Work package 7 - Deliverable 10

Report on How to Run Effective Demonstration Projects: Results from the AcceptH2 Project

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Public Acceptance of Hydrogen Transport Technologies

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Introduction

The introduction of hydrogen (H2)-fuelled vehicles is taking place in selected demonstration cities worldwide, with a view to achieving full commercialisation. However, the successful introduction of these vehicles will depend not only on technical maturity, but also on public acceptance of these new fuels and technologies. While there is strong industrial and political interest in the introduction of H2 vehicles to the market, a belief among many experts persists that the wider public would not accept hydrogen for safety reasons.

Using survey-based methods for data collection, the AcceptH2 project aims to contribute strongly to a better understanding of the public acceptability of H2 technologies, and hence enable the introduction of H2 vehicles to be carried out with a clear strategy towards public acceptance. AcceptH2 is a cross-continental comparative assessment of public knowledge, acceptability and preferences ('willingness to pay') for H2-fuelled buses, in five cities: Berlin (Germany), London (UK), Luxembourg, Oakland (US) and Perth (Western Australia).

This report presents a comparative assessment of changing public awareness, attitudes and willingness to pay associated with the trial of H2 buses in four of the partner cities: Berlin, London, Luxemburg and Perth. By comparing public awareness, acceptability and preferences associated with hydrogen transport *before* and *after* the introduction of demonstration H2 buses in different cities across the world, the project aims to: 1) investigate the factors that determine the *effectiveness* of H2 bus demonstration projects in shaping public knowledge, perceptions, values and use, and on the basis of these findings, 2) to develop *recommendations* for maximising the positive influence and uptake of future demonstration and commercial projects.

Introduction to Cities Involved

The cities involved in the AcceptH2 project are Berlin, London, Luxembourg, Perth and Oakland. In this report however, findings will only be presented for the first four cities. This is because Oakland did not carry out an *after* survey; hence it was not possible to assess the influence of the demonstration projects on public perceptions.

London

The largest of the cities involved in this project is London, which has a population of 7.4 million (GLA, 2002). London's air pollution levels rate as amongst the highest in the UK and it is estimated that 1600 accelerated deaths and 1500 hospital admissions for respiratory conditions per year occur as a result of air pollution (GLA, 2002). The major cause of air pollution in London is road transport - as in most of the other cities in this project. Road transport is also a major contributor to carbon dioxide (CO_2) emissions: it is responsible for 22% of all UK CO_2 emissions (for the year 2003) (DUKES, 2004) and 21% of all CO_2 emissions in the Greater London area in 2004 (GLA, 2004).

There have been a number of alternative-fuel vehicle trials in London, including the trial of 3 electric minibuses for Camden Community Transport between 1995 and 1997, 19 CNG coaches in the borough of Merton since 1997 and a 1-year trial of a hybrid electric/ fuel cell van by the City of Westminster from December 1999. There have also been many trials of alternative-fuel buses in the UK, mainly CNG and LPG, although in total there are only around 100 currently in operation. To date there has been little experience with hydrogen or fuel cell (FC) vehicles in the UK. The 3 H2 FC buses, introduced in December 2002 in London as part of the European-wide *Clean Urban Transport for Europe* project (CUTE), are the first of their kind in this city. They will be running for a period of 2 years.

Berlin

The next largest city in this study is Berlin, which has a population of 4.5 million. Berlin was host to one of the world's first H2 fleet vehicle demonstration projects, which took

place in the 1980's. This consisted of the trial of ten medical vehicles propelled by H2-powered internal combustion engines, between 1984 and 1988. Further H2-related demonstration projects followed in the late 1990's, including the BMW Clean Energy World Tour 2001, which consisted of a tour of H2-powered BMW vehicles in a number of cities worldwide. The tour ended in November 2001 with a closing event in Berlin.

Although Berlin has had ample experience with H2 vehicles, as noted, the H2 bus trial is the first of its kind. The H2 bus trial in Berlin involved the trial of one MAN bus in the city, operated by the local public transport service provider BVG from May 2004 to December 2005. Compared to the other cities involved in the project, the trial in Berlin has involved the least number of buses and shortest trial period.

Luxembourg

Luxembourg city has a population of 81,000 inhabitants, making it the least populated city in this project. As in London, there have been a number of alternative-fuel transportation initiatives, such as natural gas buses and hybrid electric-diesel buses (currently in operation). However, prior to the H2 bus trials, there had been no experience of hydrogen or fuel cell vehicles in the Grand Duchy.

Three H2 FC buses were introduced in Luxembourg in December 2003 as part of the CUTE project. They will be operating in the city for a period of 2 years.

Perth

Perth, in Western Australia, has a population of 1.4 million inhabitants (ABS, 2001). In Perth, motor vehicles contribute 80% of CO_2 emissions, 40% of VOC's and 42% of NOx emissions (Department of Environment, 2003). Alternative fuels are used quite widely in Australia: at the beginning of 2003 there were about 2500 CNG vehicles, and over 500,000 LPG vehicles operating in Australia. In Western Australia specifically, several Perth Local Government Authorities are trialing biodiesel trucks, and the Western Australia Public Transport Authority is aiming to trial 12 biodiesel buses for about 3 months. The current policy of the Western Australian government is to replace all

existing diesel buses in the public transport fleet with Natural Gas Buses. This is undertaken as part of the natural bus replacement programme.

As with London and Luxembourg, Perth has had no previous experience of hydrogen or fuel cell vehicles. Thus the 3 H2 FC buses, introduced in Perth in September 2004 as part of the *Sustainable Transport Energy for Perth* (STEP) H2 bus trial, are the first of their kind in this city. They will be operating for a trial period of 2 years.

Analysis of Impact of H2 Bus Trials on Awareness, Acceptability and Preferences

This section presents the results of the regression analyses that were carried out on pooled ex ante and ex post survey data for each city. The purpose of carrying out such analyses is twofold: firstly, they allow us to identify which variables influence knowledge, acceptability and WTP for H2 buses and storage in the various cities. Secondly, these analyses allow us to identify whether there have been statistically significant changes in knowledge, acceptability and WTP for H2 technologies. Full details of the results and analysis can be found in the report entitled: '*Comparative Analysis of the Impact of the H2 Bus Trials on Public Awareness, Attitudes and Preferences: a Comparative Study of Four Cities*' which can be found on the project website (www.AcceptH2.com).

Results of the various regressions exploring changes in public awareness about H2-vehicles, and unconditional support and preferences for the large-scale introduction of H2 buses in each city show that, 6 months into the trial of H2 buses in each city, there have been a number of changes. These are summarised below.

Raising Awareness

1) Awareness about H2-powered vehicles has increased amongst respondents in Luxembourg and Perth only.

2) Summary statistics indicate that awareness about the H2 bus trials was highest in Perth (57% of bus users 54% of non-bus users had heard about the bus trial), followed closely by Luxembourg (51% of bus users had heard about it[1]). Conversely, in London, only a 20% of bus users and 15% of non-bus users were aware of these trials.

Attitudes

3) Unconditional support for the large-scale introduction of H2 buses increased in all cities involved.

Preferences (Willingness to Pay)

4) WTP for the large-scale introduction of H2 buses has not changed, in most cases, except:
    a. In Luxembourg, where there is an increased WTP extra annual tax, but no change in WTP extra bus fare.
    b. In Berlin, where there is an increased WTP extra annual tax only (but only significant at the 10% level).
    c. In Perth (whole sample) where there is an increased WTP extra annual tax only (but only significant at the 10% level).

Attitudes of H2 Bus Users

A small proportion of bus users interviewed in each city had actually travelled on one of the H2 buses: 12 respondents in Berlin (4.5% of sample), 11 respondents in London (4.4% of bus user sample), 47 respondents in Luxembourg (19% of sample) and 15 respondents in Perth (9% of bus user sample).

It is clear from these figures that Luxembourg bus users have had greater direct experience of the H2 FC buses being trialled in their city, whilst bus users in Berlin and London have had the least experience of these buses. This is likely to be a direct

[1] Non-bus users were not sampled in Luxembourg, or Berlin either.

consequence of the different sizes of the cities, and hence relative accessibility of 3 H2 buses, plus the limited trial-period for the Berlin H2 bus (approximately 6 months).

Based on the empirical literature (e.g. Altmann and Graesel, 1998; Gould and Golob, 1998), it is expected that direct experience of a new environmental transport technology will increase acceptance. However, a Logit regression on the binary variable H2SUPP, representing unconditional support for the large-scale introduction of H2 buses in each city (where 1=yes, 0=no) indicates that direct experience of a H2 bus has *no significant effect* on support for the large-scale introduction of H2 buses. Similarly, interval regression analysis of willingness to pay data indicates that direct experience of a H2 bus has no effect on WTP values in any city.

Furthermore, respondents interviewed on-board H2 buses in Luxembourg were less likely to unconditionally support the large-scale introduction of H2 buses, and more likely to say that their support depended on the outcome of the trials. Additionally, on-board respondents in Luxembourg (and Berlin, although only significant at the 10% level) were WTP significantly *less* in extra taxes to support the introduction of H2 buses, compared to all other ex post respondents. However, their WTP extra bus fare was not significantly different, suggesting that values estimated using the tax-based payment mechanism might be reflecting attitudes towards taxes rather than attitudes towards the H2 buses.

Nonetheless, the overall lack of effect of direct experience on acceptance, coupled with the attitudes, noted above, of on-board respondents in Luxembourg and Berlin, suggest that the experience of the H2 buses has been less positive than would have been hoped. This raises a number of key questions about the effectiveness of these trials in 'convincing' members of the public about their value. If riding on a H2 bus has no significant influence on the likelihood of support, then one needs to question whether these buses are providing the same level of performance, comfort, reliability of conventional buses.

However, respondents who had travelled on a H2 bus in London, and respondents who were interviewed on-board a H2 bus in Luxembourg and Berlin, rated the H2 buses better than conventional buses. Thus, results indicate that, despite rating the H2 buses more positively than conventional buses, direct experience has had no significant influence on attitudes and WTP for the large-scale introduction of H2 buses. In-depth qualitative interviews would be useful at this stage to explore the reasons for this finding.

It is suggested that direct experience of the technology must be coupled with adequate information on hydrogen (to increase prior knowledge, which was found to be a key driver for unconditional support in most cities) and information on the environment (to influence environmental sensibilities, which were found to be key drivers for support and WTP in most cities), in order to influence acceptance.

Discussion and Conclusions

These results suggest that the H2 bus trials have been more effective in raising public awareness in Perth and Luxembourg, compared to Berlin and London. Although it is evident that three H2 buses will be more visible in smaller cities such as Luxembourg (population 81,000) or Perth (population 1.5m), compared to larger cities such as London (population just under 8m) or Berlin (population 4.5m), it is suggested that the different levels of influence of the H2 bus trials on bus user awareness in each city also reflects the extent of public outreach and information campaigns that accompanied these demonstration projects.

In Perth, in particular, there has been an extensive public dissemination campaign associated with this trial, involving brochures, school visits, TV programmes, a dedicated website, conferences and various radio interviews. Luxembourg also made radio commercials when the buses arrived, and more than 1,000 persons took part in dedicated guided tours during the first six months of the Luxembourg bus trial alone. In contrast, in London only a handful of articles about the bus trials were published in the media; in

Berlin, as noted, the trial involved one bus only operating for about 6 months, and very limited media attention.

On the basis of these results, it is suggested that the effectiveness of the H2 bus demonstration projects is a function of two key factors:

1. The extent to which the public has been engaged via information and communication campaigns.
2. The relative exposure of the buses, which is in direct proportion to the size of the cities.

Furthermore, there appears to be an increase in unconditional support in all cities, and an increase in WTP in Luxembourg (taxes only) - and Perth and Berlin (at 10% level) - that has not been explained by any of the socio-economic or attitudinal variables included in the regressions. This suggests that some other factor has changed, which has led individuals to value H2 buses more, *ex post*. This could include:

1. Changed attitudes to new environmental technologies
2. Changed attitudes to climate change
3. Changed attitudes to transport and emissions.

These changes may have occurred as a result of increased media attention to these issues. In London, for example, there have been a number of television programmes and newspaper articles, over the past year, about climate change and transport emissions; it is possible that this information has influenced attitudes towards new environmental transport technologies, such that respondents are more likely to express unconditional support for H2 buses despite no prior knowledge about this particular technology.

Glossary

AcceptH2	Acceptance of Hydrogen Buses Project
CNG	Compressed natural gas
CO_2	Carbon dioxide
CUTE	Clean Urban Transport for Europe
FC	Fuel cell
H2	Hydrogen
LPG	Liquefied petroleum gas
MAN	Maschinenfabrik Augsburg Nürnberg
NOx	Nitrogen oxides
STEP	Sustainable Transport Energy for Perth
VOC	Volatile organic compound
WTP	Willingness to pay

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