequency of specific images that people connect to hydrogen and directly to perceptions of safety. (ECTOS, KTH Stockholm, Imperial College, 2003 – 04, HyFLEET:CUTE 2006)

BERLIN



PERTH

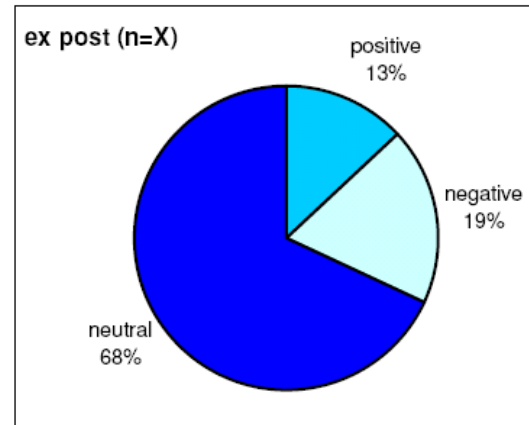
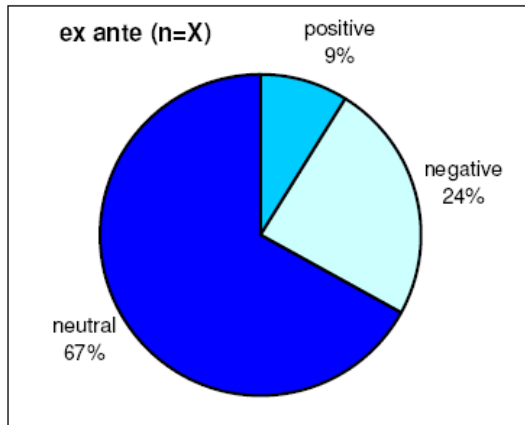


Figure 14 Distribution of total number of associations with the word ‘hydrogen’ in Berlin, Germany and Perth, Australia, prior to (ex ante) and after (ex post) demonstrations of hydrogen fuel cell buses. The illustration shows that people’s opinion changed in Berlin but was quite stable in Perth⁴.

It is generally accepted that quality information, higher education levels and positive personal experience make individuals in general more acceptable to novelties. Indeed this is highlighted in the DOE survey (2005): Hydrogen Baseline Knowledge Survey and the HyFLEET:CUTE study in 2007. In surveys made in London the respondents chose not to take a stand in some issues before they had more information on the issue. Public opinion can change with time. This is quite normal if projects or ideas have been introduced in

⁴ 1.1 _____
 AcceptH2, Full Analysis Report, Comparative Analysis of the Impact of the Hydrogen Bus Trials on Public Awareness, Attitudes and Preferences: Comparative Study of Four Cities, Tanya O’Garra, Imperial College, London, 2005

campaigns or media in the meanwhile (see Figure 14). 90% of the respondents in the ECTOS survey 2001 claimed that hydrogen projects and hydrogen technology had not been introduced enough to the public. In 2005 45% claimed the same and asked particularly that this would be done within the school system, not recognising that this had indeed been done. Still those who support the use of hydrogen as the main fuel for land transport and for ships were 93% in 2001 and 86% in 2005 respectively.

Hydrogen contains energy as any other fuel type, but its physical character is very different from the liquids which are in common use. The industry realises that the equipment that transfers the fuel into vehicles and the vehicles themselves are the interface that meets the public. Therefore the perception of safety amongst (potential) customers is often measured (ECTOS 2004, CUTE ;KTH 2004, HyFLEET:CUTE) The Natural-Hy consortium is a collaboration network of car manufacturers and they launched the StorHy project⁵ which aims at discussing which criteria customers find important for the design of future fuel infrastructure, even if the energy carrier becomes hydrogen.

An important issue brought into focus in these studies is the concern about the high prices of hydrogen compared to fossil fuels. People are either asked if they are willing to pay (WTP) higher fares in hydrogen buses or if they would accept higher fuel costs of during the introduction period for hydrogen (ECTOS 2004; CUTE, KTH Stockholm 2004; H2 Accept, Imperial college 2004 – 2005, HyFLEET:CUTE, 2006)

The last column in the matrix tables gives a short comment on what the authors interpreted as important finding of each study. The ongoing hydrogen projects within the EC 6-7th framework program, such as HyApproval⁶, Roads2Hycom⁷, HyLights⁸ and others have large social studies on their agenda. They look more at the administrative levels, legal aspects, standards, codes, commercialisation of fuel cells and marketing preferences and

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⁵ StorHy www.storhy.net 2005 (WP E1 og E2)

⁶ <http://www.hyapproval.org/>

⁷ [/www.ricardo.com/roads2hycom/registration.aspx](http://www.ricardo.com/roads2hycom/registration.aspx)

⁸ www.hylights.org/

framework for operation of H₂ stations, as well as good housekeeping rules rather than the points where the public meets the fuel.

4.3 Other reference studies

The social discipline is much broader than studies on public opinions or consumer preferences. In context with sustainable development social issues incorporate equity, equality, job opportunities, qualifications, cultural aspects, social capital, societal development and good policies. Still in the compiled report of abstracts of papers issued on the 2006 World Hydrogen Energy Conference, in Lyon, the emphasis is kept on the technological development of technological hydrogen modules such as material in storage cylinders, or production of vehicles. The holistic picture overlapping societal impacts, job patterns, the need for education and training and societal cost of those efforts are not to be found in the conference papers.

European cross-disciplinary studies that link costs, environment and social issues are called “socio-economics” while studies from the USA on similar work are called ‘Life Cycle Cost’ (LCC) or societal cost studies⁹. The focus of the European work tends to be the speed of technical development, availability of natural resources and impact on the environment,¹⁰ including human health impacts. Often the LCA studies are connected to demonstrations made by specific industrial partners who test their equipment and scrutinize their production methods (undoubtedly to select the methods that include lowest environmental impacts), but are at the same time sensitive towards publishing the data. Outcomes will depend on the context but for the partners that have high stakes in developing the technology, information on efficiency and prices are understandably sensitive but essential to benchmark the development within the industry as a whole. Still these European demonstration studies are grounded in empirical data.

The European first attempt to link costs of excess wind power with costs of hydrogen produced for vehicle fuel is Linnemann’s and S.Wilkens’ study published in 2006¹¹. But in

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⁹ Odgen J, Williams Larson. Societal Lifecycle Cost of Cars with alternative fuels /engines Journal of Energy Policy Jan 2004.

¹⁰ Linnemann J. & R. Steinberger-Wilckens PLANET—Planungsgruppe Energie, Realistic costs of wind-hydrogen vehicle fuel production und Technik GbR, P.O. Box 4003, D-26030 Oldenburg, Germany

¹¹ ditto

the paper it is not clear whether wind mills would be *socially accepted* in the areas proposed for wind farms. In other words: The externalities (disrupted views or changes in land use) are not taken into account nor addressed as an influential social aspect in the implementation phase of such a project, which obviously would act on the realisation costs.

Similar American studies emphasise price development of hydrogen¹² sometimes adding social and environmental costs, but lack substantiation in measured or similarly obtained empirical data. These studies are made by independent academic researchers and introduce a broad spectrum of influential factors.

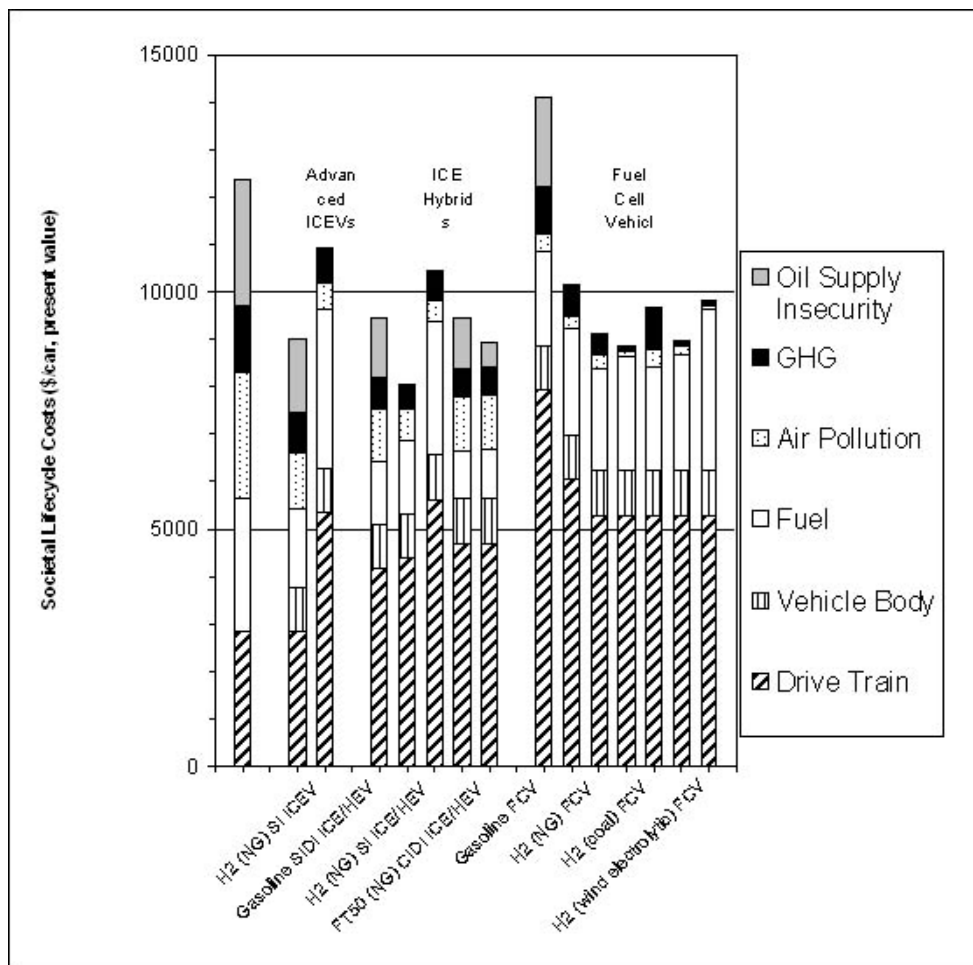


Figure 15 Societal life cycle cost of compatible vehicles with various drive trains according to Ogden et al (2004)

UC Davis in California has published a range of studies that can assist in policy development concerning hydrogen fuel integration into society. These papers use theories,

¹² Yang C. & J. Ogden: (2006) Determining the lowest cost H2 Delivery mode, Int. Journal of Hydrogen Energy

forecasted price for natural gas and model simulations rather than data collected from technical demonstrations¹³. These studies link environmental and social aspects into total costs; for example is the cost of warfare to secure energy supply¹⁴ included in Life Cycle Societal Cost and becomes included in vehicles rather than cost of transportation. Compared to the supported research within European hydrogen demonstration projects they are still not very realistic. But the methodology is to be noticed.

Life cycle assessments (LCA in Europe) or Life Cycle Impacts become Life Cycle Costs in the USA, where environmental and health care plus other costs posed on society are summed up into the price of vehicles during its life time rather than the European style to compile environmental impacts singularly and then costs in a different category. The European studies give the Life Cycle Environmental Impact assessment without linking those to societal costs. An upcoming amendment is the methods proposed the EC supported NEEDS project¹⁵; New Energy Externalities Developing Sustainability where most environmental effects from energy projects are correlated with the price of environmental externalities and social factors.

In the US, the research agenda seems rather to deliver information in the form of prices as for marketed goods and services. The studies seem to be driven by eventual business opportunities, price development rather than technological performance or the chance for entrepreneurs to take on new challenges. Terms like Socio-Economics (EU) become Bound Socio-Technical tests¹⁶ (US).

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¹³ Sperling D. & J. Cannon eds. (2004) The Hydrogen Transition, moving towards the post petroleum age in transportation. Elsevier Academic press, New York

¹⁴ J. Ogden, R.H. Williams and E.D. Larson, "A Societal Lifecycle Cost Comparison of Cars with Alternative Fuels/Engines," Energy Policy, January 2004, pp. 7-27.

¹⁵ NEEDS Projec, 6th FP no: 502687; New Energy Externalities Developments for Sustainability, /www.needs-project.org

¹⁶ Vergragt, P.; Brown, H.S.(2006) Innovation for Sustainability: The Case of Sustainable Transportation. Online www.tellus.org/publications/Innov_Sust_Vergragt_Brown.pdf

4.4 Public discourse on hydrogen and other fuel types 2001 – 2008



Figure 16 After conferences on hydrogen the media published positive stories on hydrogen as the future fuel option for the Icelandic market. But as soon as a new conference was held and a new drive train and fuel was introduced the media presented that option as the future fuel option

Public discourse is probably best represented by the local media. It is an accepted custom in the Icelandic newspapers even the radio that individuals write or call to share their opinions voluntarily if they want to add to or criticize the current popular discussions or recent news for example about latest technology development or interviews with experts during conferences (see Figure 16) and meetings. Icelandic New Energy bought the service of a surveillance company¹⁷ to follow all local media discussions on hydrogen, hydrogen cars, methane and later other alternative fuels during the HyFleet:CUTE project time.

The first trialling of hydrogen powered vehicles and the visibility of the buses re-invigorated political discussions about new options for using energy, decreasing emissions from transport and the possibility of exporting hydrogen. The hydrogen project appeared to have heralded a new energy era. The effect of initiating the hydrogen projects drew the attention to Iceland's renewable energy systems as well as the hydrogen projects during an era when natural gas was penetrating most markets. Newsweek, NBC and the BBC published interviews and pictures about the FC buses and the hydrogen station. These interviews were quoted widely in the local media and Hydrogen was placed on the local and international agenda. The

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¹⁷ Fjölmiðlavaktin www.fmv.is

Administrative level was kept on their toes and had to recognize the high interest. In interviews on the street the Icelandic public were suggesting that it was absolutely normal and ‘nice’ that hydrogen was being introduced into the local fuel mix. This media attention had a very positive impact on the societal discourse on hydrogen between 2001 and 2006 when biofuels, grabbed attention because they had entered the international scene.



While the discontinuation of the running of the first generation Fuel Cell buses caused disquiet among the Icelandic public, international attention continued including the nomination by Russian academics of Prof Sigfusson from the University of Iceland, for their Energy award.



Interest in the hydrogen initiatives continues to be a regular stop for TV crews and energy tourists from many countries and seem to be used as a popular incentive to push forth discussions on renewable energy and new fuels in other parts of the world.

But during the same time the local interest in other fuel types has increased and therefore comparative questions have become more obvious than only questions on hydrogen. Other technologies such as methane, bio fuels and electric battery vehicles, seem to have raised the critical assessment of all new and old fuel options, but locally generated energy carriers recur in the discourse.

The most vivid criticism has come from two professors in Chemistry¹⁸. Jónas Bjarnason has urged the hydrogen team in Iceland to release all data details on the drive train and efficiency of the fuel chain and states that it is a mistake to spend resources on hydrogen. The other is a professor at the University of Akureyri who promotes battery driven transport with battery

¹⁸ see Morgunblaðið 2006, 2007, 2008 and Fréttablaðið 2007

hubs along the main roads where drivers can change empty batteries for fully loaded ones. Ulf Bossel¹⁹ who was invited to speak on a conference on alternative fuels²⁰ in October 2007 has also been quoted as an argument against extensive use of hydrogen for transport. His favoured fuel type is synthetic methanol to be used with fuel cells.



Figure 17 the international media has put a considerable pressure on Icelanders; Government, power companies and the public by showing constant interest to the hydrogen projects.

Carbon sequestration has also been introduced during the same era. Travellers can buy carbon sequestration certificates and the fund is used to plant trees in selected sites. The University of Columbia, Université Paul Sabatier and Reykjavik's Energy are jointly running a sequestration test where emissions from geothermal plants are led into basalt bedrock whereby the CO₂ should bind with minerals and petrify²¹.

These are just a few of the issues that have been covered by the Icelandic media during the HyFLEET:CUTE project time, all on use of renewable energy and new fuels. But the stronghold in the media is the broad cooperation and good connections to the many important persons that recognize the virtues and shortcomings of the current hydrogen technology that has helped to keep hydrogen and the latest hybrid technology alive and kicking. Good relation

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¹⁹ See European Fuel Cell Forum www.efcf.com

²⁰ Dring sustainability see: www.driving.is/07/driving07.html

²¹ The Carbfix project, <http://www.or.is/Umhverfiofgfraedsla/CarbFixverkefmid/>

with stakeholders and relevant interest groups plus simple yet well grounded information on the hydrogen projects on the web have kept the communication on a friendly level.

4.5 Conclusions for further studies Wp5.4

From the introduced studies and status of societal discussions it can be stated that the social field gives various insights into the status and acceptance of hydrogen and the related technology. The approach has not been harmonised or boiled down to a simple research approach. There is incongruence between studies on the different sides of the Atlantic and therefore it has been difficult to compare studies on international bases. US studies are rather theoretical and to a large extent based on questionable assumptions because they lack rooting in practical measures.

The results of the European commission funded HyWays²² project, (Hydrogen road map for Europe) indicate that the maximum penetration of hydrogen as a fuel vector by 2020 is predicted at only 2%. In order to get (even) there, competition with other fuel options has to be taken into account and specific measures made to facilitate the hydrogen integration, as it will not be the only option on the competitive market. What becomes the role (and the freedom of choice) of the public when it comes to reaching these milestones? Does the public play a role in implementing sustainable development, or will hydrogen do the trick alone?

In Europe, energy policy measures have taken more into consideration the impact of global warming on the economy and other social impacts from the extended use of fossil fuel. Still Hydrogen and renewable energy has not been pointed out as the single option to reach the double dividend of cutting oil imports to Europe and raise efficiency. Research nuclei come up with suggestions for policy to mitigate climate change²³ and even transition management towards a hydrogen economy but realisation is still not evident for the public. Whereas transport and traffic have many more aspects than only fuel and emissions, efficiency and technological progress (refer to Figure 18) hydrogen, or for that matter, hydrogen economy should not be considered in isolation from other relevant factors. Noise, traffic congestion,

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²² www.hyways.de/hynet/

²³ PEW centre on global climate change, reports from various authors 2001 – 2007. www.pewclimate.org

travel time etc are not related to fuel types but still are correlated in peoples' minds to all options of travel, fuel, planning, cars, public transport and the environment.

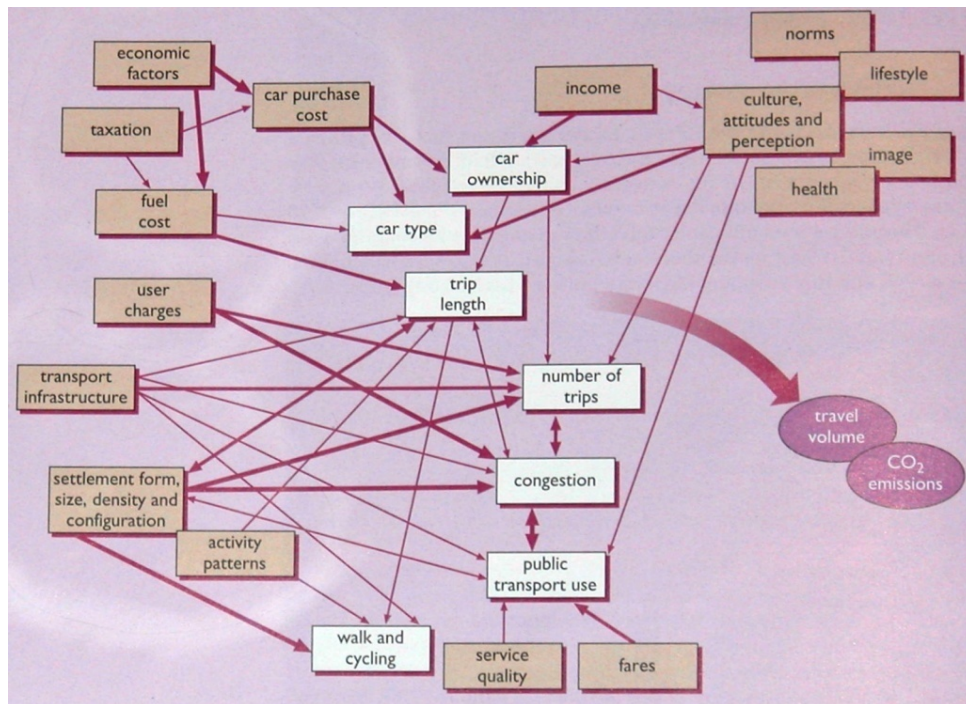


Figure 18 Factors contributing to the complex interactions of travel demand (Warren 2007)

5 Discussion and settings for additional social research

Based on the analysis of former studies as described in chapter 4 the research team within HyFLEET:CUTE decided project to broaden the scope of the social studies according to the former analysis and engage various stakeholders in dialogues about all types of fuel that can

- 1) cut local CO₂ emissions and
- 2) be made from local resources.

Within the WP5.4 a variety in research approaches were also used to reflect the importance of these new wider frames that give the sample or population to connect hydrogen to other types of fuel and transport means, use open ended questionnaires and interviews to establish social preferences in this context. Still the goal was kept unchanged: To dig into the reasoning behind the local opinions and find gaps in knowledge; find issues which are considered important and respond to the public requests for information. The following exercises were carried out to study the grounds further.

5.1 Focus group discussions

The following recount describes a related exercise which was carried out in March 2007 in Reykjavik to follow up the attitudes of young people on alternative fuels and energy questions especially. Students were selected partially because the study is part of the tasks of the University of Iceland within HyFLEET:CUTE and partially to be able to correlate opinions to educational disciplines, political views or profession.

The goal for the research group exercise was to compare to what was had been learned in public surveys in Iceland, also to test this method in a new context. Focus groups are usually used to establish examples of customer preferences of specified products on market and how these selections are substantiated. The general surveys give answers to pre-phrased questions while focus group discussions is more flexible can therefore bring in issues that the participants connect to the given issue.

Methods and Procedure

The focus group method is used mostly to find out preferences within a specified target group. It is often used to assist in formulating marketing strategies, but can be useful as tool to understand how opinions can be connected to the background of customers, what can be

missing in their general knowledge, general assumptions and what influences choices and opinions. The focus group method gives the opportunity to discuss issues in more depth as compared to a questionnaire but still gives indications of opinions that linger within the selected group. Outcomes of focus group discussions should never be generalised as THE public opinion but rather as a collection of opinions that are connected to a specified topic.

The exercise unfolds as a maximum ninety minutes discussion on 3-5 questions in a group of 5-8 people, and facilitated by a person who knows the questions and assists in balancing the group dynamics. One or two persons take notes during the sessions (preferably with a tape recorder) and there are several ways of processing the discussion into a useful report.

For the purpose of this exercise 24 individuals were offered to participate in the exercise, and 21 accepted. No premium was offered but the participants had refreshments and healthy snack during the discussion. Only the young people working in the banking and investing section asked for a premium and only one still accepted to participate in the discussions.

A short description of the focus group method was used as introduction to the organisers. For this purpose a paper from the IZT (Institut für Zukunftsstudien und Technologiebewertung or Institute for Futures Studies and Technology Assessment in Berlin) proved to be helpful²⁴.

The exercise was carried out in Icelandic and therefore only the background frame for the exercise, goals, general descriptions, exercise organization, the questions and the outcomes are reported here and translated to English. The discussion was taped and then transcribed by the operating students. The transcript is approximately 150 pages and is kept at Icelandic New Energy for future references. Two students from the University of Iceland, one from the human geography department and the other a BSc in Biology were allocated the task to organise and contact the selected individuals. They also acted as taking notes during the discussions, write them out word to word and analyse the text.

An expert, with long experience from a consultancy firm, was hired to facilitate the group discussions. The four people involved in the execution were: Kolbrún Georgsdóttir, BSc in Geography, Guðrun Lilja Kristinsdóttir BSc in Biology and the facilitator was Sunna Þorðardóttir, MSc in Geography, consultant at Capacent and an experienced facilitator. Karl

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²⁴ Henseling Christine, Tobias Hahn und Katrin Nolting (2004) *Die Fokusgruppen-Methode als Instrument in der Umwelt und Nachhaltigkeitsforschung* IZT, Werkstattbericht no 82.

Benediktsson, University of Iceland supervised some parts of the research. Maria Maack, University of Iceland/Icelandic New Energy supervised the exercise, set the goals and formulated the questions.

About 50 illustrated pages of information material collected from the Icelandic Energy authority (a public information brochure on alternative fuels and, energy statistic from 2005 and a leaflet with suggested policy from the energy authority to facilitate tests and introduction on alternative fuel on the Icelandic market^{25, 26}) was posted to the participants that had accepted to come. 10 basic questions were added as a fun test for the participants before and after reading the material.

Goals:

According to W5 description the goal of task 5.4 was to get a deeper understanding the public preferences on environmental quality and alternative fuel options. The outcomes should be compared to former studies on public acceptance and become material for interviews on economic tools and policy instruments to facilitate further development of the hydrogen economy. In order to emphasise usable outcomes it was decided to work with a category of people the can become influential in the next generation, namely young energy experts, politicians and academics.

The exercise should produce answers to the following 4 main questions. The following sub-questions were used to facilitate the discussion:

- 1) Was there anything that surprised you while reading the information on the alternative fuels, and why?
- 2) How much of the available local renewable energy (hydro and geothermal) would you be willing to use in power generation in Iceland? For what purpose, in which timeframe? How would you like to see the energy development in this century? Are you willing to sacrifice Icelandic nature-scenery for the purpose of power generation? How much would you be willing to utilize?
- 3) Would you support the use of local energy sources to produce alternative fuels for transport? Does it matter for which purpose the power is generated? Is it important or of no significance if Icelandic society becomes independent and self sufficient for its own fuel needs? How

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²⁵ Barðadóttir Helga, Ragnheiður I Þórarinsdóttir, Agust Valfell: Vistvænt eldsneyti. The material is available in pdf form on the official website of the energy authority:

www.os.is/Apps/WebObjects/Orkustofnun.woa/swdocument/3697/Vistv%C3%A6nt+eldsneyti+kynningarb%C3%A6klingur.pdf

²⁶ Energy statistic of Iceland, 2005, available on the official website of the energy authority in pdf form:

www.os.is/Apps/WebObjects/Orkustofnun.woa/swdocument/3878/Orkut%C3%B6lur+2005.pdf



- important is it that Iceland is in the forefront in research and demonstrations in using new fuels?
- 4) Let us presume that all types of fuel are available and that all technical problems have been solved. Even though we do not agree on a single type of new for transport, we can discuss ways of introducing fuels on the market. Please comment on the following questions: Should new fuels be subsidised? If yes, where should the financial support come from? Should alternative vehicles be subsidised or the fuel? What do you suppose the changes would be if a locally made fuel were to be marketed? Is more public information needed? Which fuel type would you prefer – which choice would you support?

Process

In processing the material the names of individuals in reports (in Icelandic) were changed. The assisting students also noted their general remarks and impressions. Specific attention is paid to things that are common to the groups and what seems to be a fundamental difference in preferences and attitudes, which issues are most frequented, obvious lack of information, some information on the behaviour of the respondents, but the facilitator took care that everybody got their fair chance of talking. At the same time questions from the groups are listed.

Outcomes according to questions

The entire focus group report is to be found in appendix C to this report but here follows a summary of the views collected from all groups for each of the listed question.

Q1 Was there anything that surprised you while reading the information on the alternative fuels, and why?

Summary Q1

The group of experts claimed that the information material had been outdated. The other groups learned many new things.

Fuels are not so much connected to the environmental discussion in Iceland

The general knowledge on alternative fuels is low, except for energy experts,

Q2 How much of the available local renewable energy (hydro and geothermal) would you be willing to use in power generation in Iceland? Facilitating questions: For what purpose, in which timeframe? How would you like to see the energy development in this century? Are you willing to sacrifice Icelandic nature and scenery for the purpose of power generation? How much of the renewable potential would you be willing to utilize?

Summary Q2:

The amount of power from renewable should be correlated to the purpose of the use. Alternative fuels are not familiar in the public discourse, should be presented more. There was a general consensus that aluminum smelters / large energy consumers are not the only choice for creating jobs, either because of the environmental effects or the controversial effects in socio-economics and too much investment in one type of industry. Too high emphasis on socio/political values rather than market dynamics in the decision making was discussed. The largest difference in opinions is more correlated to political agenda than background education.

Market values reoccur in the discussions; Internalization of external costs discussed.

Q3 would you support the use of local energy sources to produce alternative fuels for transport? Facilitation issues: Does it matter for which purpose the power is generated? Is it important or of no significance if the Icelandic society becomes independent and self sufficient for its own fuel needs? How important is it that Iceland is in the forefront in research and demonstrations in using new fuels?

SummaryQ3:

Consensus between groups: Visibility in everyday life is considered the best marketing. Diesel cars and methane cars were more discussed than hydrogen, ethanol or hybrid cars. Too little information is presented to the public on alternative fuel types

Q4 Let us presume that all types of fuel are available and that all technical problems have been solved. Even though we do not agree on a single type of new for transport, we can discuss ways of introducing fuels on the market. Please comment on the following questions: Should new fuels be subsidised? Facilitating questions: If yes, where should the financial support come from? Should alternative vehicles or the alternative fuel be subsidised? What do you suppose the changes would be if a locally made fuel were to be marketed? Is more public information needed? Which fuel type would you prefer – which choice would you support?

Summary:Q4

Young politicians had made up their minds: - economic aspects would rule out hydrogen. Consensus that if the policy is to use alternative fuels then the government should exempt clean vehicles from import taxes charges²⁷. The cheapest and user friendliest infrastructure should win the market. Also that clean fuels should be used in public transportation, public transportation should be made free of charge.

Experience of using focus group method

The focus group exercise was made to learn if this method could give a different insight into the public opinions from those that have appeared in public surveys on hydrogen so far.

This method gives much more flexibility to find out if people have the information required to substantiate their views and make up their minds on the alternatives. Also, if they don't have information, what do people use as backup for their opinions, - their education; political view or environmental awareness, interest?

- *What we learned is that our groups showed little knowledge on alternative fuels, even the level of young energy experts.*
- *That the general media such as national news, international web pages, international news and interviews is a source that is used to form opinions, but not so much educational or information material.*
- *Even when offered as a preparation it is not used, but statements in the media are taken as trustworthy sources of information without critical reflection on the background or eventual interest behind the media presentation*
- *No reference or value set on fuel security – self reliance said to be old fashioned. Low knowledge, little discussion and controversial opinion on using renewable energy to make an energy carrier. The participants lack life cycle insight. Little knowledge on vehicle technology; Lack of info on efficiency in fuel chains;*

Reflections: Alternative fuels have not been put in context to the environmental discourse in Iceland because of the high proportion of renewable energy in the national energy mix. People are more concerned about how much pristine land will be sacrificed for the next power project and look away from the global emissions. This can be seen from the fact that external costs such as cost of pristine land and the internalization of externalities from power plants often

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²⁷ Nobody mentionend that this has already been done by law in 2005.

came up in the discussion. This might reflect a general tendency that economics has more influence in opinion formation than environmental affairs.

The outcomes of the focus group discussions will most certainly influence the way information on hydrogen vehicles and fuel chain will be handled in materials presented to the public.

5.2 2007 semi constructed interviews (HYFLEETCUTE)

A neutral interviewer was bought to the task of conducting semi-constructed interviews with two types of stakeholder groups; A) the early adapters or 9 couples (15 individuals) who are owners of gasoline-battery hybrid cars (made in Sept. 2007 – April 2008). These were selected as having rather high environmental awareness and the purchasing power of following their vision of an efficient and clean technology. The people proved to have varied educational levels, belong to upper middle class, 30 – 50 years old. B) Energy experts that hold powerful positions in society and can influence the governmental policy and the implementation of this. The interviews were conducted in Icelandic but an English summary is as follows. (Oct. 2008, Helga Ögmundardóttir, anthropologist, Institute for sustainable development, University of Iceland.)

Ecologically interested car owners

The project was carried out in Sept. 2007 – April 2008 and funded by the Reykjavík Energy Company Fund for environmental and energy research. It is a part of a bigger study (HyFleetCute and SMART-H2) on the social, environmental and economic implications of a technological transition in Iceland towards a more sustainable fuel use, emphasising locally made fuel that can cut CO2 emissions from traffic; a joint effort by the Institute for Sustainable Development at the University of Iceland and Icelandic New Energy Ltd.

The purpose was to map out people's ideas and visions of a future where alternative fuels were in use and the traditional carbon-based ones had been put aside. Two groups were selected for interviewing; 9 owners of petrol-hybrid vehicles and 8 specialists in the energy/fuel sector in Iceland. Deep semi-constructed interviews were conducted with the participants, recorded and transcribed. Some theoretical and practical background reading was also done to prepare the questions and sharpen the focus of the study. News and other

media were scanned during the research-period and information from several workshops, focus-group meetings and lectures on the topic was also utilised.

In the interviews, people were asked to contemplate on the situation today and then on what kind of a future they would like to see in Iceland and the world in general in terms of fuel use and types of vehicles. They were both asked to describe their personal and professional preferences and to argue for and against the different alternatives the world sees today as the fuels of the future.

People were in general confident that the world would go towards a future with more sustainable fuels and that the solutions would first and foremost be provided by new technologies and mechanisms of the market. It was therefore crucial that the development was not interfered with (e.g. that authorities would refrain from preferring one alternative to another with imbalanced funding and thereby stifling potential developments) and that the inherent nature of these two systems, which will set us on the right track, was given room to grow. The main driving force behind a change taking place was seen as the constant rise of carbon-based fuel prices which would force individuals, governments and companies to seek new alternatives. The world's oil will not be used up and environmental concern or needs will only rank second or even third as primary forces to drive the transition.

Most people saw a hybrid system as the next step and some saw it leading to an electric future, particularly in Iceland since people there are used to its use, plus that it is cheap, convenient and sustainable. Many saw it as an advantage that it is locally produced whereas others said it was not a good thing to stop the import of fuel (or any other goods for that matter) in a world where global trade is seen as a good thing. But the idea of importing biofuels was not attractive to the majority, especially since their production competes with food-production and increases disputes over land. The idea of hydrogen as the fuel of the future placed people in one group of sceptics and another (much smaller) of those who were positive but saw a further technical development as necessary for its general use. A hybrid hydrogen-electricity vehicle was i.e. named as a possible alternative. Hydrogen and methane were mostly considered as potential fuels for fleets, whereas hybrid plug-in vehicles and pure electric ones were the best alternatives for private use.

Table 2 Issues raised in interviews by the ecological interested drivers in Iceland.

Issues listed by ecological drivers	Criteria at purchase of environm. vehicle	Criteria in use of environm. vehicle	Criteria in refuelling	Criteria for future fuel systems
1st criteria	<ul style="list-style-type: none"> •Good impression Esthetics •Curiosity •Interest in technology 	<ul style="list-style-type: none"> •Image – clean conciousness 	<ul style="list-style-type: none"> •As easy as gasoline 	<ul style="list-style-type: none"> •Too high price for oil will drive the development • Safety •Environment second •Access, convenience and familiar know-how in operating vehicle
2nd criteria	<ul style="list-style-type: none"> •Positive image / enviro. image 	<ul style="list-style-type: none"> •Efficiency •proud of participating in pushing for development 	<ul style="list-style-type: none"> •Understandable 	<ul style="list-style-type: none"> •Plug in electricity cars using Icelandic electricity and established grid
3rd criteria	<ul style="list-style-type: none"> •Efficiency 	<ul style="list-style-type: none"> •Space and convenience •Good performance in snow 	<ul style="list-style-type: none"> •Easy access 	<ul style="list-style-type: none"> •Hybrid systems foreseeable •Hydrogen efficecy questioned
4th	<ul style="list-style-type: none"> •Cost 	<ul style="list-style-type: none"> •Too much snob 		<ul style="list-style-type: none"> •Fuel mix •Go for fuel independance without subsidies
Contro-versial	<ul style="list-style-type: none"> •Silent running •Technology •Worse enviro 	<ul style="list-style-type: none"> •Not efficient enough Powerless •More danger of catching lightning 		<ul style="list-style-type: none"> •If Iceland can take own course and should •Vehicles still imported

The interviewees stressed the necessity to have an open mind towards new alternatives. They should not cost too much and preferably become cheaper sooner than later. They stated that even if fuel could be provided locally, cars would always be imported in Iceland and that people there would therefore be dependant on technological development in other areas of the world. The image of a clean and sustainable country is important, though, and should be maintained. They generally saw environmental matters and fuel and energy production as interlinked and any energy production and use would therefore affect the environment in one way or another. Knowledge and spreading of information was important but people would not be willing to change their habits too much; a new technology had to require similar know-how as the old one for people to be willing to adopt it. Cars are an important part of people's self-image and changes in their appearance, use and function could not go in just any direction.

The key-words used by most of my informants were: *development, technology, market* and *progress* and these were seen as rather automatic entities, with inherent qualities and if left in piece, they would lead us into a brighter world.

Specialists (in Energy sector)

When setting up infrastructure for the production and distribution of hydrogen as a clean alternative fuel for vehicles, the operator plans a yearly budget for running the station. These plans are based on a foresight of how the number of hydrogen-vehicles will develop during the following seasons. These plans may be a little optimistic considering low penetration of hydrogen vehicles on the market. But companies who support projects and demonstrations that actually test the available equipment are almost punished for their effort, whereas taxes and running costs are fixed costs for the few produced units that they can sell to customers.⁸ Deep semi-constructed interviews made Sept 2007 – April 2008. University degrees, administration, funding and business 30 – 50 years old; 3 women, 5 men and compared to the outcomes of the January 2008 Workshop of 30 pers. interested in fuel development.

Table 3 topics emerging in interviews with energy specialists on future fuel options. The arrows emphasise conflicts

Issues listed by experts on the future of fuel systems	Criteria at purchase of vehicle	Criteria for selecting new fuel types	Criteria for future fuel systems	How will transition happen
1st criteria	NO new fuel vehicles on market	<ul style="list-style-type: none"> •Security of supply •Price •Efficiency •Locally made 	<ul style="list-style-type: none"> •Price will rule the development 	<ul style="list-style-type: none"> •Let the market have its way •Government must set policy and support energy companies in tests •Clean fuel and vehicles should be less taxed •Best option NOT a political choice
2nd criteria	Convenience Accessibility cost	<ul style="list-style-type: none"> •Depend on international technical trends •Test what scientists recommend 	<ul style="list-style-type: none"> •Environmental factors will influence but not drive •Hybrids for efficiency 	<ul style="list-style-type: none"> •The value of environment and nature should be included in charge •Companies should cooperate in testing new technology
3rd criteria	Environmental concern	<ul style="list-style-type: none"> •Electricity ideal •Hydrogen too low efficiency •Methane too scarce, •Ethanol questionable 	<ul style="list-style-type: none"> •Begin with fuel mix on market 	<ul style="list-style-type: none"> Public movements should inform about all Warn about dubious decisions
4th		<ul style="list-style-type: none"> •Keep an open mind during transition •Clean image good for Iceland •Power production will cost environm. impacts 	<ul style="list-style-type: none"> •Link to the independent locally developed energy system 	<ul style="list-style-type: none"> •Drawback that friends get most funding rather than all ideas.
Controversial		<ul style="list-style-type: none"> •Ethanol not considered a local option / will develop internationally 	<ul style="list-style-type: none"> Energy independence/ Cheaper to import fuel for a small market 	<ul style="list-style-type: none"> Not consensus on taxation to low CO2 emissions. NGOs too negative, supportive discourse lacking Market-direction vs. Technology-direction

5.3 Work shop 2007

There were three workshops held within the frames of WP5 social research. First a small discussion workshop was prepared in April 2007 to test the preparation and the method and see how well the form could be used to outline views. Ten people from the hydrogen operation group and then ten unrelated to the hydrogen project (outside stakeholders) but could master a discussion in English also arrived on invitation. All invited guests accepted the offer and the following comments were collected:

1. Visions of those who attended seemed to be well aligned.
 - All agree that alternative fuels (to oil) need to be found
 - All appear to be in favour of moving toward hydrogen as a transport fuel in Iceland

2. The outside stakeholders have questions about the timeline (when will it happen)



3. All stakeholders have doubts about the commitment of:
 - oil companies
 - car companies
 - the government
4. There are in particular concerns about the lack of H₂ vehicles and questions about when and where they will appear and can cars be made only for Iceland?
5. Stakeholders are concerned about continuity
 - They want to know why the buses were parked or the hydrogen tests ‘were discontinued’ and why the H₂ buses are not kept running
 - Stakeholders wonder why hydrogen is not visible in their everyday life at the same time as Iceland is presented as the world’s first hydrogen economy in the international media
6. Stakeholders want to see more rapid progress
 - Managing expectations is crucial (what will happen by 2020 and how can stakeholders see that it is happening)
7. There is not much discussion of why moving to hydrogen would be good for the environment.
8. Questions arise about the competing technologies such as battery drives, bio-fuels, methane etc.

5.4 Fuel futures, workshops in 2008

In the Appendix D there is to be found the first section of an invitation document to 45 people. This example is a translation from the Icelandic. The document was prepared for a stakeholder workshop that should discuss an extended view on all fuel options for Iceland. The goal was mainly to look at local options to decrease emissions from transport. Through other research it had become evident that the public „outside hydrogen projects had caught interest in all types of fuel and that they see hydrogen only as one option for the future. Therefore the University decided to invite representatives to discuss their vision of the fuel type of their preference in a workshop. The goal was to construct a common local fuel vision; a public input to the discussion on governmental policy on fuel for transport. A professional facilitator Jón Haukur Jónasson was hired to manage the workshop and a group of students selected and prepared reading material for those who accepted the invitation. The students registered the discussions, listed and classified topics and processed the outcomes.

Preparations

Three energy experts suggested 45 eventual participants (hoping for 30 to attend). The following criteria were used to suggest these: Representatives from many layers of society,

interested in societal development, background in social, environmental or economic areas; positioned within known sectors that use fuel extensively, planning personnel, researchers, education developers or regulating bodies. Table 4 gives an idea of these categories, but he representatives should be equally divided in gender and age distribution.

Table 4 the categories of people invited to the fuel workshop in 2008.

Level	Societal role	Technical role	Economy	Environment
Government	Travel and tourism association	Orkusetur Vegagerðin	Central bank	Head of environm committee
Municipalities and community	The city research centre	City and other community technical department	Leader of the agenda 21 (Umís)	Political Opposition HSE inspector
Institutes	Lung specialist at the National research Hospital	Energy Authority Centre of entrepreneurship	Statistical office	Planning and EIA agent Marine and Port authority
Education and research	IR Vocational schools, out of Rvík	Biofuel option – Farmers University college	UoI dep of economy, Techn Uof Rvk	U of didactics Docent for enviro-education
Care users	Consumers association	Car technicians	Automotiver Association	NGO Framtíðarlandið

After this the following communication took place: The invitees were sent a document explaining the following:

- Goal of the Workshop
- Reasons
- List of participants
- Reading material on all types of alternative fuel and the government policy for cutting down CO2

Four rooms were ordered to host the workshop and 3 students plus head of Institute and head of resource departments participated fully in the preparation and processing of the outcomes and organising the material into useful scenarios to set research and demonstratin frames.

Then the invited guests were asked to prepare themselves by writing a few paragraphs that could stand as an imaginary newsflash in the year 2030 on how the last stages of shifting from fossil fuels has been successful in Iceland.

The workshop data was collected on notes that the participants returned in after the workshop, posters where concepts were collected as answers to the list of questions that had been addressed in the various workshop sections.

Summary of issues raised in the workshop

The workshop revealed high interest in the topic, 24 participants showed up from industry, oilsector, carretailers, researchers, power companies, schools and environmental NGOs. The discussion was open and positive and kept on a sensible level by the facilitator. The workshop was very successful, the participants were active and many valuable ideas were compiled, information was exchanged, classified and listed. A list of unanswered questions were collected and an action plan drawn up.

The main conclusion was that similar tests as have been done with hydrogen need to be studied with other types of local fuel and new drive trains. The ideas that attracted most attention were methane, batteries and hydrogen and drive trains that utilize these with the highest efficiency. Participants agreed that it would be preferable to secure fuel types from local sources and even move fast in order to use the experience as material for consultancy within renewable energy systems.



Figure 19 During the fuel vision workshop people showed up from the car industry, research institutes, environmental associations to exchange ideas on fuel and decreased emissions.

Many topics were raised that need further research to give answers to open ends. These research topics were either quantifiable issues such as the amount of energy needed for either hydrogen production or battery charging, whether the electric distribution system could support increased electricity demand to charge vehicles, which changes in traffic and planning would be needed to respond to growing population etc. A list of research topics and a timeline for the research was then formulated for the students of the environment and natural resources. Also these outcomes were sent to the relevant representatives in the energy agency and to the governing bodies that facilitate such the eventual fuel change.

“People were in general confident that the world would go towards a future with more sustainable fuels and that the solutions would first and foremost be provided by new technologies and mechanisms of the market. It was therefore crucial that the.... authorities would refrain from preferring one alternative to another with imbalanced funding and thereby stifling potential developments..”(HÖ)

5.5 Hands on Hydrogen – training course

While organising the societal map of actors one target group was selected as very influential but had not been involved in the hydrogen projects. Therefore a part of the research strategy it was decided to facilitate an alliance with them. The target group is **teachers and technical trainers**.

Already in 2006 contacts were made to the. Electronic training centre in Aalen to find out if it would be possible for them to host a training course run in English rather than German. The Electro Zentrum, Aalen (Southern Germany) specializes in hydrogen electronics. The goal was to invite Icelandic teachers to get acquainted with H₂ technology and experiment in a safe laboratory. The centre organised a course during two weeks in June 2007 and mixed lectures, training exercises and study visits into a practical agenda. The department of continuous education for vocational trainers in Iceland was contacted to assist with the dissemination of the opportunity, the course was promoted in all vocational schools and a travel grant was obtained from the EC supported Leonardo program.

The participants obtained a short introduction presentation and a text book on hydrogen and fuel cell technology in Icelandic before they left. An important assistant, Mr Gunnar Þór Jónsson, who has been working in the FC maintenance shop since the start of the fuel cell bus tests went with the group as an assistant.

After the course the teachers have kept contact and a few fit a short overview of hydrogen technologies into their prospectus.

Hands on Hydrogen was rewarded for innovation and good planning within the Leonardo program , but the real value in the return was the skills that the participants obtained and the later collaboration to support each other after the return.

6 Discussion: Comparison of the effectiveness of all methods, outcomes and development of public views

Since the first hydrogen initiatives were organised in Reykjavik 1999 various approaches have been used to follow the public opinion dynamics. The learned lessons have been used to formulate information for the public, information on the projects and the hydrogen companies. Also, information has been addressed specifically to companies and communities with the aim of helping them to consider cleaner fuel policies. The staff in the hydrogen projects has participated in numerous workshops and conferences on energy, drive trains, emissions and community development. Ideas have been brought to special municipality committees and members of parliament. Presentations about the projects and social studies have been attended by hundreds of tourists and local student and interest groups. No special effort is made to highlight or overrate the virtues of hydrogen, but awareness is rather built up a secondary effect of disseminating general information. **The dissemination is based on what has been found out via social studies and the same grounds is used to communicate with the highly interested international media.**

6.1 Conclusions and suggested further social studies

Public acceptance studies will continue and used as a tool for strategic introduction in new markets. But whether they are helpful in finding out hydrogen's role as a vector to attain sustainability is a different matter. Hydrogen is only one aspect of transport development. Travel and amount of traffic is another. Therefore the GOAL of social studies must be clear before these are undertaken. Too often they have been confined to get answers to similar questions as were posed to the public in a different country.

'Managing Transport Energy' is a collection of studies that rather focuses on the opportunities that can contribute to reach a plausible solution for *transport* in the future²⁸. In this compilation of studies it is firmly pointed out that alternative fuel options will only partially solve the problem of emission and acceptable efficient transport. Figure 18 shows factors that influence management of transport and many of these are of the social

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²⁸ Warren J ed.(2007) , Managing Transport Energy, Power for a Sustainable future, Oxford Press in association with the Open University

nature. These will affect the way hydrogen will be and should be integrated; the question is how this can be done successfully, effectively to cut emissions from transport and efficiently to fit our future budget. Perception, attitude and culture (the issues from the acceptance matrix) are only 3 out of the 19 influential issues.

Within the hydrogen related social research the social dilemmas have simply not been addressed. Perhaps this is because the studies have been made only on hydrogen and hydrogen equipment not on hydrogen and societal development, just taxation to facilitate the mitigation of climate change, technological transfer to transition economies e.g. who and how are we, the industrialized economies going to support sustainable development and mitigate global climate change? Currently it is mostly confined to only using economic tools to install global equity with global economy to save the global environment. But Hydrogen can become an important part of a more renewable economy and perhaps this would be achievable with more integrated research approaches and brave policy measures.

According to the HyWays hydrogen road map for Europe the maximum integration of hydrogen as a fuel vector by 2020 is predicted as only 2%. Until then hydrogen will be in rough competition with gradually progressing efficient fossil fuel systems. Hydrogen driven vehicles will be set aside because other drive types must also have a fair chance, much is left to prove that effective carbon sequestration can be sustainable. The social impacts and efficiency of international biofuels-chains needs to be established, battery-vehicles may be in revival.

Further research

Within the hydrogen related social research many dilemmas have not been addressed. Perhaps this is because the studies have been made only on hydrogen and hydrogen equipment not on *hydrogen and societal development and comparison to other options*. A list of research issues that can give a more complete picture is given below:

- Public response to accidents in all energy systems should be evaluated probably in the focus group form. Accidents have occurred and will occur with oil, gas and hydrogen.

How much cost is invested in safety in each system and what have these influenced the system development?

A list of research issues that can give a more complete picture is given below:

- Integration of real Life Cycle Costs and real technical performance – this means similar studies as the UC Davis has published but connected to efficiency along the fuel chain and real technological performance.
- Research that goes deeper on regional opportunities and how these could be affected by either ‘hydrogenisation’ or development towards biofuels. Connect to local natural resources, demographics, policy concerning sector development, planned land-use, and harmonisation with current social patterns. Such in-dept study can only be done with real interaction with the local population, consultancy with local politicians and workshops, panels etc. A good initiative to develop such a tool is the project CreateAcceptance²⁹
- Comparison of various fuels, their efficiency, cost and not the least their influence on social patterns, need for education, training, preplanning within urban areas etc. This is the most frequent question that is posed by the public.
- In order to draw up a more holistic picture of the role of hydrogen in a sustainable future, various disciplines must unite and undertake more integrated studies and not be afraid of comparing outcomes to other alternatives.
- Assessments of societal impacts such as changes in transport options, effect from new infrastructure on building patterns, need for education and training for the Hydrogen society during the introduction of new fuels has not been issued but enters the discourse within the hydrogen specialist communities.

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²⁹ EC funded project Create Acceptance no 518351 Cultural influences on Renewable Energy Aceptance and Tools for the development of communication strategies to promote E ACCEPTANCE among key actor groups
www.createacceptance.net

- Social research where the data collection and the interpretation is done by sociologists instead of engineers, economists or representatives from the industry is essential. These various disciplines must be involved in the design of the surveys and their interpretation.

Editors' conclusions

Reliable equipment that brings higher comfort or other well appreciated improvements into the public lives' do not need specific introduction – they simply become everyday commodities. A prime example is cell phones. In other cases goods compete in quality or lower prices; goods declarations are intended to inform the customers. In the case of hydrogen and fuel cells, it has been suggested that the public must be educated about the environment, global warming, fuel situation and the market has to be won, even during the time that the oil economy shows little sign of fatigue. A shift in paradigms takes a generation to execute according to Professor Bragi Arnason, University of Iceland („Grandfather hydrogen”) perhaps that is too late, given the current energy outlook and rising demand.

If social research can help to speed up the transition then a good investment is to allocate more into social research, but then the outcomes must be applicable to facilitate a more rapid actions to facilitate new transition to cleaner transport. Hydrogen technologies will quite likely become one of the fundamental vectors of this.

Which role do researchers, politicians or vehicle industry and city planners see in this chaotic transition era for the public? How can the public use the freedom of choice and still move society towards sustainability? This is very much the question of whether research should serve the public or a specific agenda.

The social studies that have been undertaken within the HyFLEET:CUTE Wp5 have been extremely helpful to establish a dialogue with the future end users, normal people that will enjoy the systems that we can bring to optimisation. But the same people also make

demands; strict demands. These can be collected and discussed easily using the methods that have been outlined in this report.

7 Reference list

TAcceptH2 , Full Analysis Report, Comparative Analysis of the Impact of the Hydrogen Bus Trials on Public Awareness, Attitudes and Preferences: Comparative Study of Four Cities, Tanya O'Garra, Imperial College, London, 2005 also: Assessing local situations – London, Luxembourg, Munich/Ottobrunn, Perth, Oakland – WP2, 2003 Online available at:

www.accepth2.com/results/docs/WP2_final-report.pdf, www.accepth2.com

www.accepth2.com/results/docs/AcceptH2_D9_Full-Analysis-Report_050804.pdf

www.accepth2.com/results/docs/WP3_final-report.pdf

Comparative analysis of ex-ante surveys – Berlin, London, Luxembourg, Perth - WP 6, 2004 www.accepth2.com/results/docs/AcceptH2_D6_Preliminary-Analysis-and-Comparison-of-Questionnaire-1-Results.pdf

Alvesson Mats, Kaj Sköldbberg (2000): Reflexive methodology, New Vistas for Qualitative research, Sage Publications Inc

Barðadóttir Helga, Ragnheiður I Þórarinsdóttir, Agust Valfells: Vistvænt eldsneyti. The material is available in pdf form on the official website of the energy authority:

Carbfix project, <http://www.or.is/Umhverfiogfraedsla/CarbFixverkefni/>

Create Acceptance CE project no 518351 (2006 – 2008) Cultural influences on Renewable Energy Acceptance and Tools for the development of communication strategies to promote ACCEPTANCE among key actor groups

Cunningham, J.B. (1993). Action research and organisational development. London: Praeger.

Denzin, N.K., & Lincoln, Y.S. (1994). Handbook of qualitative research. London: Sage.

DOE USA; Christy Cooper, U.S. DOE, Tykey Truett, ORNL, Rick Schmoyer, ORNL, Urvi Parekh, Hydrogen Baseline Knowledge Survey, U.S. DOE/Sentech

Elektro-Ausbildungszentrum Aalen, www.eaz-aalen.de

Energy Authority in Iceland:

www.os.is/Apps/WebObjects/Orkustofnun.woa/swdocument/3697/Vistv%C3%A6nt+eldsneyti+kynningarb%C3%A6klingur.pdf

Energy statistic of Iceland, 2005, Energy Authority of Iceland available on the official website of the energy authority in pdf form:

www.os.is/Apps/WebObjects/Orkustofnun.woa/swdocument/3878/Orkut%C3%B6lur+2005.pdf

ESTEEM – tool: Handbook for stakeholder management, webbased handbook for project managers based on experience from implementing renewable energy Available online at: www.esteem-tool.eu/fileadmin/esteem-tool/docs/ESTEEMmanual.pdf

European Fuel Cell Forum www.efcf.com

Fjölmiðlavaktin – the media surveillance service in Iceland: www.fmv.is

Glesne, C., & Peshkin, A. (1992). *Becoming qualitative researchers: An introduction*. New York: Longman.

Henseling Christine, Tobias Hahn und Katrin Nolting.): *Die Fokusgruppen-Methode als Instrument in der Umwelt und Nachhaltigkeitsforschung* Werkstattbericht no 82.

Howe, R., & Lewis, R. (1993). *A student guide to research in social science*. Cambridge: Cambridge University Press.

Kagoshima Agricultural University: Project to establish the renewable energy prospects and hydrogen for a green island, personal communication Jan, March July 2006 with M. Maack unpublished report.

Kreuger, R.A. (1988). *Focus groups: A practical guide for applied research*. London: Sage.

Linnemann J. & R. Steinberger-Wilckens PLANET—Planungsgruppe Energie, Realistic costs of wind-hydrogen vehicle fuel production und Technik GbR, P.O. Box 4003, D-26030 Oldenburg, Germany

Merton, R.K., Fiske, M., & Kendall, P.L. (1990). *The focused interview: A manual of problems and procedures*. (2nd ed.). London: Collier MacMillan.

Morgan, D.L. (1988). *Focus groups as qualitative research*. London: Sage.

Odgen J, Williams Larson. *Societal Lifecycle Cost of Cars with alternative fuels /engines* Journal of Energy Policy Jan 2004.

Patton, M.Q. (1990). *Qualitative evaluation and research methods*. (2nd ed.). London: Sage.

PEW centre on global climate change, reports from various authors 2001 – 2007. www.pewclimate.org

Sperling D. & J. Cannon eds. (2004) *The Hydrogen Transition, moving towards the post petroleum age in transportation*. Elsevier Academic press, New York

Stern review (2006) on the economics of climate change,

Stewart, D.W., & Shamdasani, P.N. (1990). Focus groups: Theory and practice. London: Sage.

Vergragt, P.; Brown, H.S.(2006) Innovation for Sustainability: The Case of Sustainable Transportation. Online www.tellus.org/publications/Innov_Sust_Vergragt_Brown.pdf

Warren J ed.(2007) , Managing Transport Energy, Power for a Sustainable future, Oxford Press in association with the Open University, London

Wikipedia, www.en.wikipedia.org/wiki/

Yang C. & J. Ogden: Determining the lowest cost H2 Delivery mode, article pending for publication in the International Journal of Hydrogen Energy

EC supported projects with partial social studies: Websites

CreateAcceptance EC funded project no 518351 Cultural influences on Renewable Energy Aceptance and Tools for the development of communication strategies to promote ACCCEPTANCE among key actor groups www.createacceptance.net

HyApproval; HyApproval project: Analysis and comparisons of existing studies, WP 3, 2003 www.hyapproval.org/

Hyways www.hyways.de

StorHy www.storhy.net 2005 (WP E1 og E2)

Roads2hycom www.roads2hy.com/