Work package 6 - Deliverable 6

Comparative Analysis of Berlin, London, Luxembourg and Perth Ex-Ante Surveys

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Summary

This report compares the main findings of the four economic valuation studies conducted between July 2003 and February 2004 in Berlin, London, Luxembourg and Perth for the ACCEPTH2 project. These studies used survey-based methods to investigate public perceptions and attitudes towards hydrogen fuel cell buses, and estimate willingness to pay for the environmental benefits (air and noise pollution reductions) of the large-scale introduction of hydrogen buses in the associated cities.

In general, perceptions about hydrogen were predominantly neutral and knowledge of hydrogen and fuel cell vehicles relatively limited. The lack of knowledge did not appear to affect public interest on the hydrogen bus trials since widespread support was granted to this initiative. However, attitudes towards large-scale introduction of hydrogen fuel cell buses and development of a refuelling infrastructure were less enthusiastic and required additional information. Willingness to pay (WTP) for the extensive introduction of hydrogen buses was elicited using the contingent valuation method and two different payment vehicles: the estimated mean WTP per bus fare (£0.21 = €0.31 = A$0.54)[1] was quite high and represented 22% of the mean standard bus fare, while the estimated mean WTP extra taxes annually (£15.37 = €23.18 = A$40.65) was comparatively lower. Models generated using ordinary least square (OLS) regression methods had weak explanatory power ($0.14 < R2 < 0.34$) but were robust and it was found that the main variable that significantly influenced WTP was environmental sensibility.

[1] Exchange rates used throughout this paper (1EUR = 0.66GBP = 1.75AUD) refer to the 14th of June of 2004 and were obtained from the European Central Bank website (www.ecb.int/stats/eurofxref/).

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1. Data Collection

Table 1 presents summary statistics of the surveys conducted in Berlin, London, Luxembourg and Perth between July 2003 and February 2004. Each survey took around 3 months to complete and 1,392 telephone[2] interviews were made. Only 98% were analysed, since the 26 non-bus users from Berlin/Luxembourg and 7 incomplete questionnaires were removed.

Table 1: Sample Details

	Interviews			Bus Users			
Cities	Conducted	Complete	Analysed	Yes		No	
Berlin	365	364	345	345	95%	19	5%
London	420	414	414	308	74%	106	26%
Luxembourg	307	307	300	300	98%	7	2%
Perth	300	300	300	146	49%	154	51%
Total	1,392	1,385	1,359	1,099	79%	286	21%

2. Socio-Economic Characteristics

Table 2 presents socio-economic characteristics of the sample of 1,359 analysed interviewees. Females were predominant (60%) and average age of respondents was 44 years. The average income[3] (£29,267 = €44,029 = A$77,317) and car ownership (74%) were very high, but there was wide variance across cities. For instance, average income of London respondents was double of Berlin interviewees, and car ownership in Perth was almost twice of Berlin.

Table 2: Sex, Age, Income and Car Ownership

							Average Income				Car Ownership				
Cities	**Male**	**%**	**Female**	**%**	**Sample**	**Average Age**	**GBP**	**EUR**	**AUD**	**Sample**	**Yes**	**%**	**No**	**%**	**Sample**
Berlin	151	44%	194	56%	345	49	£20,684	€31,339	$54,843	220	194	56%	150	44%	344
London	171	41%	243	59%	414	39	£41,738	€62,608	$110,190	366	282	68%	132	32%	414
Luxembourg	107	36%	193	64%	300	46	£25,740	€39,000	$68,250	153	246	83%	49	17%	295
Perth	113	38%	187	62%	300	44	£21,113	€31,669	$55,560	262	281	94%	19	6%	300
Total	542	40%	817	60%	1,359	44	£29,267	€44,029	$77,317	1,001	1,003	74%	350	26%	1,353

Education level (Figure 1) of the sample was very high, with 79% of the interviewees having completed at least secondary education, and 37% holding a university degree. Employment

[2] In Luxembourg the data collection used a mixed survey method (in-person + telephone).
[3] The number of respondents in each city weights the average income presented. A non-weighted average would be slightly inferior in about GBP 1,948 = EUR 2,875 = AUD 5,106.

rate (Figure 2) was also very high, with 61% of the respondents as either self-employed or holding a full or part-time job, while the unemployment rate (4%) was that of natural unemployment. Both education and employment levels in London were impressive, with 46% of respondents holding a university degree and an employment rate of 80%.

Figure 1: Education

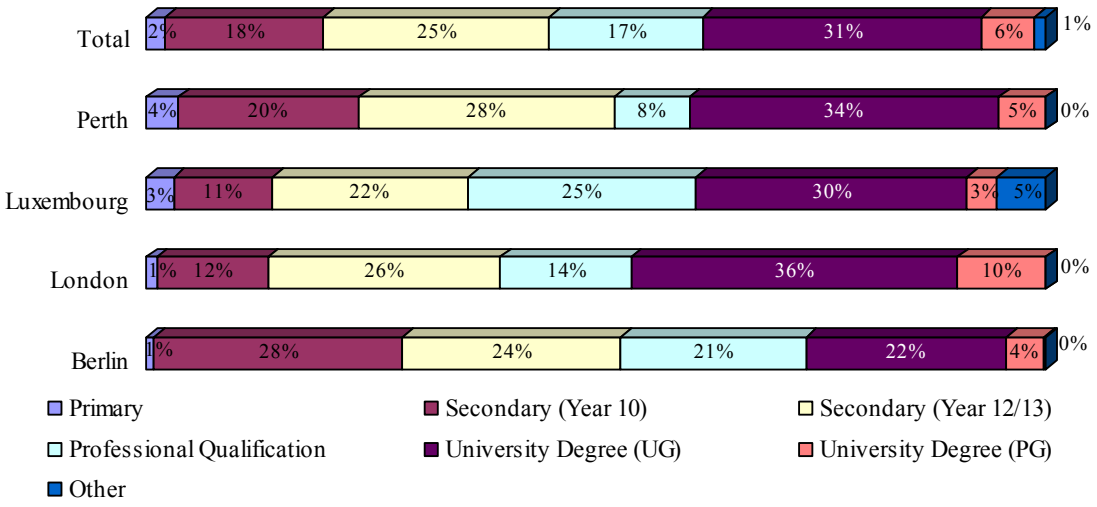
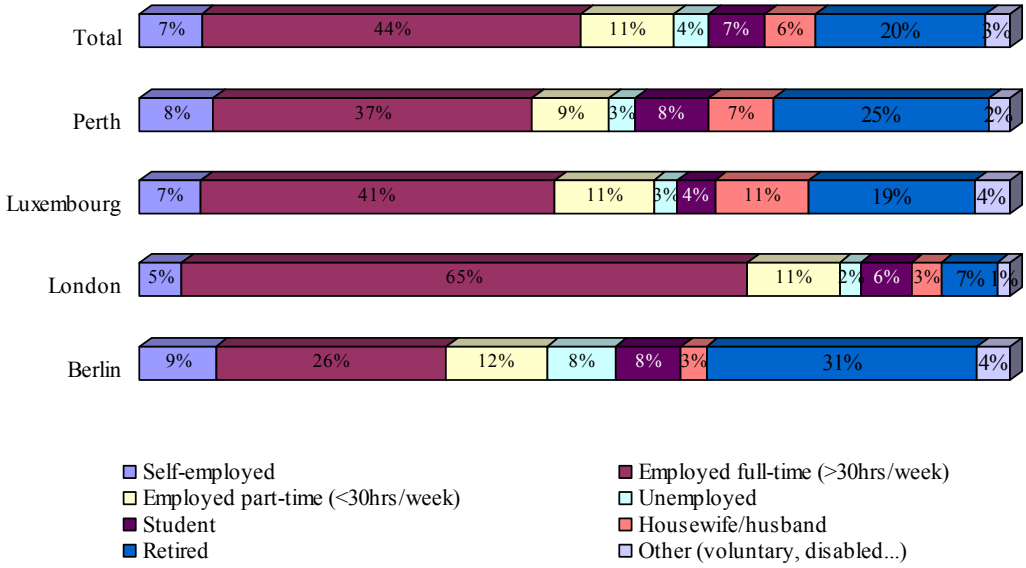


Figure 2: Employment



Overall the sample appears to be biased towards respondents of the feminine gender with high income and education levels. This may indicate a self-selection bias, which is usual in studies that depend on volunteer participation and maybe consistent with the arguably complex nature of the issues discussed.

3. Bus Use and Attitudes

The criterion used to define bus users was having used the bus at least once in the last 12 months. The proportion of bus users interviewed (Figure 3) was very high on average (79%), but varied significantly across cities, reaching its highest value in Luxembourg (98%), and the lowest in Perth (49%); this difference is due to the fact that in Berlin and Luxemburg bus users only were deliberately targeted. However, regarding the frequency of bus use (Figure 4), a clear contrast can be made between Luxembourg, where 68% took the bus at least once a week, and Perth, where only 42% did so. On average 59% of the users took the bus at least once a week and 35% took the bus 5 or more times a week.

Figure 3: Proportion of Bus Users

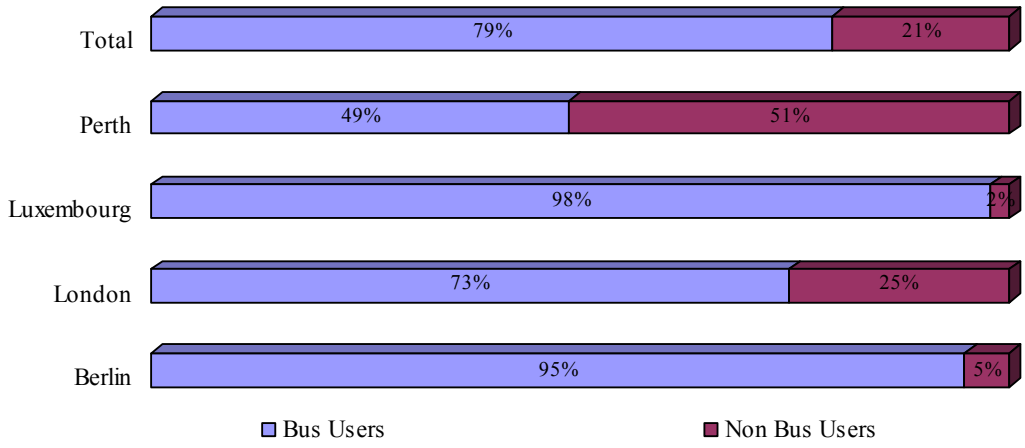
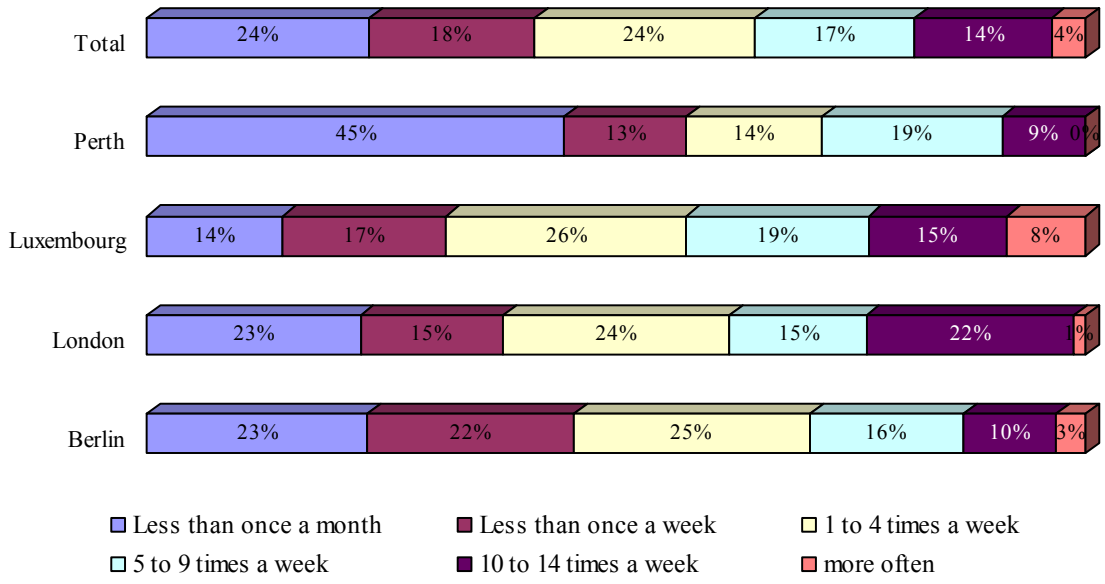


Figure 4: Frequency of Bus Use



Purpose of Bus Use

The main purposes for taking the bus were going to work/college in London (57%), and go shopping in Berlin (48%) and Luxembourg (46%)[4]. Other relevant reasons to take the bus were trips out for leisure activities and visits to friends and family.

Bus Features

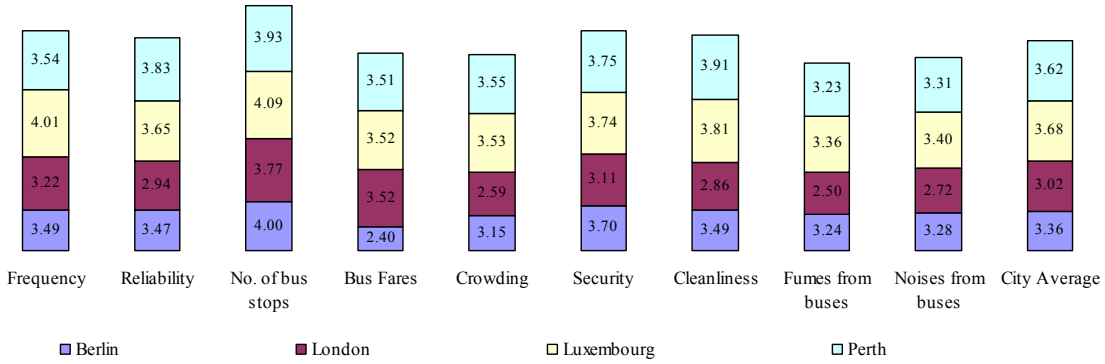
Bus users were asked to rate several features of their city bus transport system using the following scale: 1 (very poor), 2 (poor), 3 (average), 4 (good), and 5 (very good). On average, users were quite pleased with the "number of bus stops" (3.95), "security onboard" (3.58), and "frequency of buses" (3.57). However, they were less satisfied with "fumes from buses" (3.08), "noise from buses" (3.18) and "crowding onboard" (3.21).

Perception about "bus fares" was fairly good in London (3.52), Luxembourg (3.52) and Perth (3.51), but was poor in Berlin (2.40). This was consistent with the cost of single bus fares in each city, since the fares in London (£0.70), Luxembourg (£0.79) and Perth (£0.76) were almost half of the fare in Berlin (£1.45).

[4] Perth report did not include this aspect.

Overall rating was higher in Luxembourg (3.68) and Perth (3.62), while in Berlin (3.36) and especially London (3.02) users were on average less pleased about the features depicted in Table 3. The features that respondents would most like to see improved[5] (elicited using an open-ended question format) were the "frequency of buses and number of routes" in Perth, and the "frequency and reliability of buses, and the quality/attitude of drivers" in London.

Table 3: Bus Features



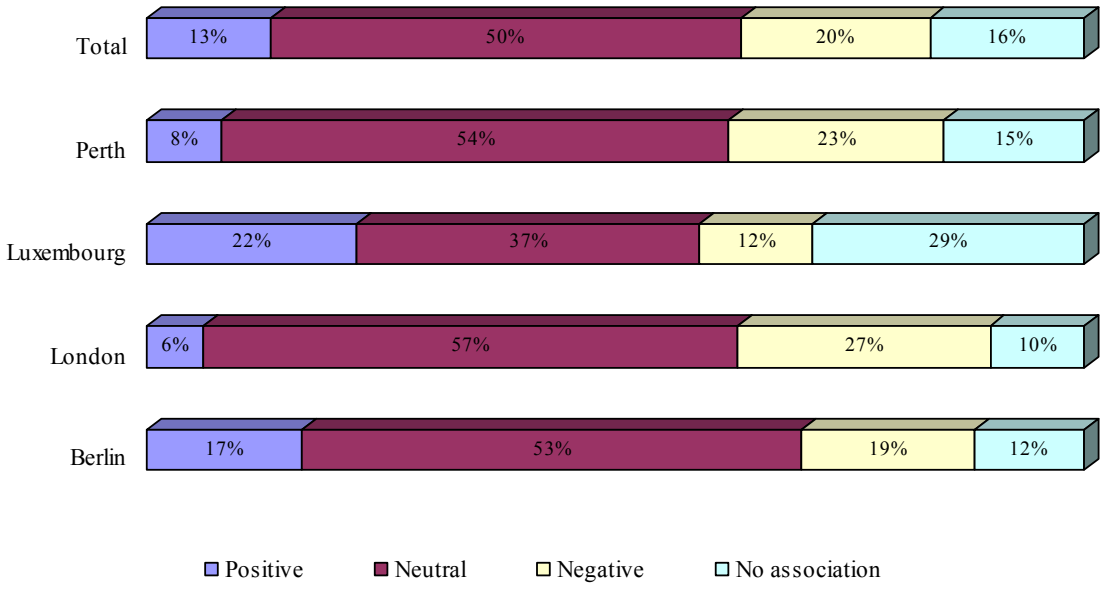
[5] Berlin and Luxembourg reports did not include this aspect.

4. Knowledge and Attitudes towards Hydrogen Vehicles

Associations with Hydrogen

Respondents were asked "Please tell me the first words that occur to you when I say the word hydrogen?" and associations were classified according to its broad nature (Figure 5). Neutral associations like "fuel" and "energy" represented half of the associations made, negative associations like "explosive" and "bomb" represented 20%, positive associations like "alternative fuel" and "clean energy" represented 13%, and 16% of respondents were unable to make any association with the word hydrogen. It is worthwhile mention that Luxembourg was the only city where positive associations outnumbered negative ones.

Figure 5: Hydrogen Associations

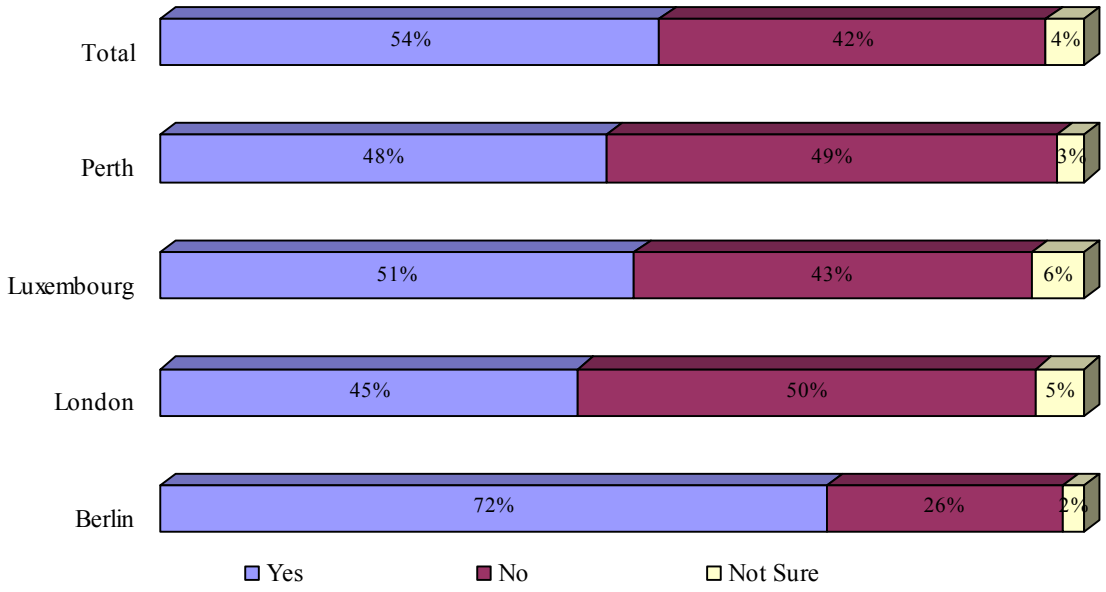


Knowledge about Hydrogen Vehicles

Prior to being given information about hydrogen and fuel cells, respondents were asked whether they knew that car companies were developing hydrogen vehicles. Just over half of

the respondents (54%) claimed to know, while almost half (42%) did not know of the existence of hydrogen-powered vehicles, and a small number (4%) weren't sure about it (Figure 6). Berlin interviewees were clearly the more informed (72% did know), while Londoners were the least informed (only 45% did know), and in general men were more familiarised than women. The main sources of information were television (36%) and newspapers/magazines (37%).

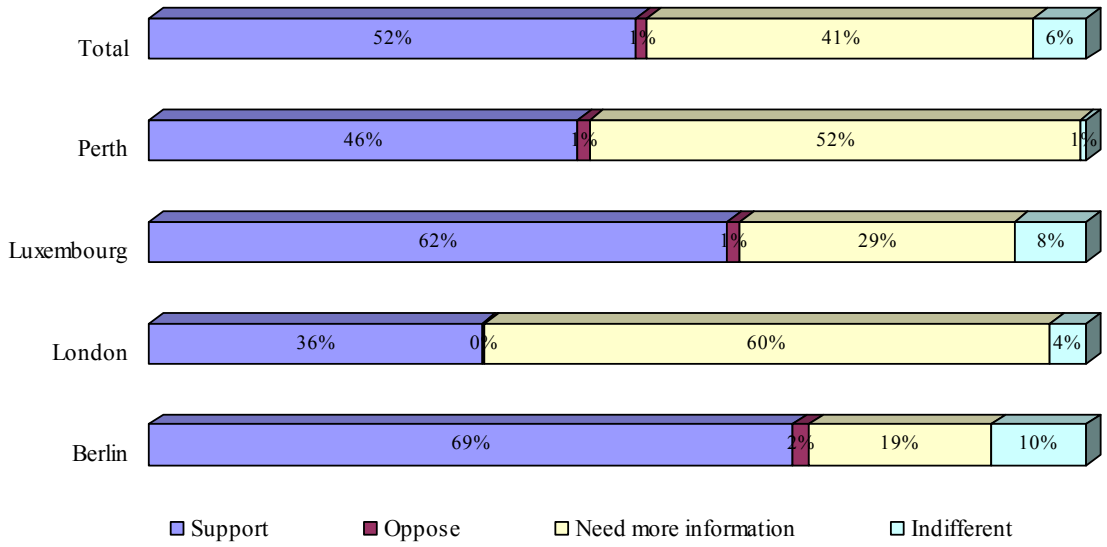
Figure 6: Did you know that car companies are developing hydrogen-powered vehicles?



Attitude towards Hydrogen Vehicles

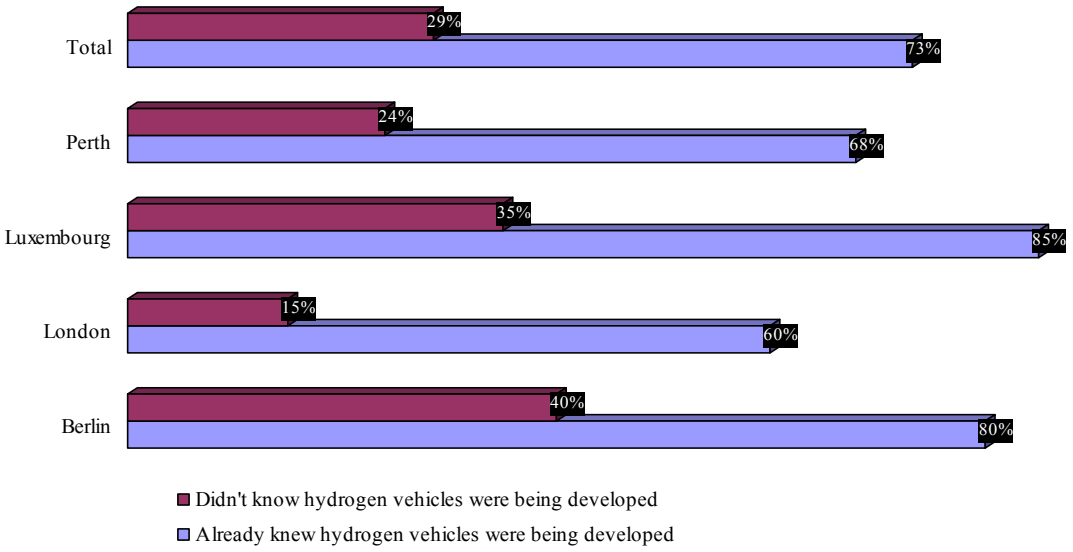
Respondents were also asked how they would feel about the introduction of hydrogen vehicles in their cities (Figure 7). A slight majority would support it (52%), but many would need more information (41%), and only a tiny number would oppose it (1%).

Figure 7: How would you feel about the introduction of hydrogen-powered vehicles in your city?



An interesting insight was that previous knowledge about hydrogen vehicles was determinant to the level of support granted, since the rate of support among those with previous knowledge was at least double the support rate of those without previous knowledge (Figure 8).

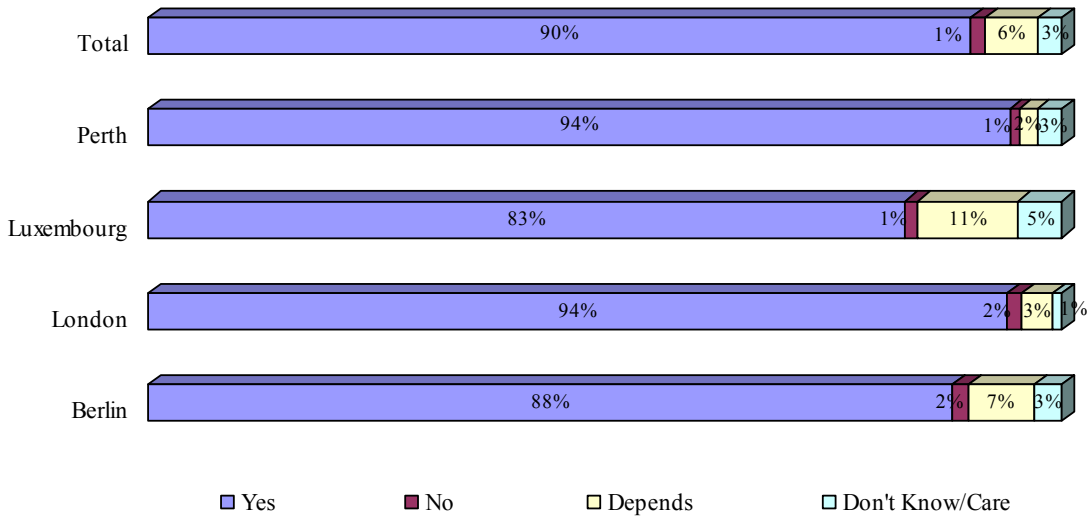
Figure 8: Importance of previous knowledge among supporters of hydrogen vehicles



Attitude towards Hydrogen Buses Trials

After being given information about hydrogen, fuel cells and the hydrogen fuel cell bus trials, interviewees were asked if they thought the demonstration projects were a good idea (Figure 9). The rate of unconditional support – generally motivated by the potential of environmental benefits – was overwhelming (90%) and opposition insignificant (1%).

Figure 9: The trial of hydrogen buses in your city is a good idea?

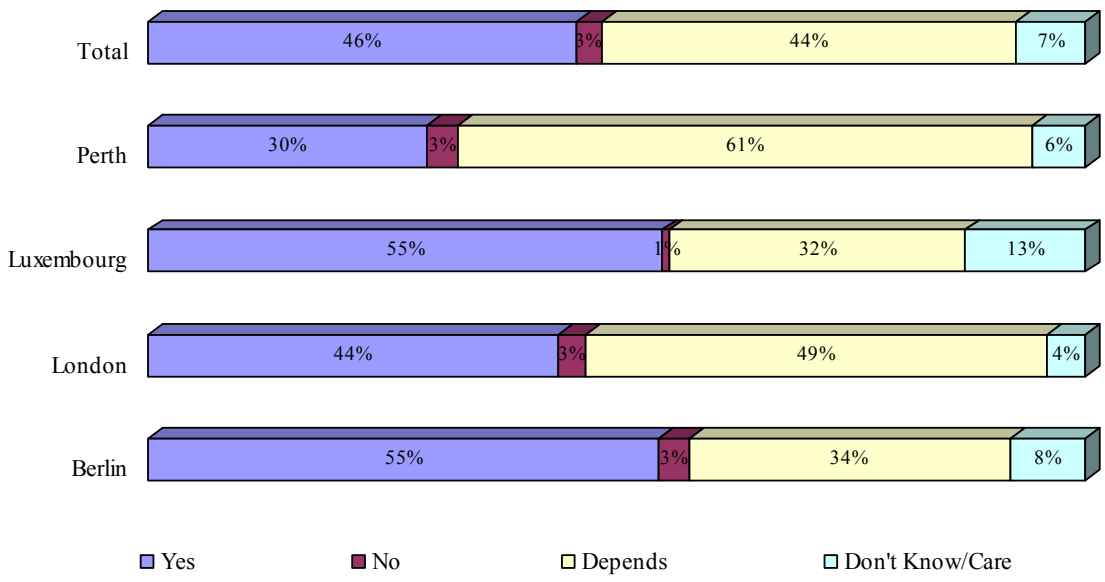


Attitudes towards Large Scale Introduction of Hydrogen Buses

Respondents were much more cautious towards the large-scale introduction of hydrogen fuel cell[6] buses (Figure 10), since unconditional support was down to 46%, while 44% conditioned support to the results of the trials and safety issues, and the opposition represented a mere 3%.

[6] Hydrogen internal combustion engine in Berlin

Figure 10: The large-scale introduction of hydrogen buses in your city is a good idea?

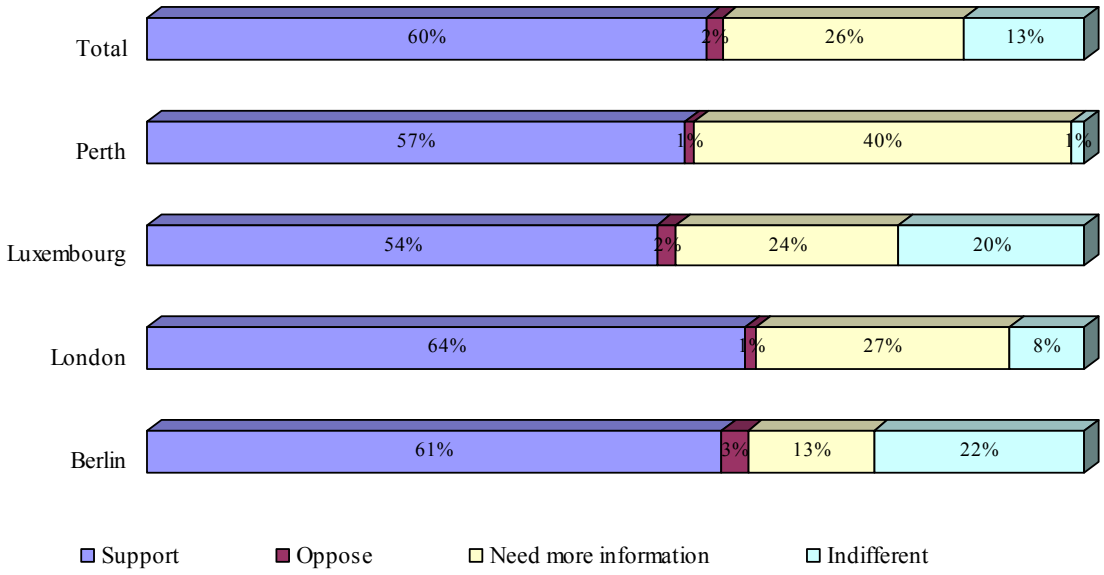


Respondents were also asked if they would try to take the hydrogen or the normal bus if there was a hydrogen bus covering their most common route. Logically, the majority (73%) would take the first bus that comes along, some (22%) would try to take the hydrogen bus out of curiosity, and only 1% said would try to take the normal bus. This indicates that the negative associations with the word hydrogen (Figure 5) did not materialize in fear of travelling in hydrogen vehicles, and thus are not a barrier to their large-scale introduction.

Attitudes towards Hydrogen Storage

A favourable perception of hydrogen storage at local refuelling stations is a crucial step towards setting up a hydrogen infrastructure that allows hydrogen to take-off in the private car sector. In Figure 11 it is clear that the majority (60%) of respondents would support local hydrogen storage, while opposition (2%) related with risk and fears of explosiveness was almost irrelevant. However there was a significant need for more information (26%) and once again previous knowledge of hydrogen vehicles increased the level of support granted.

Figure 11: How would you feel about hydrogen being stored and included as a fuel option at your local petrol station?

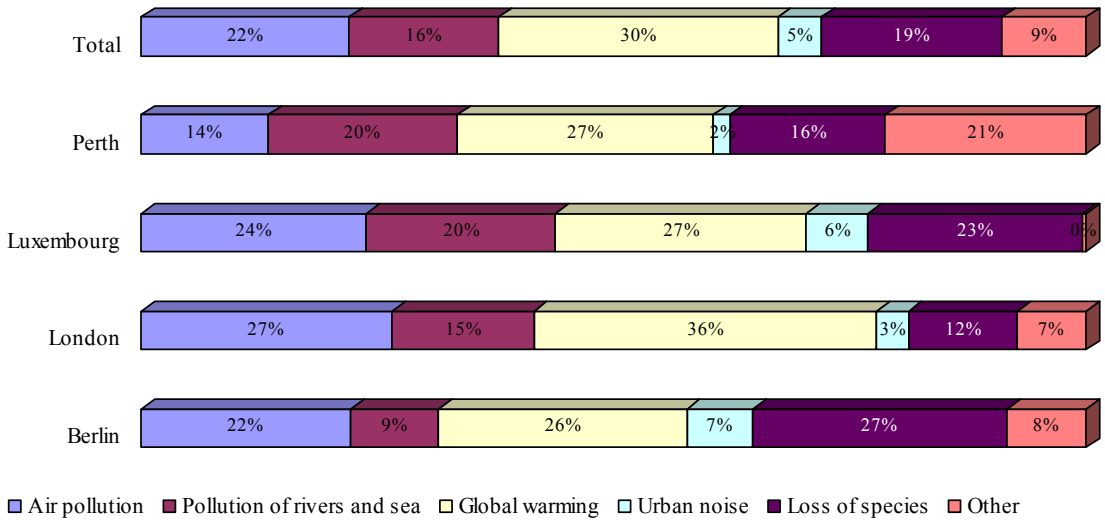


5. Environmental Knowledge and Attitudes

Environmental Priority

Since the respondents' environmental awareness might be a crucial factor that influences the acceptance of hydrogen-powered buses, three categories of environmental awareness were examined. First, the interviewees were asked which environmental issue should have priority in terms of public spending in their countries (Figure 12). Global warming (30%) was the unanimous choice, while urban noise (5%) was considered the least urgent issue to be tackled.

Figure 12: Which of these environmental issues should have priority in terms of public spending?



Environmental Knowledge and Environmental Attitude

The second factor to be assessed was environmental knowledge/attitude (Table 4), with interviewees being asked to rate their approval of eight statements related with transport and the environment using the following five categories: 1 (strongly disagree), 2 (agree), 3 (neither agree nor disagree), 4 (agree), and 5 (strongly agree). Statements S1, S2 and S3 measured environmental knowledge, while environmental attitude was assessed by statements S4 to S8.

Respondents' environmental knowledge was not particularly strong, since although it was satisfactory in statements S1 and S2, many respondents' failed to reject the commonly held misconception that the hole in the ozone layer is the main cause for global warming.

Respondents' environmental attitude was very positive with widespread agreement that "solving environmental problems should be one of the top 3 priorities for public spending" and that "it is necessary for everyone to give up certain activities in order to protect the environment".

This was reinforced by the strong environmental awareness of respondents, who predominantly disagreed with the claim that "environmental problems, such as global warming and air pollution, have been over exaggerated". The general perception that "the decline in oil supplies around the world is a major problem that will cause petrol prices to rise significantly in the next few years" and that "science and technology are the key to solving environmental problems" reveals awareness towards the drivers of change, but does not neglect the role of people's actions and habits.

Table 4: Environmental Knowledge and Environmental Attitude

	Environmental Knowledge	Berlin	London	Luxembourg	Perth	Average
S1	Greenhouse gas emissions from transport are one of the 3 major causes of global warming	3.67	3.88	3.60	3.49	3.66
S2	Car use is the main cause of air pollution in cities	3.70	3.57	3.80	3.52	3.65
S3	The main cause of global warming is the hole in the ozone layer	**2.78**	3.02	**2.40**	2.97	2.70
	Environmental Attitude	Berlin	London	Luxembourg	Perth	Average
S4	Science and technology are the key to solving environmental problems	3.65	3.55	3.80	3.68	3.67
S5	Environmental problems, such as global warming and air pollution, have been over exaggerated	**3.87**	2.10	**3.17**	2.23	1.82
S6	The decline in oil supplies around the world is a major problem that will cause petrol prices to rise significantly in the next few years	3.14	3.73	3.00	3.62	3.37
S7	It is necessary for everyone to give up certain activities in order to protect the environment	4.17	3.67	4.10	3.56	3.87
S8	Solving environmental problems should be one of the top priorities for public spending	3.97	3.90	4.10	4.00	3.99

Scale: 1 - Strongly Disagree / 2 - Disagree / 3 - Neither Agree nor Disagree / 4 - Agree / 5 - Strongly Agree

Statements S3 and S5 were recoded in Berlin and Luxembourg. Thus the **values highlighted in bold have a opposite meaning** (is/have must be read is/have not). The averages presented for these questions (corrected by adding 10 and subtracting the values of Berlin and Luxembourg to the total that is divided by four) appear to biased, and the correct averages should be slightly higher (around 0.3 higher).

Environmental Behaviour

The third factor measured was environmental performance (Table 5), with respondents being asked to assess between 1 (never) and 5 (always), the frequency with which they performed certain activities with significant environmental implications.

Overall, interviewees practically never attended environmental protests or had the concern to buy shares in environmentally engaged or ethical companies. Only rarely did they donate to environmental groups or organisations, but sometimes they avoided using the car for environmental reasons, and selected products due to environmentally friendly ingredients or packaging. But the most striking aspect of respondents' behaviour was the extraordinary commitment with recycling, which they claimed to perform always or very often.

However, this should be treated with caution since people might have answered according to the theoretical values they were expected to. Another possibility is that recycling habits have now become a daily routine, like in Germany for instance, where people are expected to separate household waste.

Table 5: Environmental Behaviour

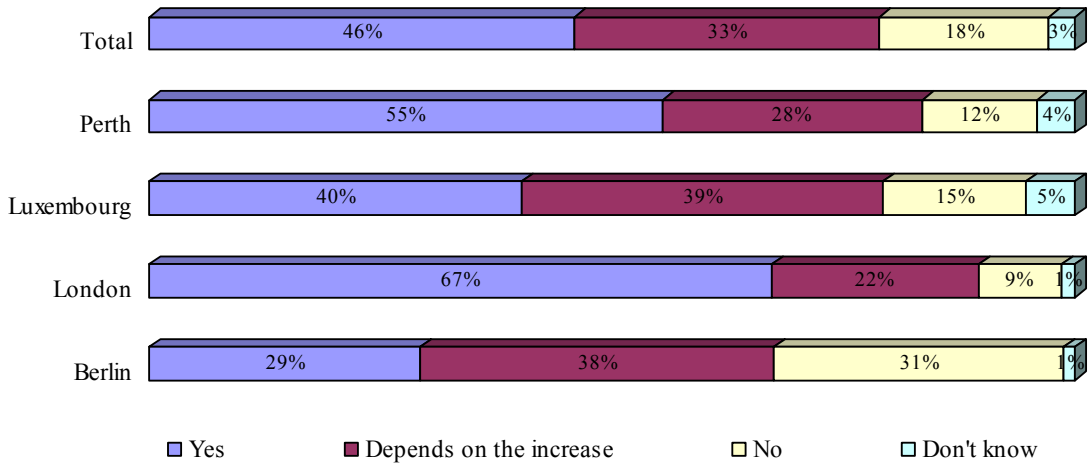
	Environmental Behaviour	Berlin	London	Luxembourg	Perth	Average
Q1	Recycle cans, glass or paper	4.61	3.84	4.70	4.40	4.39
Q2	Avoid using your car for environmental reasons	3.02	1.97	3.16	2.17	2.58
Q3	Buy shares specifically in environmental or ethical companies	1.67	1.13	1.39	1.24	1.36
Q4	Selected one product over another due to environmental friendly ingredients or packaging	3.60	2.98	3.42	3.12	3.28
Q5	Attend environmental rallies or protests	1.69	1.23	1.36	1.29	1.39
Q6	Donate to environmental groups or organizations	2.25	1.99	2.03	2.26	2.13
Scale: 1 - Never / 2 - Rarely / 3 - Sometimes / 4 - Often / 5 - Always						

Finally, environmental membership was assessed and it was found that only 14% of the respondents were members of an environmental, conservation or wildlife organisation.

6. Willingness to Pay for Hydrogen Fuelled Buses

As the introduction of hydrogen buses will certainly involve extra costs, it is important to know whether bus users would be willing to support extra costs in exchange of the environmental benefits they would receive. Therefore, respondents were asked whether they would support the introduction of hydrogen buses if that meant a small increase in bus fares. As the results depicted in Figure 13 show, 46% of the respondents would support the decision, while 33% said it would depend on the actual amount of the increase, and 18% would be against. The Londoners were the most enthusiastic, with 67% supporting and just 9% opposing, while the Germans were the less encouraged with only 29% supporting and 31% opposing. However, this may have to do with the fact that bus fares in Berlin are almost double the level of other cities.

Figure 13: Would you support the introduction of hydrogen buses if that meant a small increase in bus fares[7]?



Willingness to Pay per Fare

In order to quantify the amount respondents were willing to pay (Table 6) they were asked how much more they would be willing to pay *per fare* to have hydrogen buses introduced in their cities. A total of 1,056 interviewees were made, 233 stated a zero willingness to pay, but

[7] These figures do include protests, but if they were removed, overall support would increase.

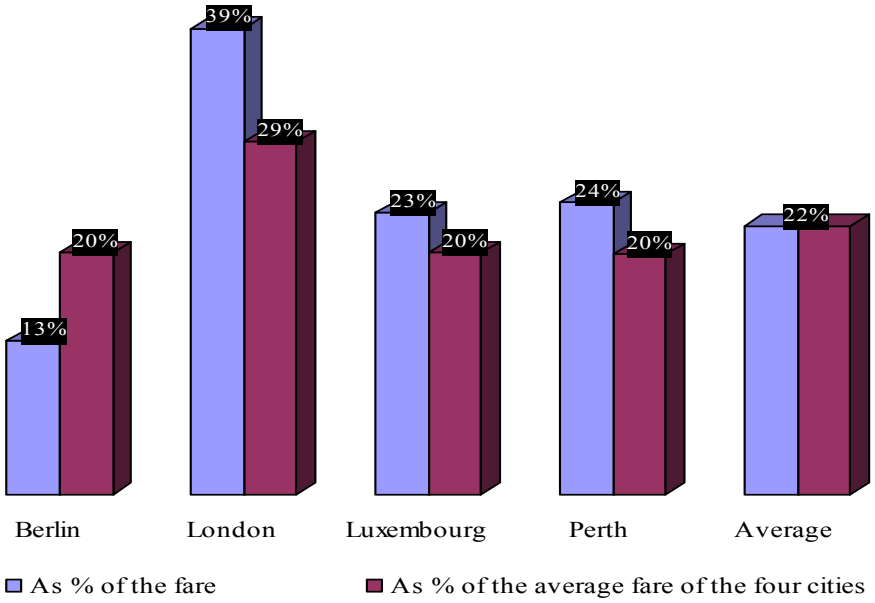
reasons given revealed that 150 were protest responses. Thus, only 83 valid zero statements were included into the analysis and, after removing 7 outliers, the analysis recognised only 899 answers as being valid. The estimated mean willingness to pay (Figure 14) per fare (£0.21 = €0.31 = A$0.54) represented 22% of the average bus fare (£0.93 = €1.40 = A$2.45).

The highest mean WTP *per fare* (£0.27 = €0.41 = A$0.71) occurred in the city – London – with the lowest fare (£0.70 = €1.05 = A$1.85), this appears to suggest that the willingness to pay for (environmental) improvements in the service depends on the differential between the value people attribute to a certain service and the price they are charged. If that gap is narrow and viable substitutes are available (underground), the willingness to pay for improvements will also be narrow. However, this baseline view is challenged by the fact that Luxembourg, Perth and Berlin have the same mean WTP *per fare* (£0.18 = €0.28 = A$0.49) although the bus fare in Berlin (€2.20 = £1.45 = A$3.85) is around twice that of London, Luxembourg or Perth. Furthermore, the average income of Berlin respondents is about half of those in London.

Table 6: Willingness to Pay - Single Fare

WTP SINGLE FARE	Berlin	London	Luxembourg	Perth	Average
Price of Single Bus Fare	1,45 GBP	0,70 GBP	0,79 GBP	0,76 GBP	0,93 GBP
Mean WTP (no protest or outliers)	0,18 GBP	0,27 GBP	0,18 GBP	0,18 GBP	0,21 GBP
Max WTP	2,18 GBP	1,50 GBP	2,97 GBP	0,95 GBP	1,90 GBP
Price of Single Bus Fare	2,20 EUR	1,05 EUR	1,20 EUR	1,14 EUR	1,40 EUR
Mean WTP (no protest or outliers)	0,28 EUR	0,41 EUR	0,28 EUR	0,28 EUR	0,31 EUR
Max WTP	3,30 EUR	2,25 EUR	4,50 EUR	1,43 EUR	2,87 EUR
Price of Single Bus Fare	3,85 AUD	1,85 AUD	2,10 AUD	2,00 AUD	2,45 AUD
Mean WTP (no protest or outliers)	0,49 AUD	0,71 AUD	0,49 AUD	0,48 AUD	0,54 AUD
Max WTP	5,78 AUD	3,96 AUD	7,88 AUD	2,50 AUD	5,03 AUD
Sample	341	282	287	146	264
Protests and Outliers	86	22	28	21	39
Sample (no protests or outliers)	255	260	259	125	225

Figure 14: WTP per fare as % of the fare price



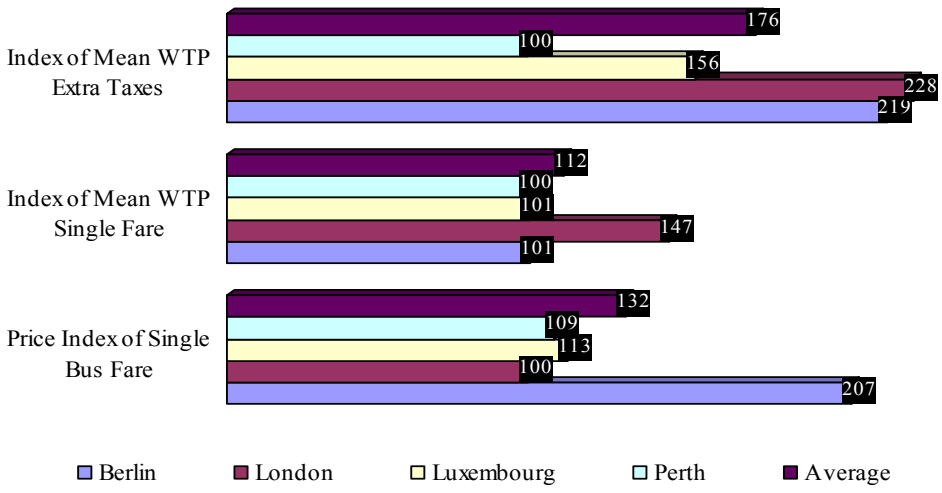
Willingness to Pay Extra Taxes

Now under a different scenario, where the introduction of hydrogen buses would be dependent on a small tax increase – with bus fares remaining the same - the interviewees were asked how much more taxes they would be willing to pay *per year* to finance the large scale introduction of the hydrogen buses. Table 7 provides evidence of the negative public reaction to the taxes option, with 637 respondents (506 protests) from a total of 1297 refusing to pay more taxes. After including 131 valid zero statements and removing 46 respondents that don't pay tax anyway (e.g. students) from the analysis, the number of valid answers drops to only 745. The estimated mean WTP extra taxes (£15.37 = €23.18 = A$40.65) was considerably lower than the WTP *per fare*, either due to temporal embedding or to negative attitudes towards tax based payments. London had the higher mean WTP in both scenarios but was shortly followed by Berlin in the taxes option, while Perth had the lowest mean WTP in both cases (Figure 15).

Table 7: Willingness to Pay - Extra Taxes

WTP EXTRA TAXES	Berlin	London	Luxembourg	Perth	Average
Mean WTP (no protest or outliers)	19,19 GBP	19,94 GBP	13,61 GBP	8,75 GBP	15,37 GBP
Max WTP	132,00 GBP	1.500,00 GBP	132,00 GBP	19,00 GBP	445,75 GBP
Mean WTP (no protest or outliers)	29,07 EUR	29,91 EUR	20,62 EUR	13,12 EUR	23,18 EUR
Max WTP	200,00 EUR	2.250,00 EUR	200,00 EUR	28,50 EUR	669,63 EUR
Mean WTP (no protest or outliers)	50,87 AUD	52,64 AUD	36,09 AUD	23,02 AUD	40,65 AUD
Max WTP	350,00 AUD	3.960,00 AUD	350,00 AUD	50,00 AUD	1.177,50 AUD
Sample	341	414	242	300	324
Protests and Outliers	177	180	90	105	138
Sample (no protests or outliers)	164	234	152	195	186

Figure 15: Price and WTP Indexes (Baseline =100)



Bus Tickets

The cost of a single bus ticket in Berlin was twice the price of a bus ticket in London, while prices in Luxembourg and Perth were slightly more expensive than in London. The average price of tickets (£0.93 = €1.40 = A$2.45) and more detailed information is presented in Table 8.

Table 8: Fares

WTP SINGLE FARE	Berlin	London	Luxembourg	Perth	Average
Price of Single Bus Fare	1,45 GBP	0,70 GBP	0,79 GBP	0,76 GBP	0,93 GBP
Price of Single Bus Fare	2,20 EUR	1,05 EUR	1,20 EUR	1,14 EUR	1,40 EUR
Price of Single Bus Fare	3,85 AUD	1,85 AUD	2,10 AUD	2,00 AUD	2,45 AUD

7. Regression Analysis

Ordinary least squares regression (OLS) was used to generate a model of WTP for each payment vehicle (single fare, extra taxes). Although from a theoretical perspective one would expect that the frequency of bus use and the perception of fumes and noise level of existing buses would be crucial factors to influence WTP, these variables proved of little importance and did not add significant explanatory power to the model (Table 9). In addition, some degree of correlation between variables such as age, education and income was found.

The coefficient of determination of both models was relatively weak ($0.14<R2<0.34$), but their robustness proved satisfactory (F-statistic significance < 0.05), thus the variation explained by the model was not due to chance. Environmental sensibility was the crucial variable to explain willingness to pay for the introduction of hydrogen powered buses, although income and satisfaction with existing buses were also relevant in 3 out of 4 surveys.

Table 9: Regression Analysis

Influence of Variables on WTP per Fare	Berlin	London	Luxembourg	Perth	Overall
Sex (male)	No Influence	No Influence	No Influence	No Influence	No Influence
Age	-	-	-	No Influence	---
Income	+	+	+	No Influence	+++
Education	-	No Influence	No Influence	No Influence	-
Knowledge of H2 Vehicles	No Influence	+	-	No Influence	No Influence
Satisfaction with existing buses	+	+	+	No Influence	+++
Environmental Sensibility/Attitude/Behaviour	+	+	+	+	++++
Influence of Variables on WTP Extra Taxes	Berlin	London	Luxembourg	Perth	Overall
Sex (male)	+	+	No Influence	No Influence	++
Age	No Influence	+	No Influence	-	No Influence
Income	+	+	+	+	++
Education	-	No Influence	-	+	-
Knowledge of H2 Vehicles	No Influence	+	No Influence	No Influence	+
Satisfaction with existing buses	No Influence	No Influence	+	No Influence	+
Environmental Sensibility/Attitude/Behaviour	+	+	+	+	++++
R2 of the Model	Berlin	London	Luxembourg	Perth	Overall
WTP Per Fare	0.19	0.14	0.25	0.19	0.19
WTP Extra Taxes	0.25	0.20	0.26	0.34	0.26

8. Conclusions

There is reasonable consistency between the results of the Berlin, London, Perth and Luxembourg surveys. However, there was large inter-city variance in issues like income, proportion of bus users and share of households that own a car. London was the indisputable leader of income, education and employment levels, while Perth had the lowest frequency of bus use. On average, around 30% of bus users took the bus 5 or more times a week, mainly to travel to work/college or to go shopping. Overall satisfaction with buses was greater in Luxembourg and Perth, than in Berlin and London. Users were particularly satisfied with the existing number of bus stops, frequency and security of/on buses but were discontent about crowding onboard, fumes and noise from buses.

Associations with hydrogen were mainly neutral and knowledge of hydrogen vehicles was relatively weak, but there was overwhelming support for the hydrogen buses trials. Support for large-scale introduction of hydrogen buses and development of local refuelling infrastructures still requires additional information, but they are generally welcomed. These are good news for the hydrogen economy, since public approval of hydrogen infrastructure is critical to its success. In addition, it was found that previous knowledge of hydrogen vehicles increased public acceptance of demonstration projects and hydrogen storage twofold. Therefore, fostering informational campaigns about hydrogen applications appears to be the right step towards an improved public perception of the technology and a wider market penetration.

Environmental attitude was generally very positive with widely held agreement that "it is necessary for everyone to give up certain activities in order to protect the environment" and that tackling "global warming and local air pollution should be priorities in terms of environmental public spending". These considerations reflected respondents' environmental maturity and understanding of the trade offs involved and degree of extension of environmental problems. Environmental knowledge was less satisfactory, since the majority of respondents did not reject the commonly held misconception that "the hole in the ozone layer is the main cause for global warming". Environmental behaviour was almost restricted to recycling habits and choice of environmentally friendly products, while environmental membership was rare as expected.

Willingness to pay for extensive introduction of hydrogen buses soared in the single fare option with a mean WTP (£0.21 = €0.31 = A$0.54) that represented 22% of the average fare, while willingness to pay using extra taxes was relatively lower (£15.37 = €23.18 = A$40.65). The main determinant to influence willingness to pay under both payment vehicles was environmental sensibility.

The fact that willingness to pay (on a yearly basis) is higher per fare than per extra taxes may suggest that the costs of large-scale introduction of hydrogen buses would be more efficiently offset by a fare increase, than by a tax raise. However, the universal nature of environmental and social-health benefits deriving from the introduction of clean buses can justify the option for taxation. Furthermore the fares of public transportation should be kept relatively low to incentive this form of transportation, which is justifiable by environmental (reduce pollution), efficiency (save resources) and equity (avoid social exclusion of the poor from public transport) arguments.