ENERGY, ENVIRONMENT
AND SUSTAINABLE DEVELOPMENT

ECTOS
Ecological City Transport System
(EVK-CT-2000-00033)

Deliverable no 12

Assessment and evaluation of socio-economic factors

Responsible partner:
University of Iceland

HÁSKÓLI ÍSLANDS

Deliverable 12, ECTOS
Assessment of Socio-Economic factors with emphasis on:
Public Acceptance of Hydrogen as a fuel
Reykjavik 2004
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This report is mainly composed of two sections:

I. Social Acceptance of Hydrogen as a fuel. Translation of a student project that measures the public acceptance of hydrogen as a fuel. It reveals all outcomes of a survey made on board the Hydrogen Fuel cell buses in Reykjavik in 2004. ……Pages 3 -29,

II. Social impacts from ECTOS. Comparisons, conclusions and discussion on social acceptance in Iclenad compared to other places and then social benefits and other influences that have been dected from the ECTOS. ……..Pages 34 - 50

Part I Social acceptance of hydrogen as a fuel in Iceland

Abstract

The outcomes of a questionnaire about Public acceptance of Hydrogen as a fuel, carried out in Reykjavik on the hydrogen fuel cell buses in March 2004, indicate that Icelanders hold a very positive attitude towards the hydrogen tests that Icelandic New Energy and Straeto the Reykjavik city bus company are currently carrying out. Yet, respondents claim that more information needed is for the public. It can also be concluded that in general, Icelanders have a positive attitude towards the idea that oil will be replaced by hydrogen in the future both from this and earlier reports on general acceptance. Passengers on the buses claimed that they might even be willing to pay a higher price for fuel during the first steps of introduction of Hydrogen. The respondents also think that that hydrogen can reduce emissions, being a clean energy carrier, and most people connect Hydrogen with other neutral or positive concepts like 'water' and 'ecolandical fuel'. Most passengers experience the fuel cell hydrogen driven buses to be safe transportation and the majority claim them to be less noisy and less polluting than the more familiar diesel buses. When these results are compared to similar findings in international surveys the Icelanders rank very high on the positive scale for acceptance for hydrogen as an energy carrier[1].

The main results are the following:

- A vast majority of the respondents 92%, claimed to look positively or very positively upon the tests that are now made with Hydrogen as fuel.
- 86% of the respondents claimed to be positive or very positive towards the development of using hydrogen as the main fuel for buses, cars and vessels.
- 36,5% of the respondents say that the price for hydrogen may be set higher than that of oil during the introductory stages.
- 48,5% think that hydrogen is a safe energy carrier
- 45,5% of the respondents claim that the tests have not been introduced enough to the public.

[1] Altman, Schmidt; Mourato, O'Garra: Analysis and comparison of existing studies, final report Aug 2003, Study in the framework of Accept H2; Public acceptance of Hydrogen Transport Technologies, contract ENK 5 CT – 2002-80653 Online available at: www.accepth2.com

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1 Introduction

ECTOS or the project 'Ecological City Transport System[2]' was carried out in Reyikjavik during the years 2001 – 2005. It was sponsored by the European Commission DG 12 Research under the program sustainable develooment and the city of tomorrow. It was the first real scale demonstration project using hydrogen as a fuel in Iceland. ECTOS became a forerunner to similar tests in 10 other cities throughout Europe) called Clean Urban Transportation for Europe (CUTE[3]) and shortly after, similar tests were launched in Perth, Australia and Beijing in China. The 33 tested buses were all of the same type, a Citaro model from Evo Bus, mounted with two 250kw Ballard fuel cells. Within the frames of ECTOS public sureveys were conducted both before the launch of the project and in 2004 wen the hydrogen buses had been running in the public transport system for approximately a year. The buses wer used in normal traffic during one shift a day and were integrated along various buslines according to where trained drivers carried out their shift within their normal driving routines. The buses can cover about 150 km during each shift and after a year in operation the three fuel cell buses had been seen on numerous routes and the driven distance amounted to 65000 km.

Several articles have been published about the general outline of the ECTOS project but the following article describes the public acceptance of this novelty, bearing in mind that hydrogen is made from water and renewable domestic energy in Reykjavik with electrolysis. The fuel tanks were filled every day at a hydrogen fuel station that was inaugurated in April 2003. At the station the public can read in Icelandic and English a brief description of the implications of using hydrogen as a fuel, how hydrogen is made with electrolysis and what happens in a fuel cell when hydrogen is used to make an electric current. The three hydrogen buses carry simple illustrated handouts that passengers can take. The booklet explains in simple Icelandic terms the main components of the national energy system, and the functions of the components at the fuel station and the components on board the fuel cell buses.

The acceptance project was carried out as a Bsc project of three students at the University of Iceland under the supervision of Karl Benediktsson, Prof. Dept of Geography, and María Maack, research coordinator within ECTOS

[2] For further information of other outcmose within ECTOS look up www.newenergy.is
[3] Further information on CUTE: www.fuel-cell-bus-club.com

1.1 Context and limitations

Public transportation only services 4% of the dayly commuters in Reykajvik. During the decades 1960 – 2000 the population in the city grew from 100.000 to 130.000 but at the same time the number of personal vehicles grew by 100% from 20 – 50.000[4] A few issues in the questionnair touch on bus traffic, transportation and environemental issues. A specific feature of the Reykjavik survey compared to similar sureveys from other parts of the world, is the selected emphasis on hydrogen as a fuel and the indication of locally produced fuel. Hydrogen was introduced in Iceland as an energy carrier concept already during the oil price crises in the 1970s. Recently, two other domestinc fuel types have been introduced, biodiesel made from biomass and natural gas tapped of the landfills in Reykjavik Yet, because of low bio-productivity in the country and the reluctance of car retailers to introduce cars using natural gas on this unsignificant market, hydrogen is probably still the most frequent mentioned fuel in the public and academic discource.

The surveys are designed to touche on issues evolving around domestic energy sources, introduction of hydrogen on a large scale and the awareness of the nature of hydrogen compared to other fuels. Fuel cells were not introduced as a particular feature of the hydrogen drive-cycle and therefore the survey may reflect more on the acceptance of shifting to a new type of domesticly made fuel and new energy scenarios rather than a shift to a new drive train tecxhnoloogy which certainly is moe costly thatn the tradictional one.

1.2 Methods

The following section outlines the methods and approaches used for the inspections of attitudes for hydrogen as a fuel. The approach to the data collection will be explained as well as the processing of the outcomes, aspects concerning the responding group and the grouping of the respondents according to gender and age.

1.3 Preparations, implementation, along with justifications and limitations.

Three students put the questionnaires about hydrogen as an energy carrier to passengers on board buses in Reykjavik in March 2004. The students prepared the questionnaires with assistance from Maria Maack at Icelandic New energy and docent Karl Benediktsson, head of department of Geography at the University of Iceland. Mrs Maack gave a list of the issues she wanted to be the focus points of the questionnaires. Further design and formulations were done

[4] Samgönguráðuneytið 2001, Losun Gróðurhúsalofttegunda frá Samgöngum, skýrsla til undirbúnings stefnumótunar (Icelandic Ministry of Transport: GHG emissions from trafic, 2001)

in collaboration within the group. The students then presented the list of 10 questions to 200 people in Reykjavik during one week. The respondents could choose between filling out the form themselves or to have the students read the questions and have them to mark the selected answers for the respondents. This is done in for a two fold reason the first is to save time. Most rides in the Reykjavik buses only take 10 – 15 minutes and therefore the approach of using a facilitator to help the respondents may be interpreted as using gentle force to achieve responces to the entire list. Secondly the reason is that it had been reported from similar setup that putting the questionnaire inside the Fuel Cell buses and rely on volounteers to go through similar questionnaires had not given good reponse-yield. Also, if the passengers had questions or comments then the students wrote these down and offered an information brochure about the hydrogen projects, which actually have been presented in the Hydrogen buses from the beginning of the drive tests.

The questions were posed only to passengers within the public transportaion system, neighbours to the fuel cell bus routes and pedestrians in the city. It is therefore not evident that the sample incorporates representatives frpom all key groups within the society..

The list of questions is shown in table 1. Passengers were asked what their attitude is towards the tests of running hydrogen buses and what people think about hydrogen as a substitution for oil products. Also what they felt about hydrogen and safety, prices for fuel and what comes into their mind when hydrogen is mentioned. Also the questionnaire touched on noise and pollution in the same context.

Two of the questions were formulated differently according to the specifically addressed key groups, although the theme should be comparable. In connection with the surveys on board the buses 50 neighbours to the hydrogen bus routes and 50 pedestrians were selected as specific target groups.

The questionnaires were put to 50 passengers on the hydrogen buses, 50 passengers on diesel buses on the same route, 50 people on the street near to bus stops and 50 people that live closely to the main bus routes where the FC Hydrogen buses have been tested. The answering rates were fairly good but in a few instances on the buses the passengers claimed to have too short time on the bus before they had to go out for their stop – often to take a second bus. It was also quite evident that neighbours in apartment blocks resisted answering the questionnaire while people in villas that stand close to the routes were much more willing to respond the questions.

Table 1.2 the questionnaire and the multiple choices

1. A test with hydrogen buses is now going on in Reykjavik. What is your reaction to that?	Very negative	Negative	Don't care	Positive	Very positive
2. Do you notice the hydrogen buses in traffic?	Never	Very rarely	A few times	Often	Frequently
3. What do you think of the sound inside the bus?	Very noisy	Noisy	I don't notice	Silent	Very silent
3. **Neighbours and people on the street:** How severe is noise from traffic in Reykjavik?	Very severe	Severe	I don't notice	Small	Negligible
4. What do you think of the bus exhaust at the station?	Very polluting	Polluting	I don't notice	Small	Insignificant
4. **Neighbours and people on the street:** How severe do you find pollution from traffic in Reykjavik	Very severe	Severe	I don't notice	Small	Negligible
5. Do you approve or disapprove of the development that hydrogen should replace oil as the main fuel for buses, cars and vessels?	Disapprove greatly	Disapprove	Don't know	Approve	Greatly approve
5.b Why?					
6. Presumably the price for hydrogen will be more expensive as a fuel than oil. Which price would you settle for?	Must be 20% cheaper	Must be 10% cheaper	Same price	Accept 10% higher price	Accept 20% higher price
7. Do you think that hydrogen is a safe energy carrier?	Very unsafe	Unsafe	Don't know	Safe	Very safe
8. What do you connect with the word Hydrogen?	Burning Zeppelin	Expensive techno Andy	Water	Local production	Clean fuel
8. b – your own additions to the list					
9. How well has the Hydrogen test been presented for the public?	Very little	Little	Have not noticed	Well	Very well
10. What would like to know or add concerning Hydrogen?					

1.4 Processing

The responses to most questions were divided between 5 choices or multiple outcomes. In general what can be called negative attitudes where kept on the left side, neutral or zero solution in the middle and positive responses on the right. This is done even though some recommend to vary the outline for positive and negative attitude so that the respondents have to use their whole attention to go through the list of questions and ansers. The software SPSS was used to categorize and correlate the answers. The following discussion is based on graphs that were drawn from the outcomes of each question. A few open questions were also posed and the answers are exposed in simple lists and frequencies.

1.5 Traits within the group of respondents

Figure 1.1 shows that 50,5% of the respondents was men and 49,5% was female.

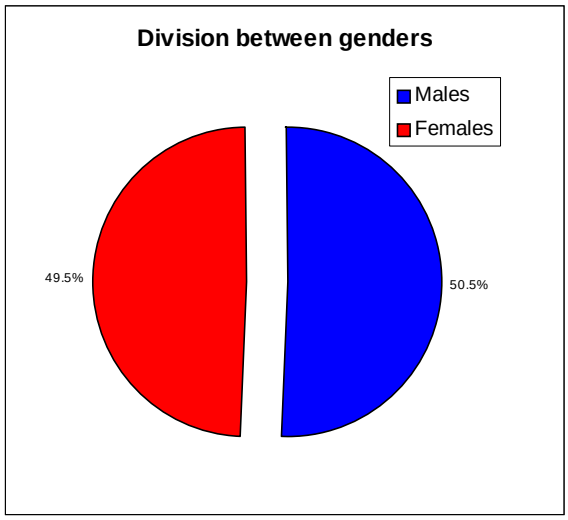


Figure 1.1

The largest age group or 82% were 16-65 years old; thereof 16-25 years old composed 33% of the total responding group. The spread between the various age groups is shown in table 1.2.

Table 1.2 Division according to age groups

Age group	Number	Frequency %
<15	6	3,0
16-25	66	33,0
26-45	56	28,0
46-65	46	23,0
>65	26	13,0
Total	200	100,0

The interviewees were not asked for their address but it is assumed that most of them live in the Reykjavik area.

2 The questions and responces

Each section repeats a question from the questionnaire and prestnes the relevant responses

2.1 A test with hydrogen buses is now going on in Reykjavik. What is your reaction to that?

In most cases, or 92%, the respondents commented positively about the test (table and figure 2.1.1). 59,5% marked very positive and 32,5% positive. Only 2% of the respondents commented negatively on the tests and 7% commented that they had no reaction. This indicates that in general the Icelandic public is highly positive towards tests with hydrogen. Whereas nobody replied having very negative attitude towards the test then that option is not shown in the figures.

When the results are correlated to the background of the target groups, then all age groups comment to have positive attitude towards the tests. It does not matter whether the passengers are asked on board hydrogen or diesel buses. If tendencies can be highlighted then the passengers on the hydrogen buses may yet be a little more positive. The majority of neighbours to the bus routes also claimed to be positive towards the tests. The only ones that more often claim to be positive and not very positive are the people on the streets see figure no 2.1.2.

Very little difference shows between the various age groups. Yet, the two youngest age groups 15 -25 and 26-45 years are those who score highest in the column very well. In age group 46-65yer the division is more equally spread between well and very well. Those who are older that 65 years are positive but less enthusiastic if that expression is accurate in the context. See figure 2.1.3.

Table 2.1.1 a test with hydrogen buses is now going on in Reykjavik. What is your reaction to that?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Negative	2	1,0	1,0	1,0
	No reaction	14	7,0	7,0	8,0
	Positive	65	32,5	32,5	40,5
	Very positive	119	59,5	59,5	100,0
	Total	200	100,0	100,0	

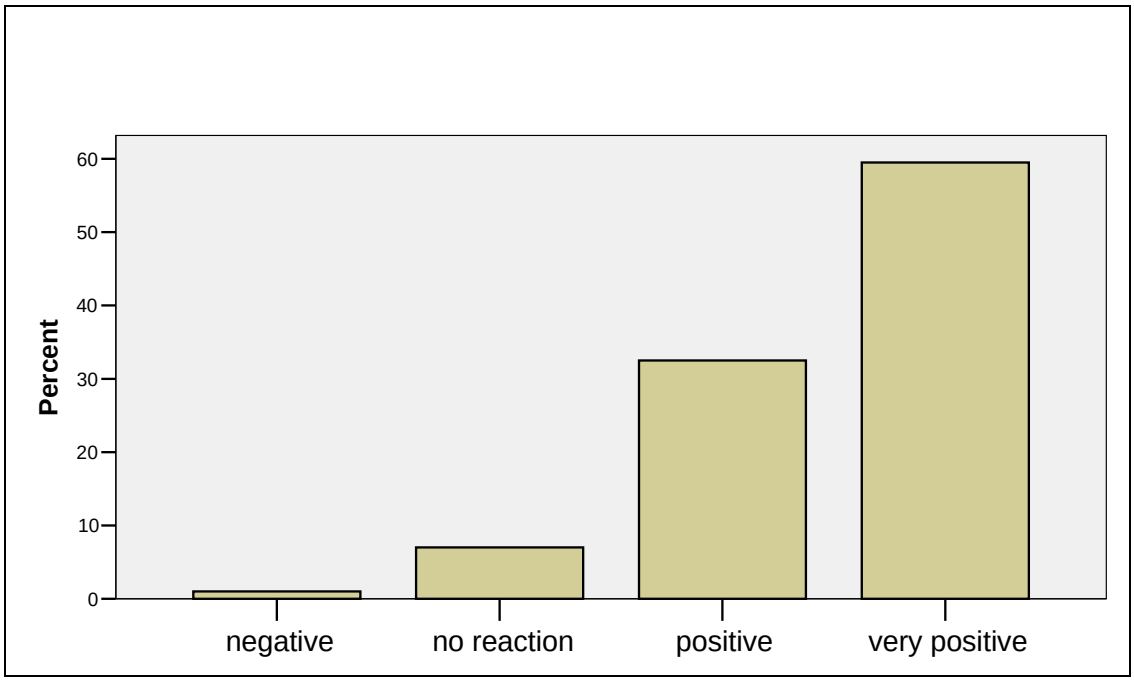


Figure 2.1.1 a test with hydrogen buses is now going on in Reykjavik. What is your reaction to that?

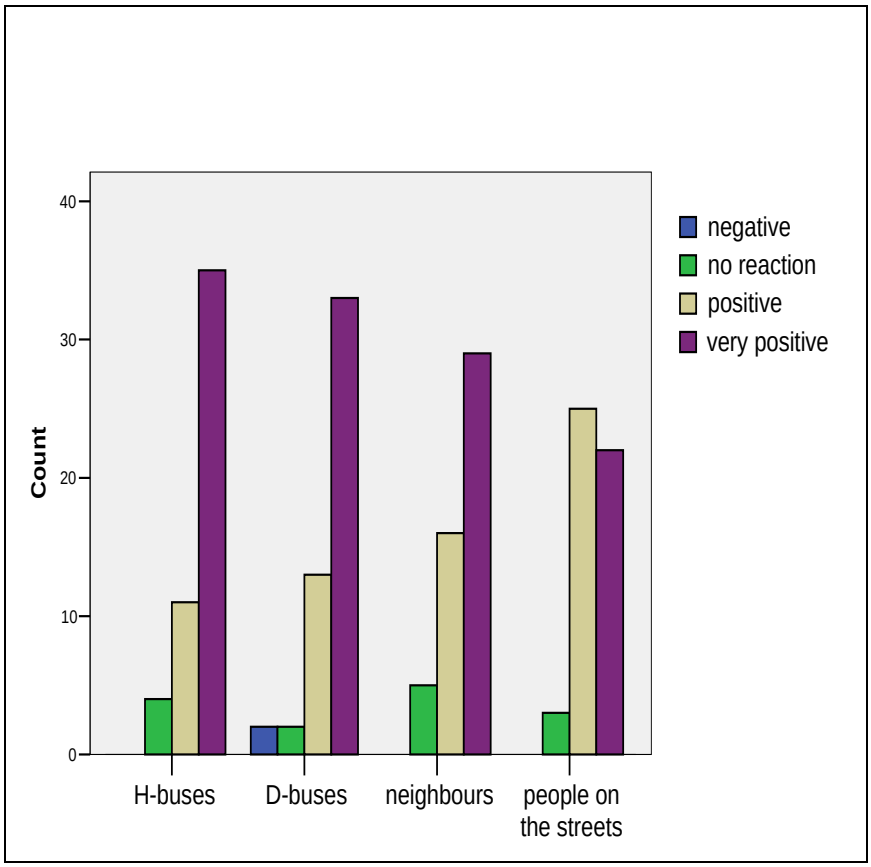


Figure 2.1.2 Distribution according to location of respondents

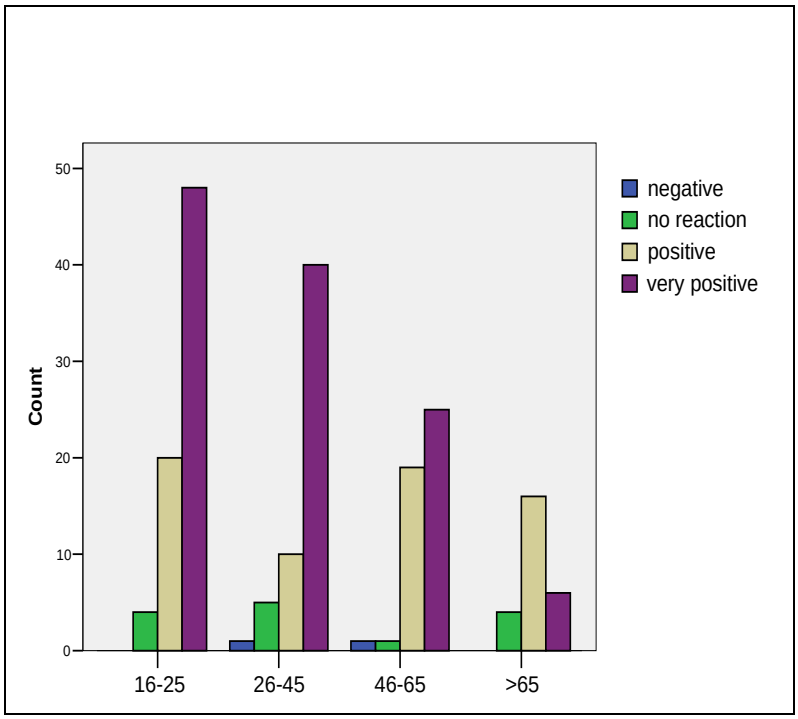


Figure 2.1.3 Distribution according to age

2.2 Do you notice the hydrogen buses in traffic?

Nearly half of the respondents or 47% claims to notice the buses one in a while, see table and figure 2.2.1. The portion that claim to notice the buses often is 17,5% and very similar to the portion that claim to note them very seldom, 18,5%. The portion that claimed never to have noticed the buses in traffic was 12,5%. The smallest portion of the respondents claimed to have seen the buses very often or 4,5%. Therefore most frequently people notice the buses one in a while. There is no difference detectable according to age, gender or location of the respondents.

able 2.2.1 Do you notice the hydrogen buses in traffic?

Valid	Frequency	Percent	Valid Percent	Cumu-lative Percent
Never	25	12,5	12,5	12,5
Very rarely	37	18,5	18,5	31,0
A few times	94	47,0	47,0	78,0
Often	35	17,5	17,5	95,5
Very frequently	9	4,5	4,5	100,0
Total	200	100,0	100,0	

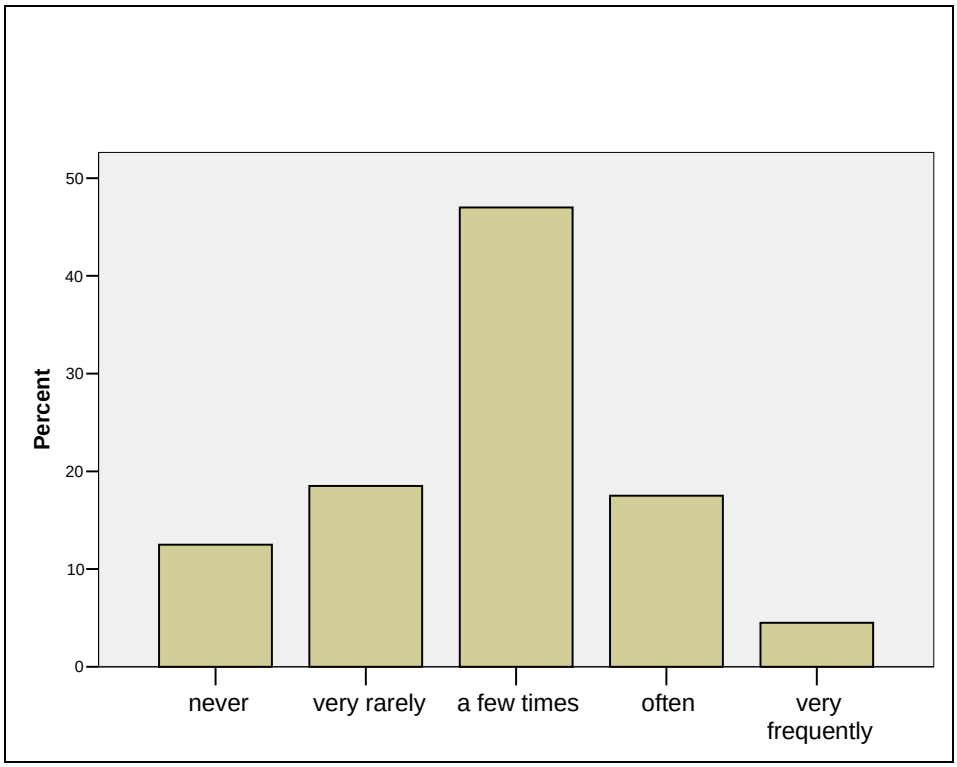


Figure 2.2.1. Do you notice the hydrogen buses in traffic?

2.3 Do you approve or disapprove of the development that hydrogen replaces oil as the main fuel for buses, cars and vessels?

In total 86% of the respondents claimed to be either positive or very positive towards this issue. The results are shown in table and figure 2.3.1. Of those 48,5% were very positive and 37,5% positive. Those who took a neutral stand were 11,5% of the whole group. Rather negative were 2% and negative 0,5%. The responses indicate again that a good majority looks upon the development of hydrogen technology in a positive way.

It is obvious that the youngest group, 15-25 years, is the part that rates highest in the positive section. In the oldest age group people are more reserved and rather claim to approve rather than approve highly of the idea that hydrogen takes over the role of the main fuel. The two youngest age groups also mark more often for neutral stand than the older age groups. In all age groups the choices approve and approve very much, still pull the most respondents as shown in fig 2.3.3.

Comparing the results from the three target groups the people in the street rather mark for improvement than great improvement. It is interesting, how many passengers on the hydrogen bus take a neutral stand, see figure

Table 2.3.1 Do you approve or disapprove of the development that hydrogen replaces oil as the main fuel for buses, cars and vessels?

Valid	Fre-quency	Per-cent	Valid Per-cent	Cumu-lative Percent
Disapprove	1	, 5	, 5	, 5
Rather disapprove	4	2,0	2,0	2,5
Neutral stand	23	11,5	11,5	14,0
Approve	75	37,5	37,5	51,5
Approve greatly	97	48,5	48,5	100,0
Total	200	100,0	100,0	

Figure 2.3.1 Do you approve or disapprove of the development that hydrogen replaces oil as the main fuel for buses, cars and vessels?

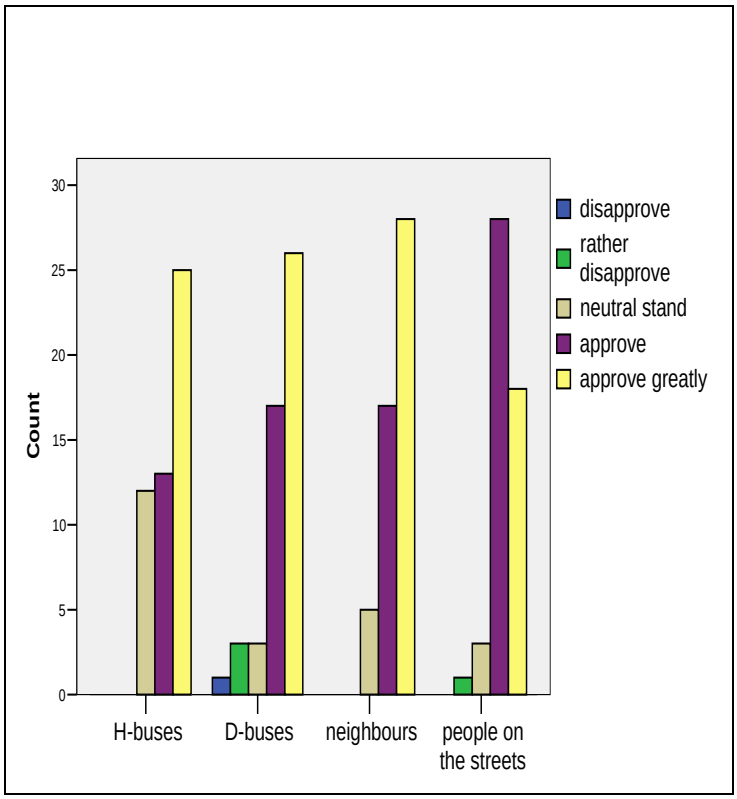


Figure 2.3.2 Division according to situation

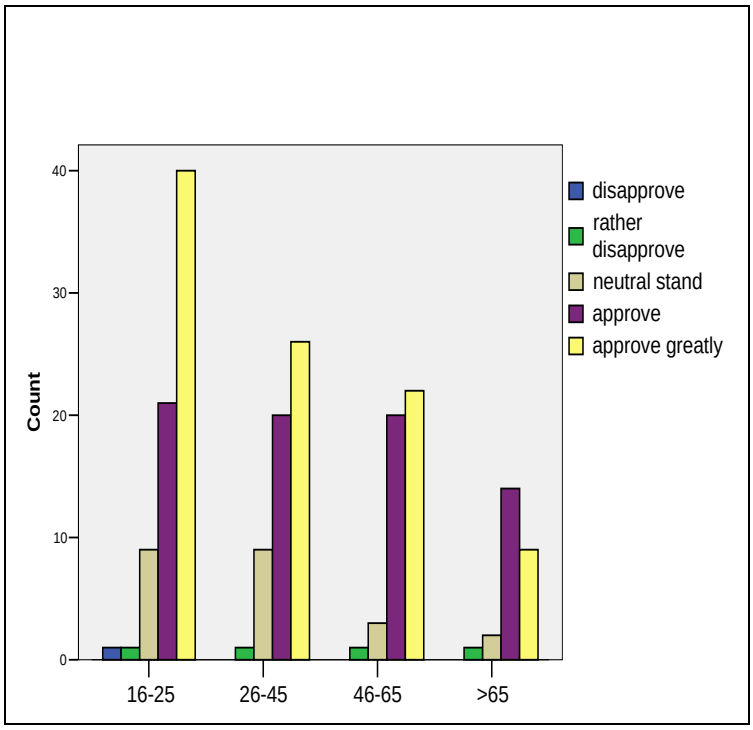


Figure 2.3.3 Division according to age

2.3.1 the respondents´ reasons

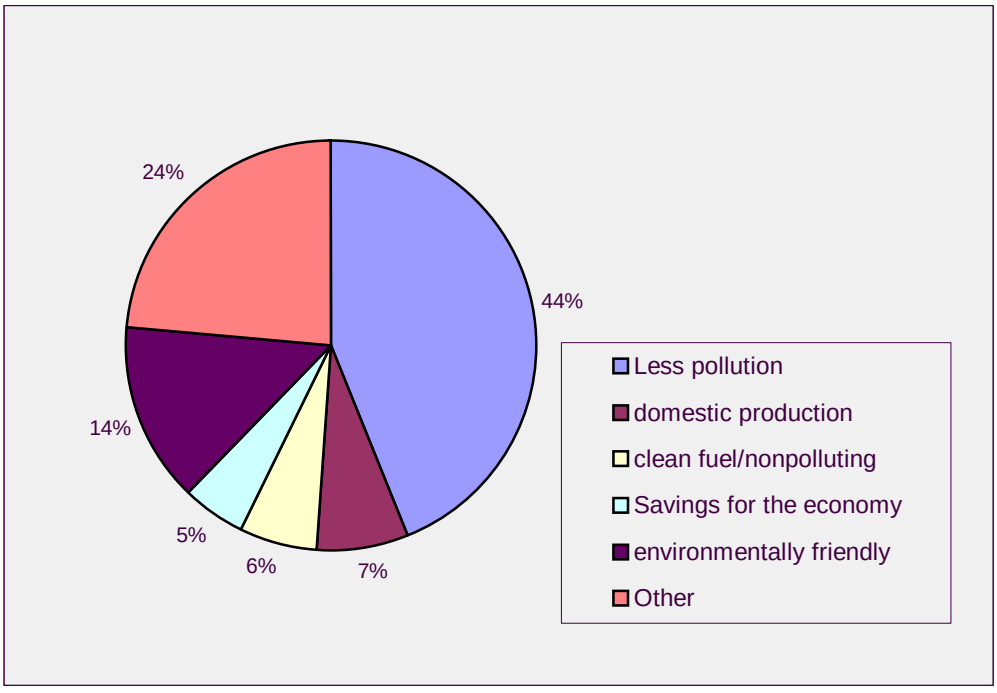


Figure 2.3.1.1 Listed reasons

People were given the opportunity to support their opinion stated in question no 5. Either the respondents could suggest a reason for their stand, or choose from a short list of options. The options were: Less pollution, domestic production, and clean energy carrier, savings

for the national economy, environmentally friendly, other. Of those that approve of the hydrogen development then the largest section claimed their reasons connected to the effects of energy use on the environment. This is more than 50% of the total responding group. To name a few other issues that people selected was domestic production and savings of import. The distribution between options is indicated in Figure 2.3.1.1 and tables 2.3.1.1 and 2.3.1.2 show the compiled list of the answers from the option 'other '.

Table 2.3.1.1 Listed reasons given by the respondents for approving the development of hydrogen technology

Approve & give own statement that concerns the environment	**Approve & give statement that does not concern the environment**
*Nature preservation (6) *Better (6) *It is the future (5) *Natural resources are restricted (4) *Less noise (3) *Natural development (3) * A clever choice (3) *Less climate impact (2) *Renewable fuel (2) *Less emissions (2) *Comfortable buses (2)	„A step in the right direction even though very much work still remains to be done." „I don't like the oil companies" „Save oil and use it to make plastics." „Higher equity of the distribution of wealth in the world." „The Icelanders then need not to participate in an oil war in 10 years time" „This all sounds so organic"

24% marked the option 'other reasons' in Figure 2.3.1.1. These respondents took an initiative to give their reasons before they were offered the other options given in the questions.

Those who disapprove the development of hydrogen as the main fuel support their answers with the following statements:

Table 2.3.1.2 Listed reasons given by the respondents for disapproving the development of hydrogen technology

„Former experience from Russia shows that there is risk of explosions"
„There are more energy carriers than hydrogen"
„Experience is lacking"
„I do not the want the other fuel types to disappear."
„The power in hydrogen cars is less."

2.4 Presumably hydrogen will preliminary be more expensive as a fuel than gasoline. Which price would you accept?

It should be noted that no attempt was made to explain the correlation between fuel cells efficiency versus internal combustion engines, energy contents pr. volume etc. Therefore it is

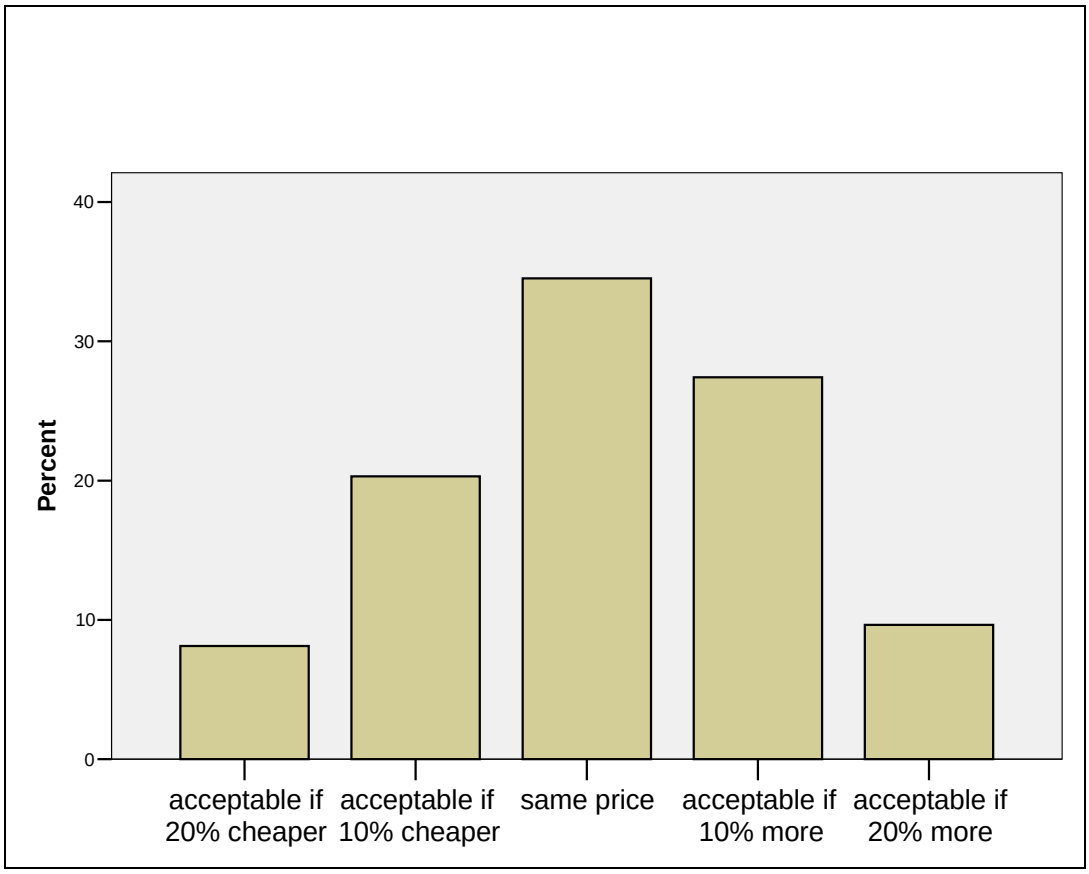
assumed that people are only considering the cost of the service delivered by the fuel. They should be comparing the cost of travelling on hydrogen compared to travelling on gasoline.
34% of the respondents claim to accept the same price for hydrogen and gasoline refer to table and figure 2.4.1. In total 36,5% respond that to begin with hydrogen may be higher but 28% want hydrogen to be less expensive to begin with. Of those who claim to be willing to pay higher price then 27% would accept 10% higher price and 9,5% to pay up to 20% higher price during the introduction of hydrogen as a fuel. The largest portion of those who want hydrogen to be less expensive, then 20% want it to become 10% less expensive and 8% that it will be 20% cheaper. Those who would not take a stand were 3%. It is complicated to interpret figure 2.4.1 whereas the reasons for the answers are not evident. Yet those who claim to accept higher price for hydrogen are a little more numerous than those who want it to be cheaper.

The attitude towards the price of hydrogen is divided between the target groups in the following way: Passengers on board the buses rather claim that hydrogen should be as expensive or cheaper that gasoline and several were worried that the hydrogen usage would render the bus fares more expensive. The people on the street and the neighbours to the bus routes would rather accept higher prices for hydrogen. It is evident that most bus passengers wanted hydrogen to be the same price as gasoline, see figure 2.4.2.

There is very little difference between the genders towards the issue of prices for fuel. Yet, men are a little less hesitant to either accept higher prices or demand lower prices. Figure 2.4.3.

Table 2.4.1 Presumably the price for hydrogen will be more expensive as a fuel than oil. Which price would you accept?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	acceptable if 20% cheaper	16	8,0	8,1	8,1
	acceptable if 10% cheaper	40	20,0	20,3	28,4
	same price	68	34,0	34,5	62,9
	Acceptable if 10% more	54	27,0	27,4	90,4
	Acceptable if 20% more	19	9,5	9,6	100,0
	Total	197	98,5	100,0	
Missing	System	3	1,5		
Total		200	100,0		



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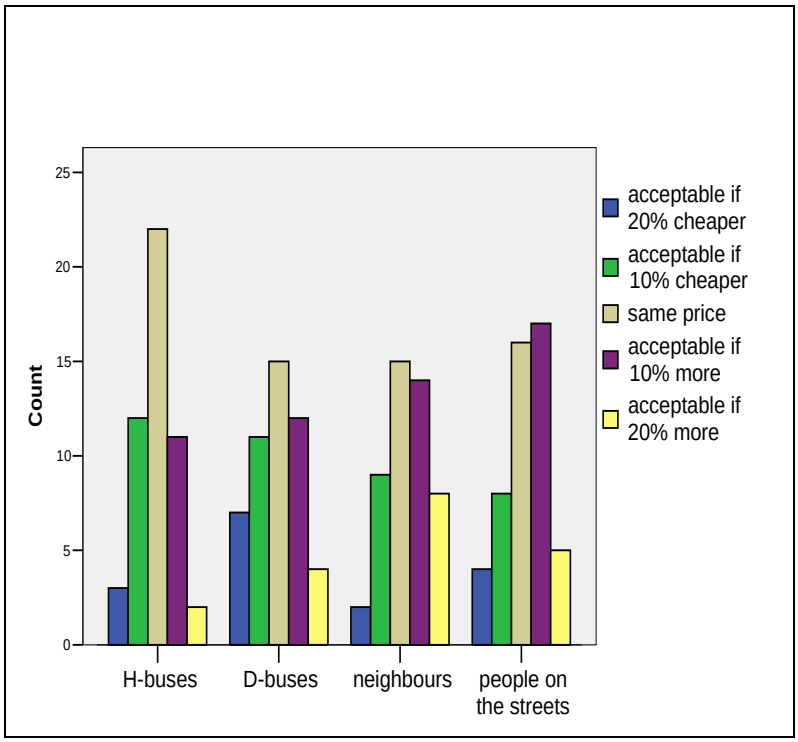

Figure 2.4.2 Distribution according to placement

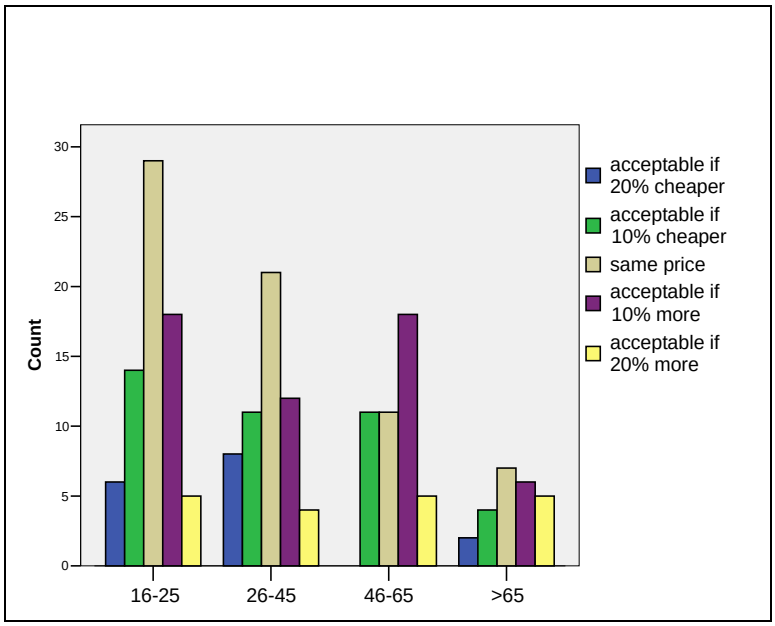

Figure 2.4.3 Distribution according to gender

2.5 Do you think that hydrogen is a safe type of fuel?

Almost 50% of the respondents claimed not to know if hydrogen is a safe fuel. (Table and figure 2.5.1.) 39,5% thinks that hydrogen is safe and 9% very safe energy carrier. On the contrary 2,5% regard hydrogen as unsafe or very unsafe fuel. Yet 48,5% of the respondents regards hydrogen to be a safe or very safe fuel. An outcome indicating that almost 50 % of the respondents' marks for

don’t know about the safety of hydrogen indicates that this issue should be made a specific topic for public information.

Considerably more women than men claim not to know whether hydrogen is safe or unsafe. Also the younger generations claim the same thing, see figure 2.5.2. And figure 2.5.3

Table 2.5.1 Do you think that hydrogen is a safe type of fuel?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very unsafe	1	, 5	, 5	, 5
	Unsafe	4	2,0	2,0	2,5
	Don’t know	98	49,0	49,0	51,5
	Safe	79	39,5	39,5	91,0
	Very safe	18	9,0	9,0	100,0
	Total	200	100,0	100,0	

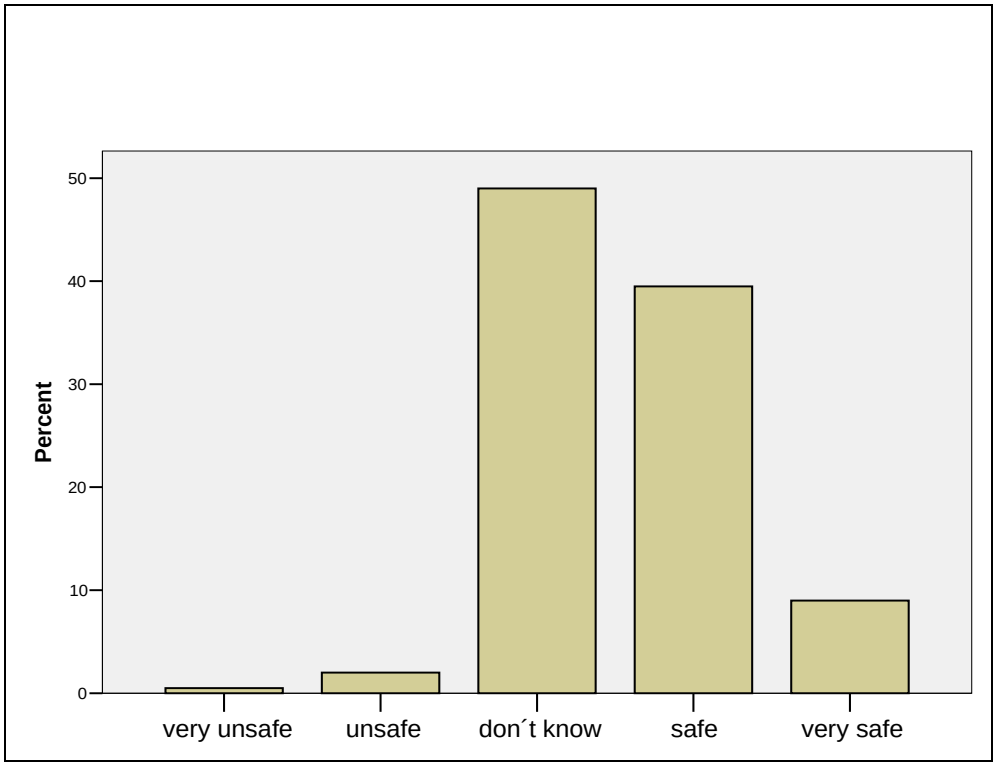

Figure 2.5.1 Do you think that hydrogen is a safe type of fuel

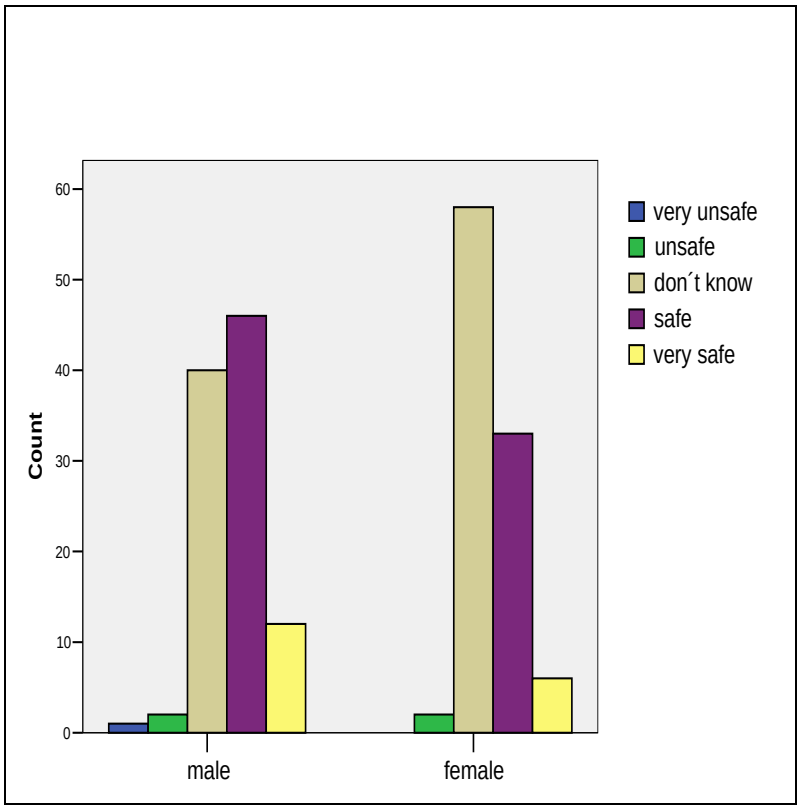

Figure 2.5.2 Distribution according to gender

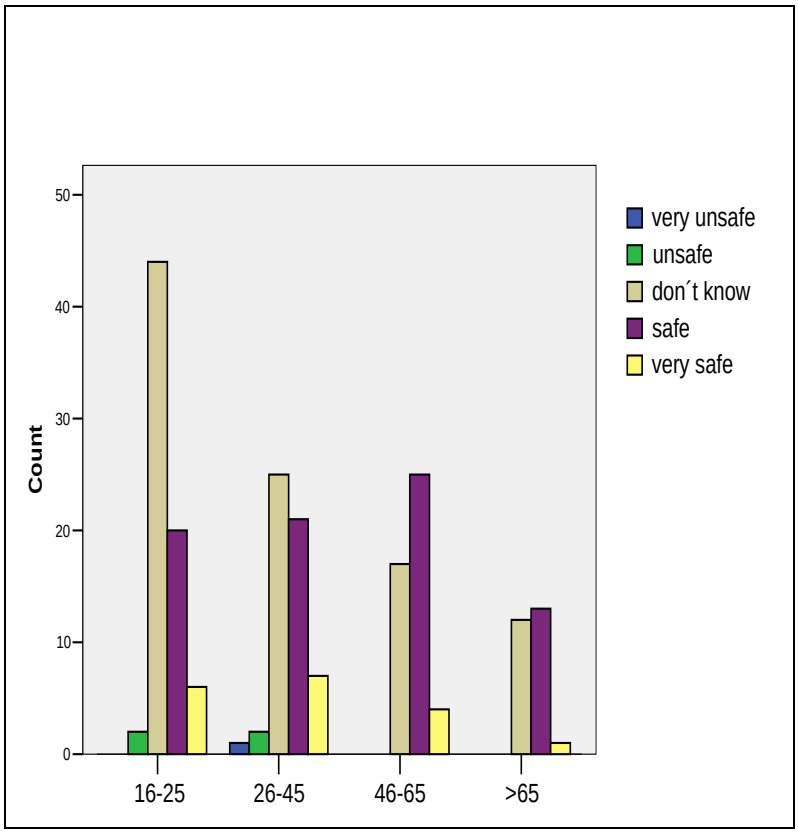

Figure 2.5.3 Distribution according to age

2.6 What do you connect with the word hydrogen?

In this question the respondents were asked to mention the concept that they link with hydrogen. Five options were given as indicated in the list of questions. 47% of the respondents connect hydrogen with clean fuel, and second most frequent correlation was to water, or 38,5% see table and figure 2.6.1. In all groups only 8% chose domestic production which is yet far more than those who chose burning zeppelins; 2% and 3% who linked hydrogen with expensive technology. Those who did not answer were 3%. These outcomes still indicated a positive reaction towards hydrogen. The public preferably links hydrogen to water, they know it is environmentally clean.

Analysing the responses according to gender gives show that women mostly connect hydrogen with clean fuel and men with water, see figure 2.6.2.

The youngest age group connects hydrogen in most cases to water, but in the older age groups the connection is most frequently to clean fuel. The majority of those who mentioned domestic production come from the older age groups but youngsters rather name water and clean fuels, refer to figure 2.6.3. This indicates that the older generation is more aware that hydrogen can be made in Iceland.

Table 2.6.1 what do you connect with the word hydrogen?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Burning Zeppelin	4	2,0	2,0	2,0
	Expensive technology	6	3,0	3,0	5,1
	Water	77	38,5	39,1	44,2
	Domestic production	16	8,0	8,1	52,3
	Clean fuel	94	47,0	47,7	100,0
	Total	197	98,5	100,0	
Missing	System	3	1,5		
Total		200	100,0		

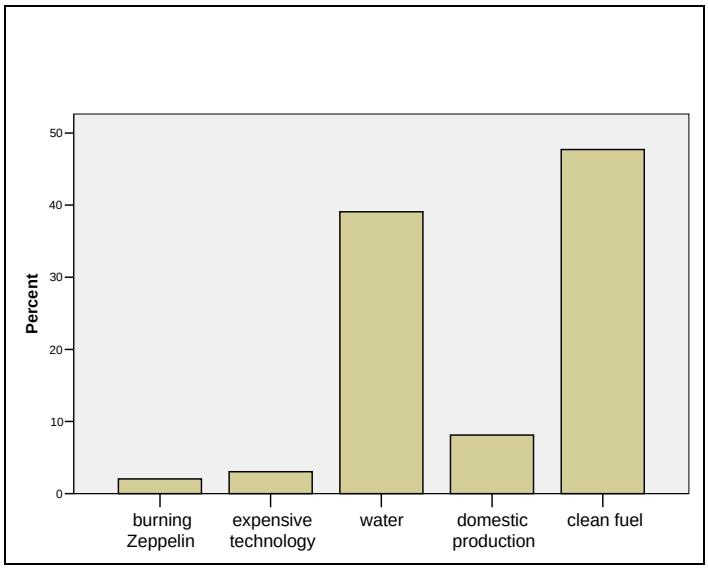

Figure 2.6.1 what do you connect with the word hydrogen?

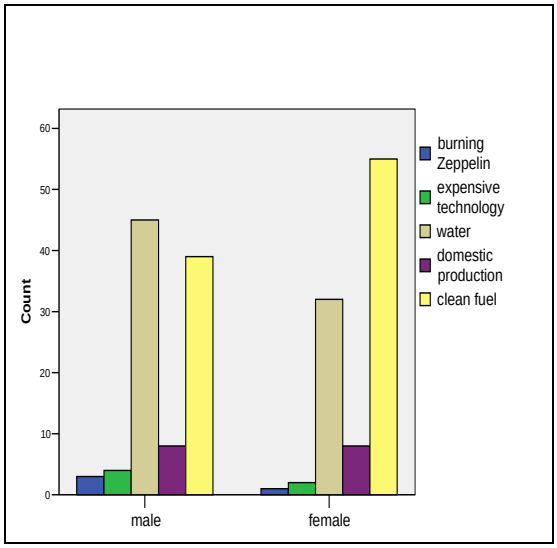

Figure 2.6.2 Distribution according to gender

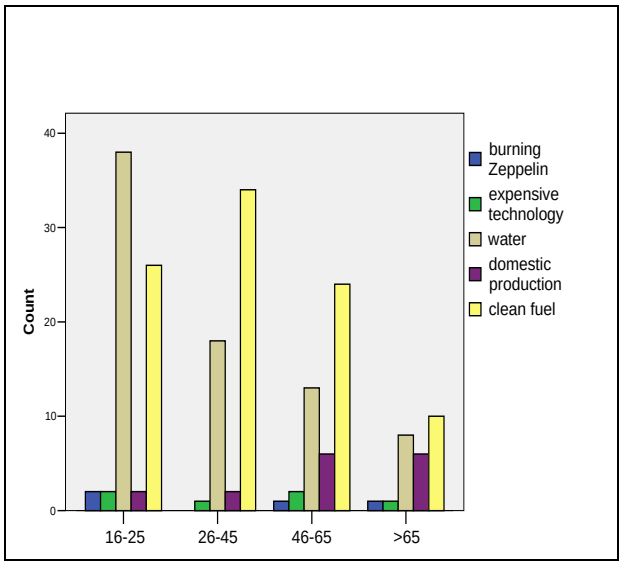

Figure 2.6.3 Distribution according to age

2.6.1 Other things that the respondents suggested

The questionnaire also gave the respondents the opportunity to suggest their own concept that they connect to hydrogen.

*Danger of explosions /bombs
*Water
*Steam
*Flammable gas
*Profesor Bragi Árnason
*Power stations and hydro dams
*Good fuel
*Domestic production
*Chemistry
*Environmentally clean fuel
*Expensive technology

2.7 How well do you think the experiments have been presented to the public?

The largest group of respondents or 45,5% claimed that the tests had been little or very little presented to the public as indicated by table and figure 2.7.1. Thereof 38,5% stated little presented and 7% very little presented. Yet on the other hand 39,5% claimed that the test have been well-presented and 4% very well. Those who claimed not to have noticed the test amounted to 15%. The information to the public therefore gets a low rating by 60,5% of the respondents.

The men are in majority of those who say that the hydrogen tests have been well presented to the public but women are in majority in the group that mark for little dissemination. The difference is very clear. See figure 2.7.2.

The youngest age group is the one that most frequently claims not to have noticed the tests with hydrogen see figure 2.7.3.

Table 2.7.1 how well do you think the experiments have been presented to the public?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very little	14	7,0	7,0	7,0
	Little	77	38,5	38,5	45,5
	Have not noticed the tests	30	15,0	15,0	60,5
	Well	71	35,5	35,5	96,0
	Very well	8	4,0	4,0	100,0
	Total	200	100,0	100,0	

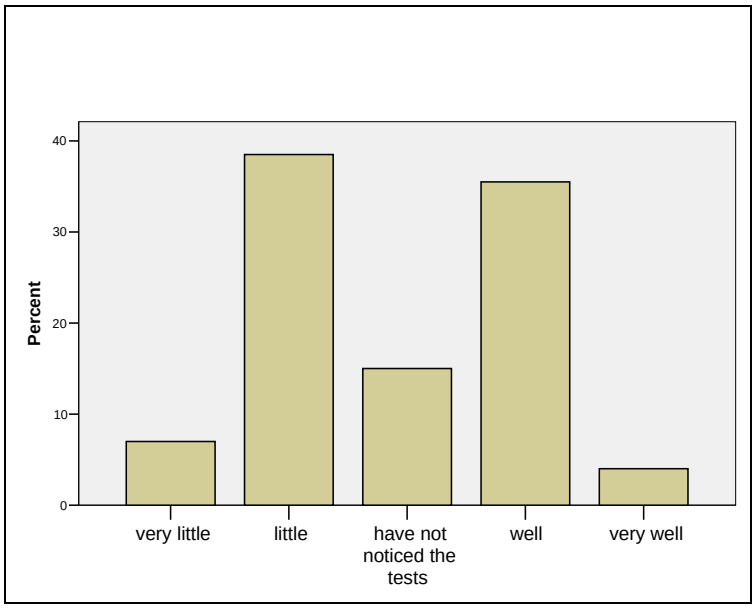

Figure 2.7.1 how well do you think the experiments have been presented to the public

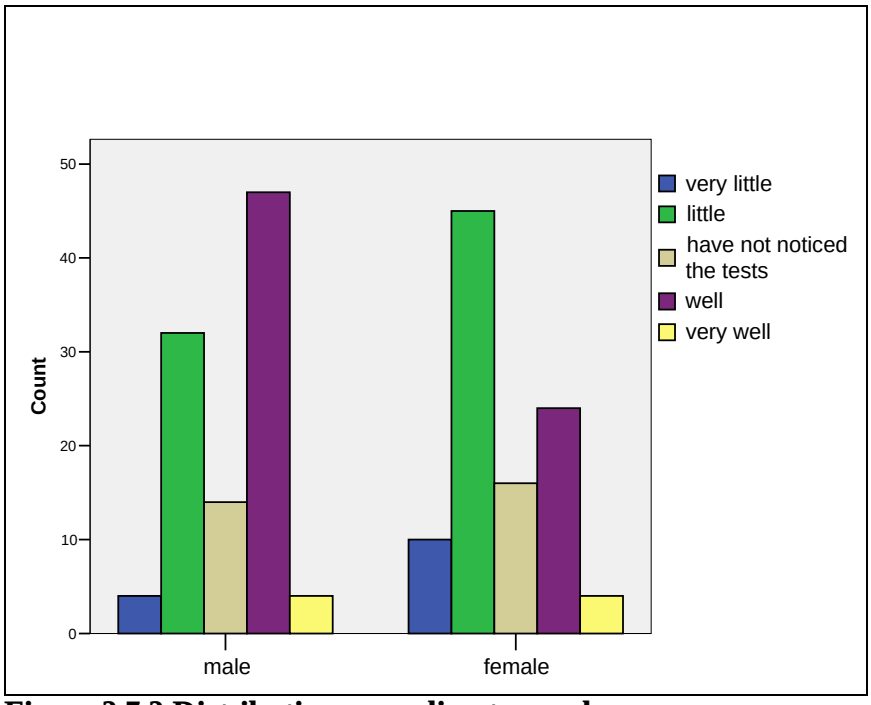

Figure 2.7.2 Distribution according to gender

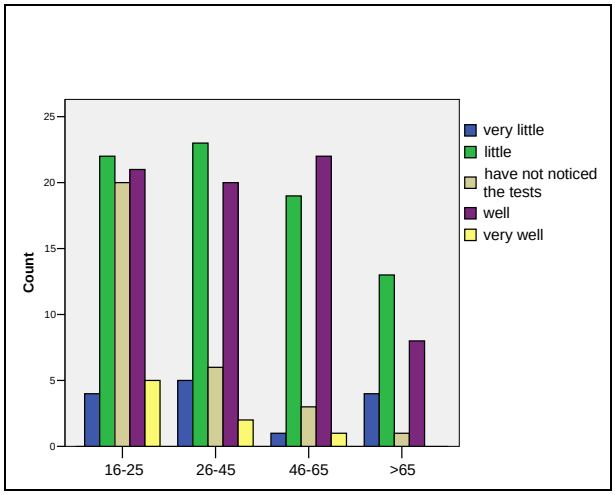

Figure 2.7.3 Distribution according to age

2.8 Is there anything you would like to know or comment concerning hydrogen?

Finally the group of respondents were invited to add comments to the questionnaires. Either they could add their own comments and thoughts or they could express what they want to know. The results are shown in figure 2.8.1

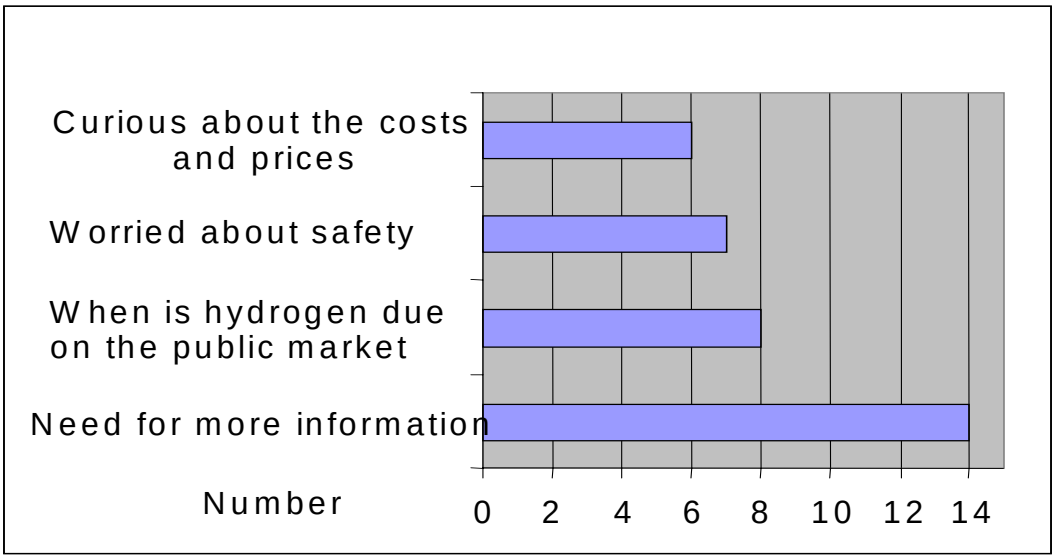

Figure 2.8.1 Comments from the respondents

Following is a list of items that respondents mentioned as being interesting: The number in brackets indicates how many make the statement.

*How is hydrogen made (4)?
*Worried that the speed and driving distance 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)

3 Specific questions according to target groups

Questions concerning sound and noise had to be put into various contexts according to responding groups. The passengers on board buses were asked bout the sound and pollution inside the bus, the neighbours to the bus routes were asked about noise from the street and air

Pollution and people on the street were asked about pollution in the city and noise from the traffic. As stated earlier each of these sections account only for 50 people (bus-riders are 100). Therefore in this part of the survey individuals have more impacts on the outcomes than in the questions were there are 200 people behind each answer.

3.1 What do you think about the sound inside the bus (Hydrogen and diesel bus groups)

When asking passengers about the sound inside the buses then the most frequent answer was that they did not notice the sound or 53%, see table and figure 3.1.1. Many people also responded that they found the bus silent (29%) but a few claimed they found the sound – or the pitch, uncomfortable (13%). Only 4% of the respondents claim the bus to be very silent and 1% to be very noisy. If these answers are combined then 86% of the people do either not notice the sound inside the bus or find the bus silent.

There is quite a difference between the view of passengers on board Hydrogen bus on one hand and a diesil bus on the other. The passengers on board the diesel bus do not notice its sound but the passengers on the hydrogen bus claim more often that the bus is particularly silent. This can clearly be seen from figure 3.1.2. No valid difference was shown between the genders or the various age groups.

Table 3.1.1 what do you think about the sound inside the bus (Hydrogen and diesel bus groups)

		Number	Frequency %	Accountable %	Total %
Valid responses	Very uncomfortable	1	1,0	1,0	1,0
	Uncomfortable	13	13,0	13,0	14,0
	Don't notice	53	53,0	53,0	67,0
	Silent	29	29,0	29,0	96,0
	Very silent	4	4,0	4,0	100,0
	Total	100	100,0	100,0	

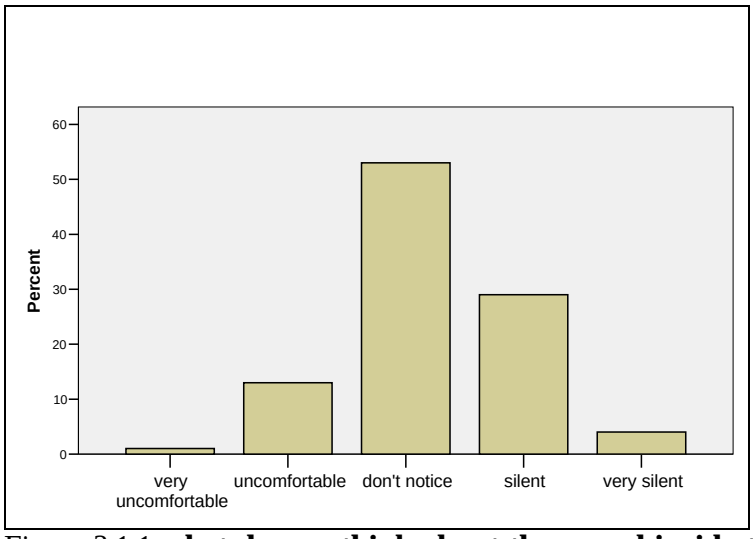

Figure 3.1.1 **what do you think about the sound inside the bus (Hydrogen and diesel bus groups)**

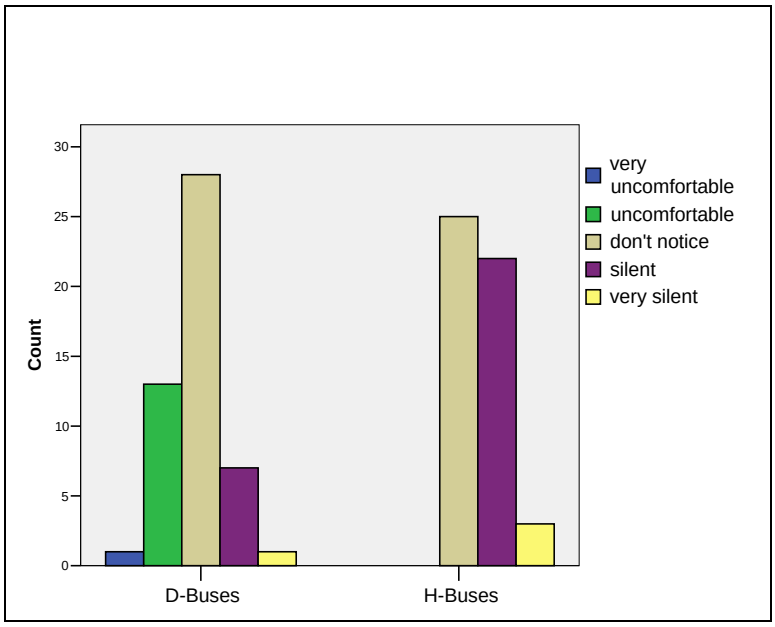

Figure 3.1.2 Distribution according to bus types

3.2 What do you think about the emissions from the bus at the bus stop?

When people were asked bout the emissions from the buses then the largest section claimed not to notice the emissions or 41%, se table and figure 3.2.1. One fifth or 20% found the pollution not significant, and 14% negligible. 15% claimed that the bus is polluting and 10 % very polluting**. Therefore in** total 75% of the respondents do not notice the emissions or find it not significant.

While comparing the answers from respondents from those who ride the diesel-buses to t0o those that were asked on board the hydrogen buses then it is evident that passengers on the diesil bus claim the bus to give rise to emissions while the hydrogen passengers claim their bus not to be polluting. See figure 3.2.2. Also men are more numerous in the group that think that the hydrogen bus is not polluting and more women mark for very polluting, figure 3.2.3.

Table 3.2.1 what do you think about the bus' emissions at the bus stop?

		Number	Frequency %	Accountable %	Total %
Valid responses	Very polluting	10	10,0	10,0	10,0
	Polluting	15	15,0	15,0	25,0
	Don't notice	41	41,0	41,0	66,0
	No significant pollution	20	20,0	20,0	86,0
	Pollution negligible	14	14,0	14,0	100,0
	Total	100	100,0	100,0	

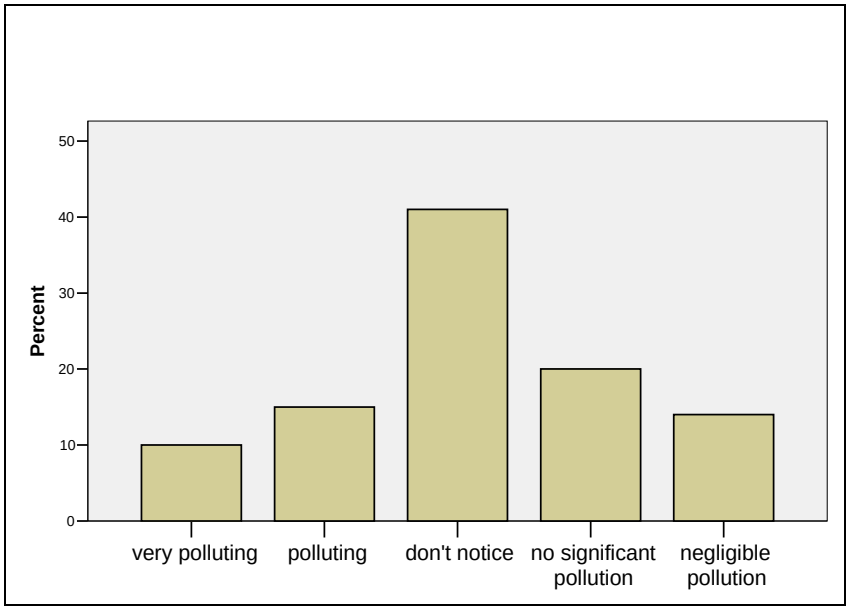

Figure 3.2.1 what do you think of the emissions from the bus on the bus stop?

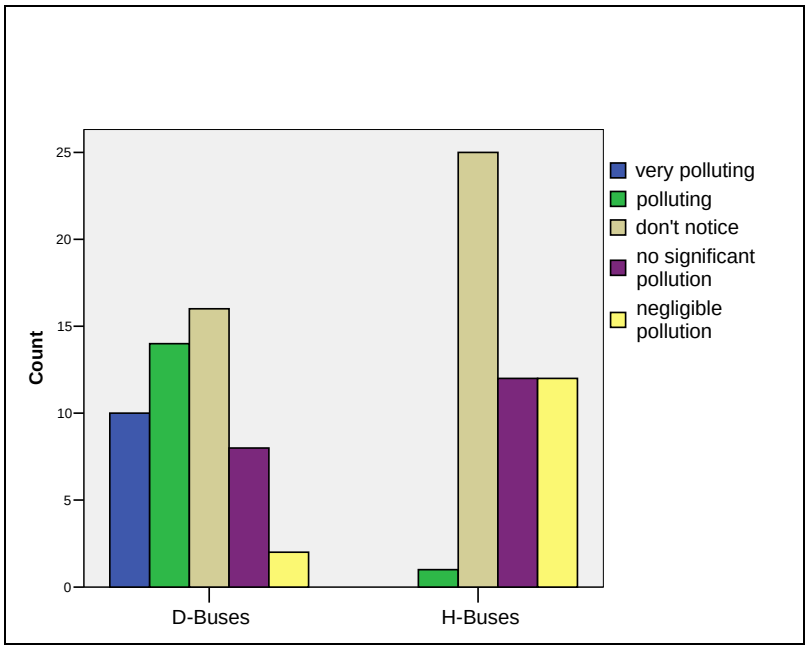

Figure 3.2.2 Distribution according to placement

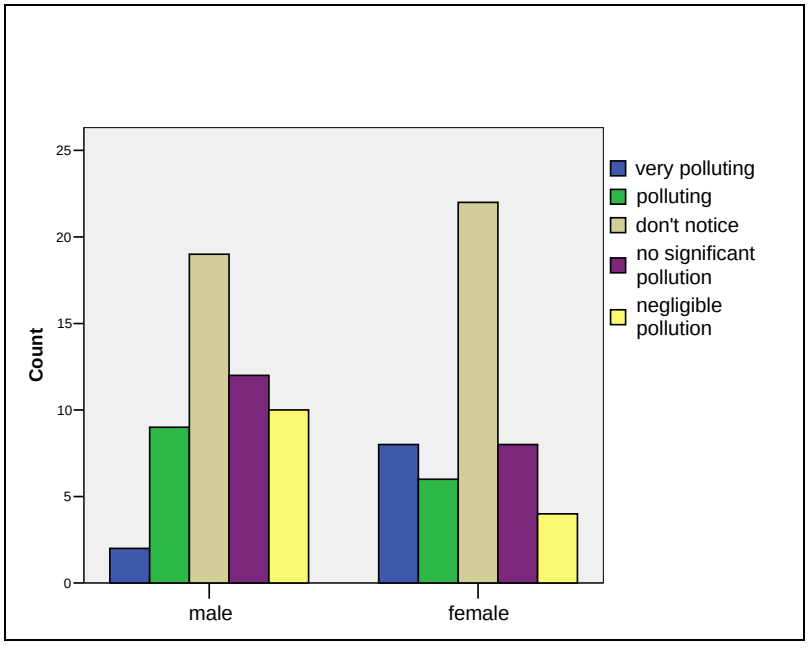

Figure 3.2.3 Distribution according to gender

3.3 Have you noticed a difference in the noise from traffic in the neighbourhood since the hydrogen buses started to drive the route?

By far or 78% of the neighbours have not noticed any difference in the traffic noise after the hydrogen buses started to drive through the neighbourhood. (Figure 3.3.1) Yet a few of them do state that the noise has decreased 14% and even decreased a lot 8%. Nobody selected to mark for more noise and considerably more noise so these do not show up on the graphs.

Those who claim that the noise has decreased are most frequently found in the age group 46-65 years see figure 3.3.2. No difference between the genders was detectable in neither this case nor their position.

Table 3.3.1 Have you noticed a difference in the noise from traffic in the neighbourhood since the hydrogen buses started to drive the route?

		Number	Frequency %	Accountable %	Total %
Valid responses	Don't notice	39	78,0	78,0	78,0
	Has decreased	7	14,0	14,0	92,0
	Has decreased very much	4	8,0	8,0	100,0
	Total	50	100,0	100,0	

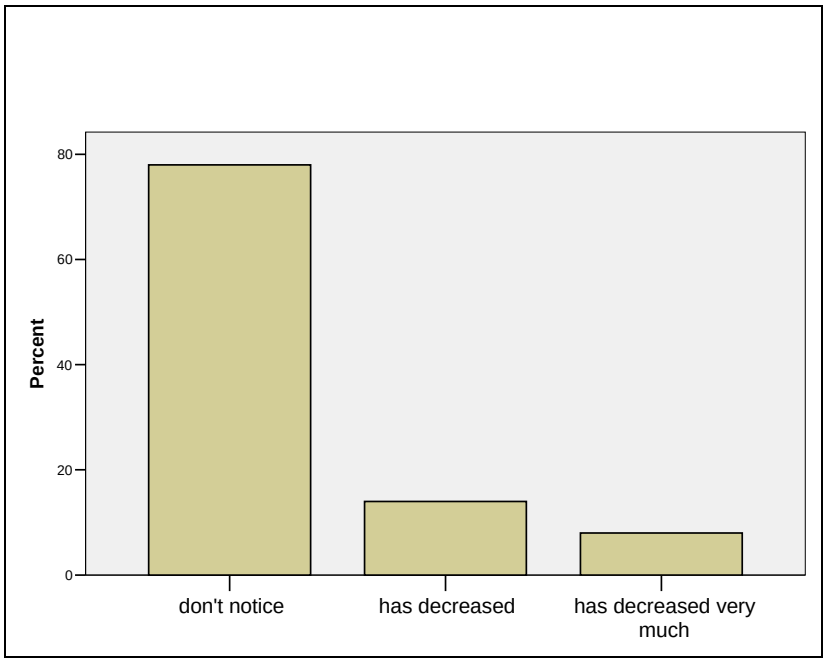

Figure 3.3.1 Have you noticed a difference in the noise from traffic in the neighbourhood since the hydrogen buses started to drive the route?

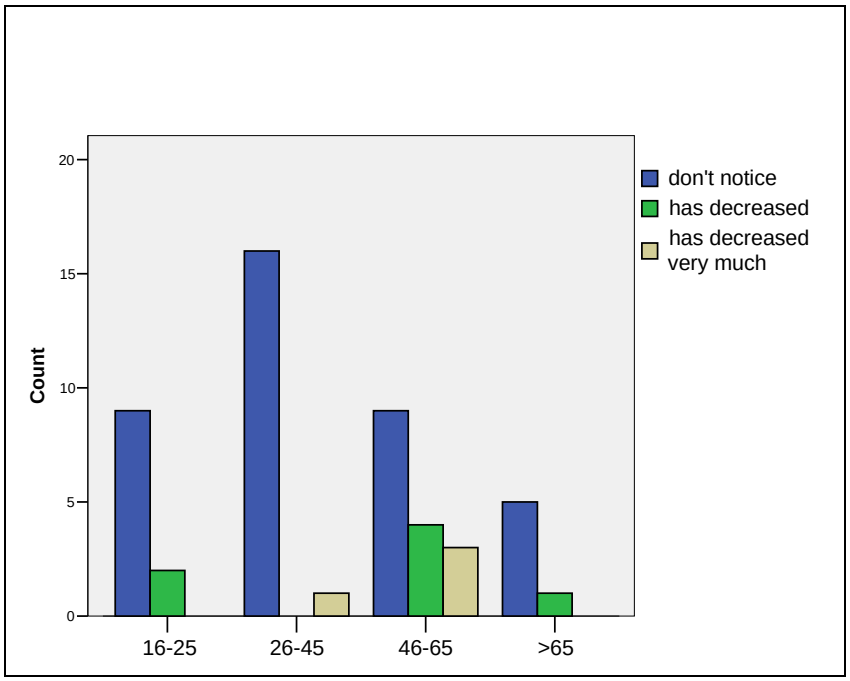

Figure 3.3.2 Distribution according to age

3.4 Have you noticed that air quality has changed since the hydrogen buses started to drive in the vicinity?

A vast majority, 90% of the respondents claimed that they had not noticed any change in air pollution refer to table and figure 3.4.1. Only 4% stated that air quality was better following the introduction of hydrogen buses on the routes in the vicinity and 1% that it had become much better. Nobody chose to mark for has gone worse or has become much worse. Therefore they do not show in the graphs. No difference in attitude was detectable between the genders, the age groups or the location or the respondents.

3.4.1 Have you noticed that air quality has changed since the hydrogen buses started to drive in the vicinity?

		Number	Frequency%	Accountable %	Total %
Valid responses	Don't notice	45	90,0	90,0	90,0
	Is better	4	8,0	8,0	98,0
	Is much better	1	2,0	2,0	100,0
	Total	50	100,0	100,0	

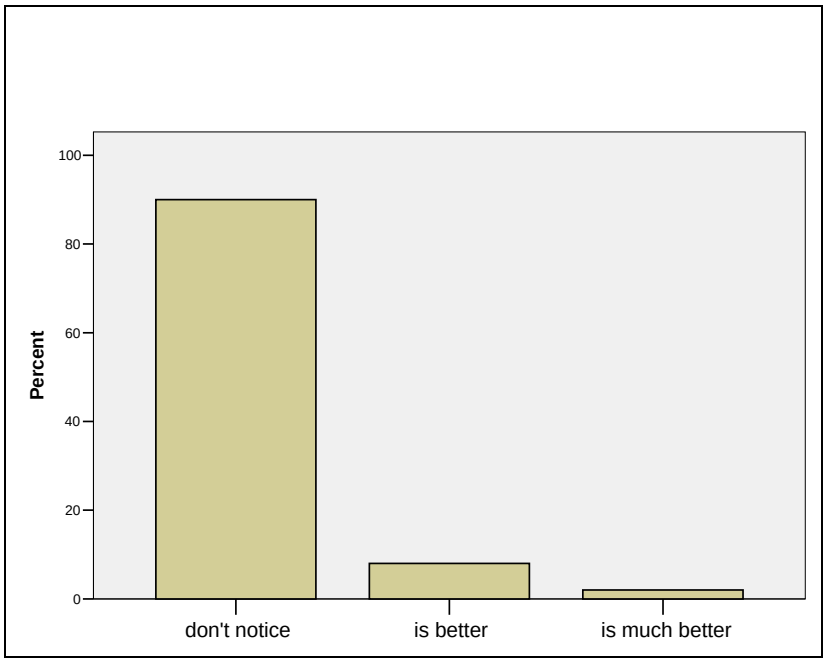

Figure 3.4.1 Have you noticed that air quality has changed since the hydrogen buses started to drive in the vicinity?

3.5 How severe is traffic noise in Reykjavik?

Most respondents or 58%, think that noise from traffic is a severe problem and 8% choose to mark form very severe problem, see table and figure 3.5.1. That makes up 66% of the respondents. 22% claimed they did not notice the traffic noise but 12% that traffic noise is only a minor problem. Again the selection neglgeble problem does not show up in the graphs because nobody selected that choice.

The results show that there are more females than males that claim the noise from traffic to be a severe problem but the men rather claim not to notice it or mark as not a significant problem. (Figure 3.5.2.) No discernable difference was found between the age groups or according to the respondents' location.

Table 3.5.1 how severe is traffic noise in Reykjavik?

		Number	Frequency %	Accountable %	Total %
Valid responses	Very severe	4	8,0	8,0	8,0
	Severe	29	58,0	58,0	66,0
	Don't notice	11	22,0	22,0	88,0
	Not severe	6	12,0	12,0	100,0
	Total	50	100,0	100,0	

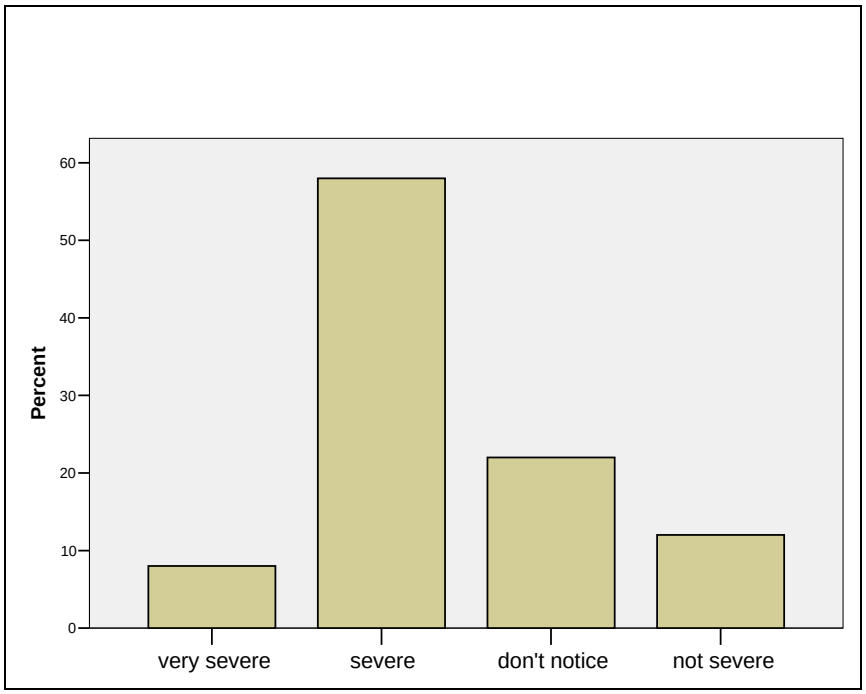

Figure 3.5.1 how severe is traffic noise in Reykjavik?

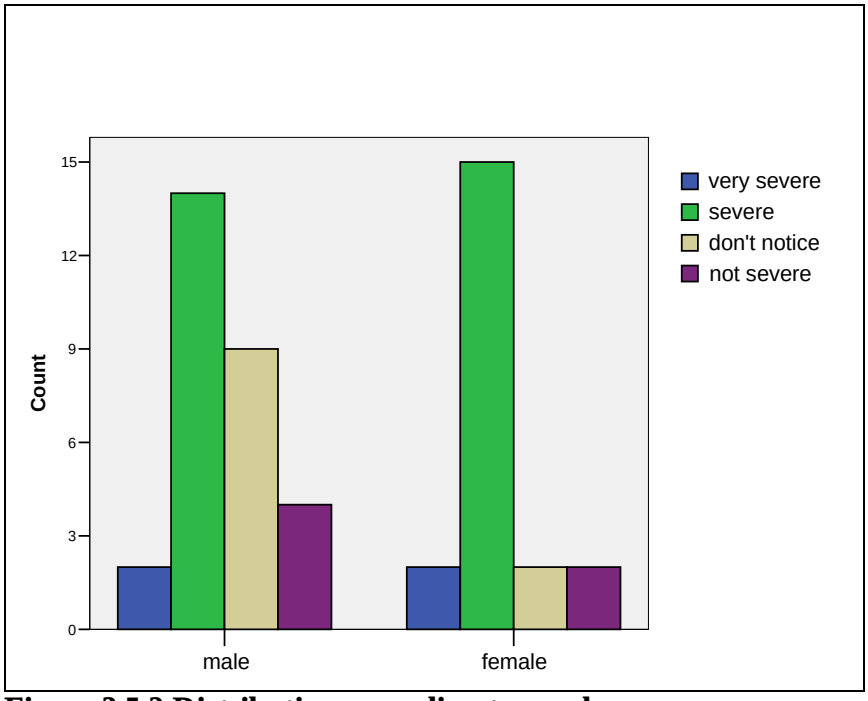

Figure 3.5.2 Distribution according to gender

3.6 How severe is pollution from traffic in Reykjavik as evaluated by pedestrians?

Table 3.6.1 how severe is pollution from traffic in Reykjavik as evaluated by pedestrians?

In all 76% of pedestrians think that pollution in the city is a severe or 58% and 18% a very severe problem as is shown in table and figure 3.6.1. Those who did not notice pollution in Reykjavik as a problem are 6% and those who evaluate pollution as a small problem are 16% and very small problem amount to 2% of the pedestrians.

		Number	Frequency %	Accountable %	Total %
Valid responses	Very severe	9	18,0	18,0	18,0
	Severe	29	58,0	58,0	76,0
	I do not notice	3	6,0	6,0	82,0
	Small	8	16,0	16,0	98,0
	Very small	1	2,0	2,0	100,0
	Total	50	100,0	100,0	

The genders show significant difference in their evaluation of pollution in the city. Considerably more females rank the pollution as being problematic. See figure 3.6.2. There is no significant difference between the age groups.

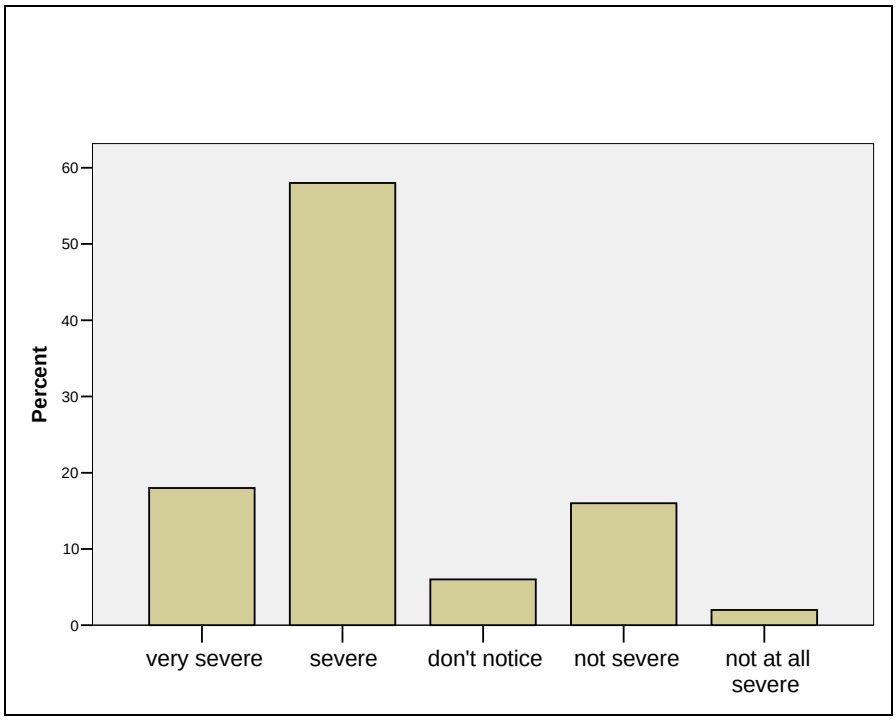

Figure 3.6.1 how severe is pollution from traffic in Reykjavik

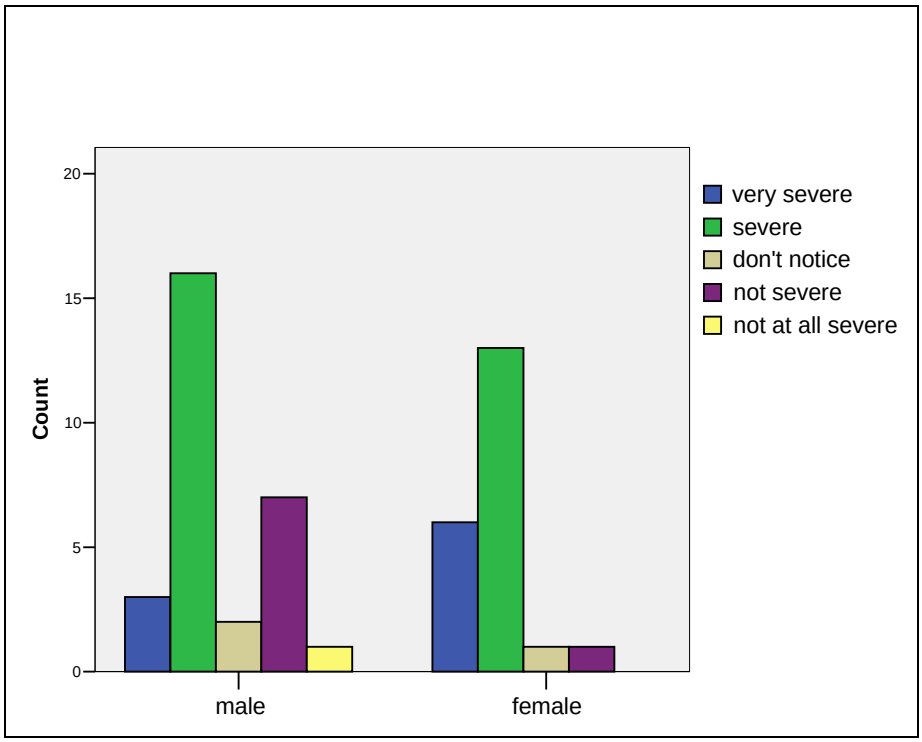

Figure 3.6.3 Distribution according to gender

3.7 Correlations and conclusions

A vast majority in Reykjavik shows a positive attitude in the survey from 2004 towards the test with hydrogen buses. Also a great majority (86%) claims to approve of the idea that hydrogen takes over the role of being the main fuel and replaces oil products. While looking at fig 4.1. the following correlations may be made: Those who hold a negative attitude towards hydrogen as a fuel (red column) only show up in the category: equal price for hydrogen and gasoline. The green column stands for those who claim to be fairly reserved towards accepting higher prices for fuels – they would only accept hydrogen if it were to be 10 – 20% cheaper or up to the same price as gasoline. Those who reserve a neutral stand towards using hydrogen as a fuel (blue column) show up in all price suggestions. Only the pink (a positive attitude) and the teal (a very positive attitude) show up in the category willing to pay 20% higher prices for hydrogen than for petroleum in the first phases. Yet the positive attitude also shows in all other categories for the willingness to pay.

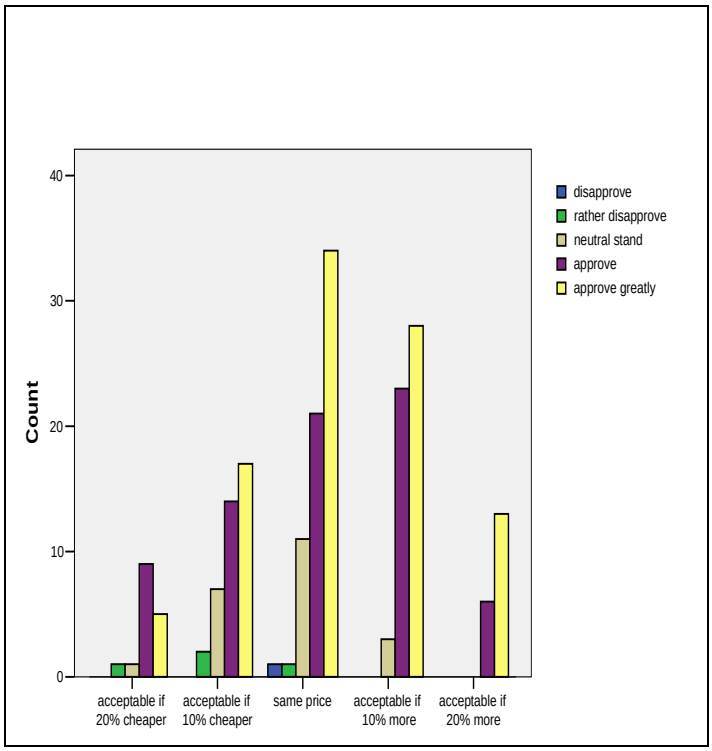

Figure 4.1 Correlation of attitude towards using hydrogen as a fuel and the mentioned prices that the same respondents claimed to be willing to pay.

Box 4.1 Remarks hydrogen prices

The interviewers wrote down the following remarks from the respondents connected to pricing of hydrogen. The remarks were:

- **If hydrogen would be offered as a cheaper fuel than petroleum it would be much easier to introduce in the market.**
- **Hydrogen should cost less than oil because it is made from water.**
- **Consumers would shift more easily from petroleum driven vehicles to hydrogen vehicles if hydrogen prices were low.**
- **It is understandable that hydrogen is a more expensive choice of fuel as it is always expensive to develop new technology. Therefore a higher price is acceptable. Also in the view that it is a more environmentally friendly choice.**

A correlation check was run between a positive response to hydrogen becoming the main fuel for buses cars and ships and the responses concerning hydrogen as a safe fuel. The survey reveals a slight correlation between the two statements. 44,5% of the respondents that consider hydrogen to be a safe or a very safe fuel also claim to be positive towards hydrogen becoming the main fuel for transportation. The percentage that claimed that they did not know if hydrogen is a safe fuel 40,5% still claimed to have a positive attitude towards the issue.

Analysing the correlation of these answers to the statements about what the same respondents connect to the concept hydrogen then 51,6% connects these to environmentally friendly fuel and 34,7% to water. The correlations may indicate that those who claim not to know enough about the safety aspects of hydrogen still hold positive attitude towards hydrogen as an energy carrier, probably mostly because of its clean environmental quality.

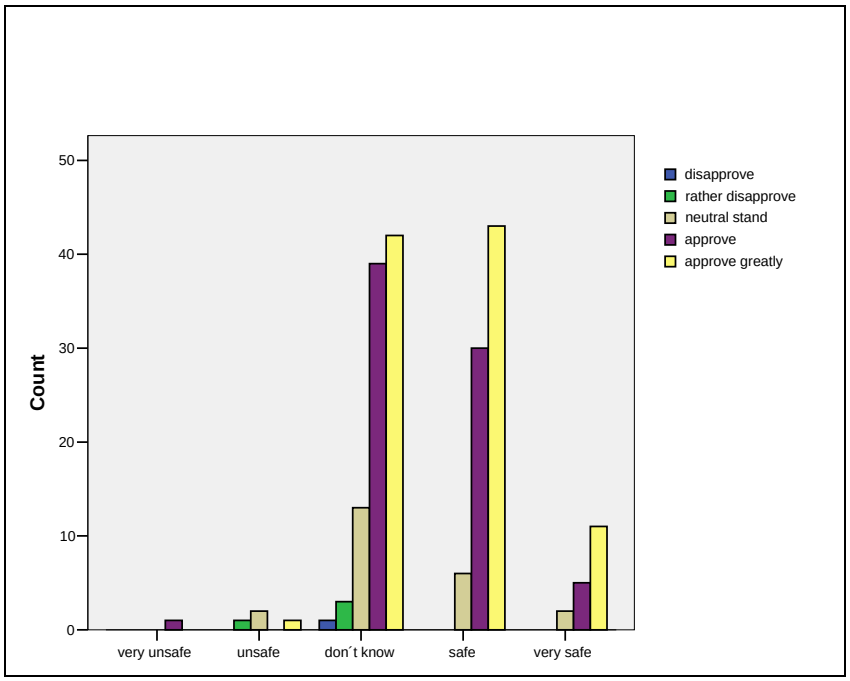

Figure 4.2 Correlation of the attitude towards safety aspects of hydrogen and the acceptance of hydrogen as the main fuel for transportation

In the age group 15-25 many individuals claimed not to know much about safety aspects of hydrogen. Therefore information about this issue should be specifically directed at this age group.

4 The Social contexts, benefits and further discussion

While asking people about what comes first into their mind as connected to the concept hydrogen then 84,4% of those who mentioned water as their first connection also claimed to hold a positive attitude towards hydrogen as the transportation fuel. 85,1% of those who connect hydrogen with environmentally friendly fuel is also positive towards hydrogen. Therefore those who do take a positive stand towards using hydrogen may do so mostly because of its environmental virtues. It is interesting to note how few respondents connect hydrogen to domestic production of fuel or only 8%. Also, connections to dramatic images of hydrogen such as expensive technology and a burning Zeppelin are quite rare. (See section 2.6.1).

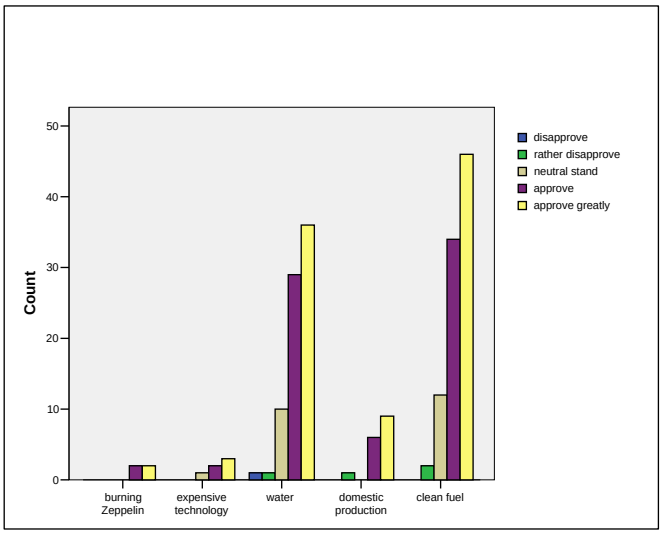

Figure 4.1 a correlation between the attitude towards hydrogen as the main fuel and what they connect to the concept hydrogen.

Two explanations are hereby offerd as to why Icelanders make the connection between hydrogen and water. One may be the linguistic relation between the words “vatn” (water) and vetni (hydrogen)”. A similar relation is also seen in German; “Wasser” (water) and “Wasserstoff” (watermaterial, hydrogen) and Swedish: “vatten” (water) and “vete” (or “vetgas” as hydrogen gas). Even though the Greek concept hydrogen has the same connection to hydro as vetni has to vatn, then those roots are not used in Eglish for the common word water; it is not related to the word hydro but to actually to the Nordic roots in vatn!

The other reason may be that the electrolytic technology is well known amongst the public; it has been somewhat of a tradition within the former state owned fertilizer plant (in operation between 1945 and 1995) to make hydrogen via electrolysis from water, whilest most other societies would see hydrogen deriving from oil refineries.

More than half of the passengers on board the hydrogen buses claimed that they did not notice the sound of the fuel cell buses. This may indicate that the sound is at least not annoying or that they give a neutral response to the question. Passengers on board fuel cell buses claimed more often than passengers on board diesil buses that they found the bus quiet. Nobody claimed the sound on the fuel cell buses to be uncomfortable. Also almost half of the respondents

claimed not to notice the emissions from the hydrogen buses. This may indicate that the emissions from hydrogen fuel cell buses do not annoy those who stand on the bus stop. Those who claimed that the hydrogen fuel cell buses are polluting or very polluting are still a handful of passangers. – Yet the emissions from the buses are easily seen as they are very pronounced white steam vents. Passengers of dielsil buses mostly classified emissions from those as being polluting and very polluting. Again these outcomes indicate that the majority of the public is aware of the difference in nature from these two emission types.

A vast majority of those who reside close to the bus routes claim they have not noticed any difference in noise from traffic after the fuel cell buses started driving. A few also indicate that the noise has decreased. Nobody claimed that the noise had increased. Perhaps the buses may have added to a better sound environment in the neighbourhood and new technology that goes unnoticed does at least not add to local noise pollution.

Most people that were interviewed in the streets of Reykjavik claimed that noise from traffic to be a serious problem in the city. About 20% respond that neither pollution nor noise is a problem in the capital area. Lastly the public claim that there has been little information availavle about the hydrogen projects for the public. A few claimed to have noticed the announcement at the onset of the demonstration, but then little followed up. A few respondents wanted to have more information about the performance of the buses and the hydrogen technology. At most people had noticed them in the traffic. Also those who claimed that they had not enough information about the safety of the hydrogen technology asked for more information for the public.

4.1 Comparison of outcomes to earlier surveys in Reykjavik

In Dec 2001, notably little less than 2 years before the hydrogen fuel cell buses started to drive on the streets of Reykjavik, a bench marking telephone survey was carried out amongst the public in Iceland.[5] The respondents were asked the seven questions that are listed in table 4 2. The sample was 1200 people in the age range of 16 – 76; mean age was 40 years. Respondents were picked randomly from the national register, which means that residents within Reykajvik and rural areas

[5] Félagsvísindastofnun Háskóla Íslands: (e.The Institute of Applied Social Science, University of Iceland) Afstaða Íslendinga til vetnis í desember 2001, (e. Public attitude towards hydrogen in Dec 2001) January 2002 c.o Aevar Thorolfsson; www.fel.hi.is

Table 4. 2 **Questions to the public in Iceland Dec 2001 concerning buses and fuel**	
1	**Have you heard about the company Icelandic New Eenergy**
2	**Do you know what Icelandic New Energy is dealing with?**
3	**Do you have a positive, very postitve, negative, neutral or very negative attitude towards the idea of using Hydrogen as the main fuel for buses, cars and ships?**
4	**Do you think that more information is needed about the possibilities of using hydrogen as a fuel?**
5	**Which media has given you most information about hydrogen options?**
6	**Do you think that riding public buses is or is not ecologically friendly ?**
7	**If the two following options would cost the same which option do you think would be a better solution from an environemtnal point of view?** **A. Keep the current bus system but use a cleaner fuel for the buses** **B. Change the system in order to tempt more people to use the public buses**

were included, 57% resided in the capital area and 43% in other parts of the country. 46 individuals could not be reached and about 250 people declined to answer the questionnaire. Those who replied were therefore 854 people, which gives 69,3% response. The respondents were classified according to their education, income and type of job. The results in this "before" survey were as follows:

- 22% of the respondets claimed to recognise the name Icelandic New Energy
- Less than 6% claimed to know what Icelandic New Eenrgy is dealing with.
- 92% of the respondents claim to have a positive or a very postive attitutde towards using hydrogen as the main fuel for buses cars and ships. 3% hold a negative attidute and 5% claim that they are indifferent.
- A vast majority, 92% complaints that public information about the options concerning the use of hydrogen technology is lacking.
- 55% of respondents have mostly obtained their knowledge on hydrogen technology trough television, 27% from newspapers but fewest (3%) from the internet
- 75% think that using public buses is ecologically friendly.

- When choosing between the options of either attempting to raise the number of people that use the public buses or to use a cleaner bus fuel then the equal number of respondents (50,5 / 49,5%) supported each option.

4.2 Comparison to surveys on hydrogen acceptance from other locations

In 2003 a parallel survey focusing on hydrogen and energy questions was conducted in three cities in equally many countries. These locations were particularlky selcted because of their participation in the CUTE project[6]. The outcomes were was published by the LBST agency in Germany. Box no 4.3 shows the main results[7].

Box 4.3 Results from AcceptH2

Within the EU-funded AcceptH2 project, surveys of the general public about perceptions of Fuel Cell buses and hydrogen and the willingness to pay more for riding clean hydrogen buses were carried out in London, England, Luxembourg and Perth, Australia before the start of hydrogen bus demonstration projects in these cities. Preliminary results of these "before" surveys were:

1. The support for hydrogen and fuel cells is generally high.
2. The knowledge about hydrogen and fuel cells is rather low.
3. Males and people with a higher formal education have a higher knowledge on hydrogen technologies than females and people with lower education.
4. Hydrogen is connected to positive (environment, etc), negative (bomb, explosive, etc) as well as neutral associations (physical properties, etc) even though the neutral associations are in majority.
5. There is practically no opposition to the introduction of hydrogen fuel and hydrogen vehicles. Many people are undecided and need more information.
6. In Luxembourg, more than 50% of all respondents would be willing to pay an additional fees to ride a hydrogen / clean bus.

Similarties with the outcomes of the surveys from Reykajvik are quite obvious. In all cases a majority claimes to have a positive stand in general towards the introduction of Hydrogen as a fuel, the women would like more informtioan and the levels of eduction influences the claimed need for more information. .

As in Reykjavik a majority is willing to pay higher fares for a ride in a hydrogen bus than other buses. The questionnaire yet puts hydrogen in a different perspective from what is done in Reykjavik. The accept H- surveys only offer passengers the option of paying a higher price for hydrogen bus rides whilest the options in Reykajvik include use of the suggested fuel also in other vehicles, namely cars and boats. In these cases it is probably the different energy-cultural context and general ideas behind the formulation of questions that dominates the essence of the public

[6] See the introduction to the paper for reference on the CUTE project.
[7] Altman et. al, 2004 Accept H, Social acceptance survey of hydrogen and fuel cell technology in London, Luxemburg and Perth Australia. LBST

responces. In Iceland, natural gas or products derived from biomass have not been discussed as much as the option of using pure hydrogen as a renewable new fuel.

In 2004 a survey was also made amongst the passengers on board fuel cell test buses to mestimate Hydrogen acceptance in Stockholm[8]. The approach to collect the passengers' views was different from the method applied in Reykjavik. Passengers were asked to fill out the questionnair and send it in the post to the institute in charge of the survey. The responding group was rather younger than the mean age of passengers and there were slightly more women that sent in their responses. The passengers in Stockholm did find the FC hydrogen buses more comfortable and less noisy than the buses they ordinarily used. They also marked that they find environemental virtues, comfort, low noise and punctuality very important assets for public buses. Yet, when asked about their willingness to pay higher bus fares while travelling with a hydrogen fuel cell bus then 63% of the respondents claimed that they would not accept higher fare- prices. – It is not evident from the survey if the passengers conncet cleanliness to hydrogen fuel cell buses..Yet, later news recount that there was a strong public reaction when the city of Stockholm decided not to support prolonged tests with hydrogen and fuel cell buses in 2005. The differences in the outcomes need to be seen in the light of the different local energy and fuel options. In Sweden ideas for new fuels include biodiesel, natural gas and alcohol from fermented biomass in this country of exce4ssive agriculture and extensive woodprocessing including paper and publ industry. Iceland has concurrently low biomass productivity and combats local erosion.

The large portion of respondents in all surveys that claim that they are interested in knowing more about hydrogen technology and fuel cells is not to be ignored. In the Reykjavik case it is mostly women and youngsters that admit that they would like to know more. In the fuel cell buses in Reykjavik the passengers were offered to take small leaflets with explanations on the functions of a hydrogen electrolytic station and the fuel cell bus. Yet, utterly few passengers take the opportunity to read about the new options during the bus ride. Therefore public education should be channelled through other media.

[8] Harldsson K and Berg H:Passagerarnas upplevelser av brännslecellsbussar i trafik på linie 66. ÅF – infrateknik, Sweden 2004 09 21.

4.3 The outcomes of a questionnaire within the bus drivers' group

Figure 4.2 The happy Nordic champion bus drivers all participated in the hydrogen bus experiments in Reykjavik[9]

In April 2004, fifteen Hydrogen FC bus drivers, see Figure , were asked about their experience from driving the fc-buses. The survey was an initiative taken by the CUTE project leaders in Luxemburg. The results show that bus drivers in Reykjavik evaluate the test as an important step towards „What eventually has to become". The bus drivers as a whole describe the tests as a pleasant

experience, the buses are quicker, more silent and are met with more positive reactions then they expected.

Only one driver lists a negative experience: „I am stressed to know that the bus I am driving is extremely expensive and I tend to get a little anxious during hydrogen bus shifts".

„I am very happy to be one of those who drive a hydrogen bus because the passengers are glad when they climb aboard. I like to surprise my regular customers when I arrive on a hydrogen bus, they take it as granted that a bus arrives punctually and a normal thing that I am the driver, but I notice their smiles when I arrive on a hydrogen bus". – The survey is incorporated in the CUTE reports.

In March 2005 Icelandic New Energy plus one if its major shareholders threw a party for all those involved in the ECTOS project. It was a very pleasant event indeed because all the bus drivers celebrated. They thanked their internal coordinator Rögnvaldur Jonatansson for pulling and pushing for their best performance within the project.

[9] Quoting the news on the website www.bus.is.

Box 1 ***Results from AcceptH2***

Within the EU-funded AcceptH2 project, surveys of the general public about perceptions of Fuel Cell buses and hydrogen and the willingness to pay more for riding clean hydrogen buses were carried out in London, England, Luxembourg and Perth, Australia before the start of hydrogen bus demonstration projects in these cities. Preliminary results of these "before" surveys were:

The support for hydrogen and fuel cells is generally high.

The knowledge about hydrogen and fuel cells is rather low.

Males and people with a higher formal education have a higher knowledge on hydrogen technologies than females and people with lower education.

Hydrogen is connected to positive (environment, etc), negative (bomb, explosive, etc) as well as neutral associations (physical properties, etc) even though the neutral associations are in majority.

There is practically no opposition to the introduction of hydrogen fuel and hydrogen vehicles. Many people are undecided and need more information.

In Luxembourg, more than 50% of all respondents would be willing to pay an additional fees to ride a hydrogen / clean bus.

4.4 Comparison to surveys on hydrogen acceptance from other locations

Box 5 shows a few outcomes from a comparable International survey made in 2003 and focused on hydrogen and energy questions. This survey was conducted in three cities in equally many countries. These locations were particularly selected because of their participation in the upcoming CUTE project[10]. The outcomes were published by the LBST agency in Germany [11].

Similarities between the outcomes from Reykjavik are quite obvious. In all cases a majority claims to have a positive stand in general towards the introduction of Hydrogen as a fuel, the women would like more information and the levels of education influences the claimed need for more information.

As in Reykjavik a majority is willing to pay higher fares for a ride in a hydrogen bus than other buses. The questionnaire yet puts hydrogen in a different perspective from what is done in Reykjavik. The accept H- surveys only offer passengers the option of paying a higher price for hydrogen bus rides whilst the options in Reykjavik include use of the suggested fuel also in all vehicles. In these cases it is probably the different energy-cultural context and general ideas behind the formulation of questions that dominates the essence of the public responses. In Iceland, natural gas or products derived from biomass have not been discussed as much as the option of using pure hydrogen as a renewable new fuel.

[10] See the introduction to the paper for reference on the CUTE project.
[11] Altman et. al, 2004 Accept H< Social acceptance survey of hydrogen and fuel cell technology in London, Luxemburg and Perth Australia. LBST

In 2004 a survey was also made amongst the passengers on board fuel cell test buses to estimate Hydrogen acceptance in Stockholm[12], Sweden. The approach to collect the passengers' views was different from the method applied in Reykjavik. Passengers were asked to fill out the questionnaire and send it in the post to the institute in charge of the survey.

The responding group was rather younger than the mean age of passengers and there were slightly more women that sent in their responses. The passengers in Stockholm did find the FC hydrogen buses more comfortable and less noisy than the buses they ordinarily used. They also marked that they find environmental virtues, comfort, and low noise and punctuality very important assets for public buses. Yet, when asked about their willingness to pay higher bus fares while travelling with a hydrogen fc-bus then 63% of the respondents claimed that they would not accept higher fare- prices. It is not evident from the survey if the passengers connect cleanliness to hydrogen fc-buses. Yet, later news recount that there was a strong public reaction when the city of Stockholm decided not to support prolonged tests with hydrogen and fc-buses in 2005.

The differences in the outcomes need to be seen in the light of the different local energy and fuel options. In Sweden ideas for new fuels include bio-diesel, natural gas and alcohol from fermented biomass in this country of excessive agricultural wastes and extensive wood-processing within the paper and pulp industry. Iceland has concurrently low biomass productivity and combats local erosion.

4.5 Various public benefits

Lessons and influences that have spread throughout the society, either as an effort of the project partners or as voluntary dissemination of interest groups add up to social benefits that are not readily measurable.. The lessons and discussions have spread widely and only parts of these can be found as references such as written documents, news, and letters from the public, discussions in political circles, school projects, student projects and further studies only to name a few. How much value might the projects add to the image of Reykjavik as a tourist destination that promotes itself as being the cleanest capital in the world?

[12] Harldsson K and Berg H:Passagerarnas upplevelser av brännslecellsbussar i trafik på linie 66. ÅF – infrateknik, Sweden 2004 09 21.

Figure 4.5 There were many tourists that asked about the hydrogen buses at the city tourist information centre during the years 2003 – 2005

4.6 Spread of information – a function of social patterns?

Social capital is a concept that for example relates to the pattern with which information spreads and transactions occur in societies; it is an aspect of the local culture. It also deals with how new ideas are integrated and whether people trust the main information sources. In general the average Icelander seems to be interested in new technology and shows a positive attitude towards testing and using hydrogen as a fuel even though general information on safety and cost aspects are not readily available. Politicians dare to talk about hydrogen, news agencies and the state television and radio broadcasting services have discussed the issue with Icelandic New Energy and others on several occasions and note when the demonstration projects and Icelandic "Energy Culture" is mentioned in the international media. Therefore the information spread has come from not only the project coordinator but many sources.

Instead of spending massive efforts in expensive publications in large supplies the staff within ECTOS accepted groups on visits, gave presentations for the public in general, and guided tours about energy and hydrogen technology. The mass media came for short and superficial interviews but the public followed with more detailed inquiries with phone calls and emails from across the globe.

Actual outcomes from the tests, news in general and stories of success and failures triggered most discussion. For further detailed reading material after the first introduction the homepage proved to be the best storage place for information. The demand for information and news was enormous and continuous after the inauguration of the hydrogen station and spread automatically to an international audience.

In the fc-buses in Reykjavik the passengers were offered to take a small leaflet with explanations on the functions of an electrolytic station and the fc-bus and the energy system at large. Yet, utterly few passengers took the opportunity to read about the new options during the bus ride but the drivers had to answer many questions. Public information should be channelled through carefully selected media; it is not evident that the public makes use of information that is

at hand. The public is interested to get the whole story, and most preferably through their popular media – radio or television. The public wants to have not only technical information but also information on sources, prices, amounts, feasibility, future prospects etc.

4.7 List of beneficiaries

The lessons from ECTOS can be organised according to the level of the beneficiaries and will not be subjected to more than necessary speculation; the issues are simply listed in Table along with a category of beneficiaries and general comments. The issues can more or less be listed as effects and spin-offs from ECTOS, even though many separate initiatives have helped the actions and magnified the effects.

Table 4.7.1 Influence on society from the ECTOS project

Category	Level	Beneficiaries	Output	Comments
Administration	Government	Icelandic officials and researchers	Hydrogen road map to be announced 27th of Jan 2006	Leading researchers and institutes have supported an outline for the integration of hydrogen as a fuel for the future in Iceland
Administration	Government	Icelandic politicians	Discussion in Parliament and political parties	The support crosses political boarders. New law that facilitates import and tests of cleaner vehicles passed in 2005. Hydrogen policy is built on the existing renewable energy policy
Administration	International parliament members	Nordic, Australian, Japanese, Korean, Chinese, German, American, Indian	High level international involvement, EC IPHE, UN and	Pressure on Icelandic and international governmental bodies
Administration	Municipality	Community leaders and administration in Reykjavik	Participation in international policy discussions	Good financial support for further tests
Administration	Community	Politicians and officials	Interest and active curiosity –	Borrowing equipment and payment for presentations
Administration	Com-pany	Staff of INE buscompany staff Maintenance staff	Skilled workers and researchers Trained drivers Trained engineers	The trained staff are a completely new social asset that can disseminate their speciality
Administration	Safety – alarm groups	Fire brigade, officials	Safety codes, training for health safety and environmental response	The HSE- plan and response to alarm can be used on further contexts and expanded to new ventures. These procedures is a new asset for society

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	Level	Beneficiaries	Output	Comments
Education	Academic	28 Groups of international students from University level and colleges	**5 Masters' students within INE / University of Iceland**	**MSc students, Icelandic, Greek and German.**
			Input into small projects, masters' students	**Phd course: 7 natioinalities, more than 50 indviduals**
Education	Academic	**5 PhD level**	**The themes are socio-technical**	**Icelandic, Belgian, German, Italian and American**
Education	Academic		**BSc level in Mathematics**	**Study of the energy flow in the hydrogen station as basis for later comparison within the IEA[13].**
Education	Academic, methodology	**students**	**An article on the comparison of social surveys**	**This one is in the process phase and will be offered to int. journals**
Education	Academic	**International scholars and the University of Iceland**	**Input to scientific papers and a book**	**Example: Journal of Hydrogen Energy and the Int. Journal of Cleaner Production; Book written by Th. I Sigfusson**
Education	Academic	**Icelandic scholars**	**2 new surveys on public acceptance**	**New aspects of public opinion on energy matters have been collected, Tey are useful for the social and political sciences**
Education	Didactics; educational instits	**Academic course for students and teachers at the Uni. of Iceland**	**Student papers**	**7 nationalities**
Education	College	**Students and teachers**	**Presentations and discussions**	**Lively input from the audience**
Education	Vocational college	**Course for teachers**	**Training in a FC laboratory**	**Icelandic Teachers in Germany trained in new technology and disseminating to their students**

Continue next page

[13] IEA stands for the International Energy Agency more specifically; the hydrogen implementation agreement and the task 18 – integrated hydrogen systems.

	Level	Beneficiaries	Output	Comments
Education	Youngsters	Summer course	Trips, course, discussion	Voluntary summer school hosted by the University of Iceland
Education	Middle stage	Educational text on hydrogen as a fuel	Chapters in two public text books	One book is used for 5th grade the other for 8th grade pupils
Education	Primary Schools	Animated film on hydrogen as a renewable energy carrier	A CD rom disk now offered on the web to the national school network	The disc was developed within the supported measure: € HYPORT ENK6-CT-2001-80449 sponsored partially by the EC, but has roots in the system that was used in the ECTOS
Media	TV	The public – in the international meaning of the word.	Documentaries in French, German, Korean, Japanese, Finnish, Swedish, Danish and Norwegian, Icelandic	The renewable Icelandic energy chain seems to have a strong attraction on international media
Media	Journals	International readers	Articles made by staff from Newsweek, the Economist, die Stern, etc etc etc[14]	Journals and magazines in very high international esteem have used the ECTOS as a case study
Media	Children programs	The youngest audience	Our – Happy –Hour	A fun technical input to the most popular children's program in Iceland.

Continue next page

[14] A detailed list of all media relations is given as an appendix see Annex V

	Level	Beneficiaries	Output	Comments
Spin-offs	National	Training course for vocational teachers	15 teachers with specifc training to teach about fc	Carried out with a grant from the EC Leonardo propgrammme
Spin-offs	National	Training facilities for further training and tests	National H2 laboratory at IceTec	Several institutes joined forces and applied for research H2 laboratory and demonstrations to establish a laboratory
Spin-offs	Inter-national	Hy-FleetCUTE		The social assessment will be applied to a broader spectrum
Spin-offs	Case study	IEA, hydrogen implementation agreement	Input for international learning	Systems from Canada

Figure 4.8 Kids that attended one out of three hydrogen summer courses thrown by INE and the University of Iceland.

4.8 Hydrogen tourism

During the ECTOS project many groups of people and of various origins wanted to have guided tours to the project facilities. This demand became so high that Icelandic New Energy decided to offer regular seminars where the organisation and the learning was presented in a systematic way. INE even charged for the extra work load during these visits. Students and staff were allocated the task to present the project according to the level of the group that requested insight into the hydrogen initiatives. Visitors from Japan were the most numerous, but groups from the EU, USA, Korea and the Nordic countries were also amongst those who paid INE a visit.

The lists of visitors are available at Icelandic New Energy.

Figure 4.9 and 4.10 The environmental committee of the United States Senate came for presentations about ECTOS and hydrogen initiatives. Another important guest would be the president of Inda.

According to counts from diaries, guests that have come to Iceland for the hydrogen initiatives, mostly to participate in international conferences and seminars or technical and study visits are more than 2000 since the kick off of ECTOS in 2001. These guests have of course used hotels, public and private transportation etc within the hospitality industry. Because geographically speaking the land lies far off the North American coast and the European continent most guests stay overnight and while guests are getting acquainted with energy matters it is most likely that these guests also look at other energy sectors in Iceland such as the geothermal and hydropower plants and learn about the governmental policy on renewable energy or the possibilities of utilizing these sources.

There is rule of thumb for calculating how much each tourist is considered to spend in Iceland on hotels, restaurants, excursions or 550 € /person. The Hydrogen tourism may have left up to 1.1 Mi € in Iceland given the above figures.

A benefit for Icelandic New Energy is also the new business opportunities that opened up, but the cost of receiving guests and spending time with these also take considerable time and resources from the company. Many new research and demonstration projects hatched during the ECTOS demonstration and the company took off as a consultancy.

4.8.1 Promotion for the public transport system

The bus operator Straeto surveyed the public discourse and media concerning the public transportation system. An increase in passenger count was not measured, but public buses were

mentioned in the media more often during the years 2003 and 2004 when the hydrogen buses became visible, refer to Figure 1[15]. Therefore the ECTOS project may have had a positive effect at least on the image of the local public transportation company. Subjects like „modern and high tech" were mentioned, the media gave good coverage on the test drives and about 90% was positive coverage which is not often the case.

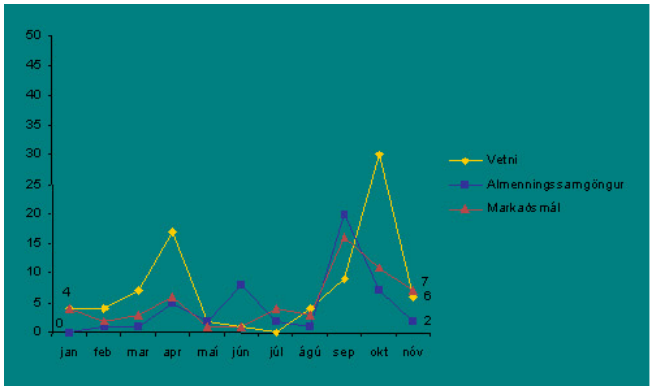

Figure 1.11 The bus company was mentioned more often than before in the local media from October 2003 in context with hydrogen (yellow line) public transport (blue line) and marketing issues (red line)

4.8.2 Shifts in material balance

Considerable time and material was of course spent on the maintenance, monitoring and upgrading of the fuel cell buses within the ECTOS, - often for the sake of testing and regulating. The nature of this work is quite different from that which is carried out with older and other types of buses. But at a similar time as the fc-buses were introduced into the public bus fleet the bus operator also imported two new buses that have internal combustion engines and run on diesel fuel. Many features of these buses are different in these two types of buses (refer to Figure), their weight is different, the carrying capacity is different and the routes that the buses drove between 2003 and 2005 are not the same. Yet one comparison will be shown here as if to remind us that not only is the fuel different for these two drive trains, but the maintenance is also quite otherwise.

As a normal routine, the gear oil and motor oil were changed in the diesil engine buses as a part of the regular maintenance. This is not necessary with the fuel cells or the electric motor in the hydrogen buses, which use very different spare parts. During the two years of similar operation the weight of the oil and grease saved were about 300kg for the three fc-buses compared to what should have been needed for three diesel-buses for the same running time. This amounts to saving of about 10.000€[16] and the price of the best grease has been increasing

[15] Eiriksson, Asgeir April 2005 presentation at the HyProFiles
[16] The figures used here are based on the maintenance diary from the bus- operators garage in Reykjavik for the two Scania buses that were imported in September 2003 and maintained in a similar way as their other diesil buses in normal operation. Source: Jan Jensen

steadily with rising oil prices. It is yet essential to mention that the diesel buses were driven more than double the distance of the hydrogen fc-buses; they took double shifts most days and drove during weekends as well.

Figure 4.12 The fuel cell buses (furthest right) are taller, heavier and in many ways different from the usual diesel buses in Reykjavik

In the electric motor that gets its energy from the fuel cells, no grease or motor oil was changed during the entire test period. Inspections revealed that this was not necessary. The staff at the maintenance bay for the hydrogen vehicles claimed that when the ECTOS project had come to an end it would not have been necessary to change the oil of the gear box nor the motor at all, but the buses were closed down properly and the oil emptied out, as clear and „*clean as drinking water*"[17].

4.8.3 Saving the cost of emissions

As a final cost / benefit estimation the cost of emissions will be added to the list. In chapter 6 describes shortly the environmental savings, yet a few environmental issues could be accounted as cost savings. The Report Extern –E suggests a multiplying factor for the emissions that usually follow transportation. As discussed in later sessions on the impact on the environment, tons of SOx, NOx as well as CO2 emissions were saved, corresponding to average emissions from diesel buses run for 65.000 km. This amounts to minimally to 4.300€ and the grease management in safe disposure for recycling 1.500€.

[17] Source: Gunnar Thor Jonsson the head of the maintenance bay in ECTOS.