



Case 21: Berlin H2Accept hydrogen bus trials

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Cultural Influences on *Renewable Energy Acceptance* and *Tools* for the development of communication strategies to promote ACCEPTANCE among key actor groups

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1. Introduction

This case study examines a pilot project concerning the introduction of a hydrogen fuelled bus in Berlin in 2004 and a public acceptance study executed before and after the introduction of the bus. These two projects were, however, managed completely separately and developed independently from each other. For this study, the representatives of the main participants were interviewed: Head of Department ‘Vehicle Management Bus’ at the Berlin public transport company ‘Berliner Verkehrsbetriebe’ Mr. Eberwein and Mr. Schmidt at the Ludvig-Bölkow-Systemtechnik GmbH.

The public acceptance study ACCEPTH2 (<http://www.accepth2.com>), included an analysis of the impacts of hydrogen bus demonstration projects on public perceptions in three European and one Australian city in order to determine broad acceptability of hydrogen fuelled public transport. Differing from other public acceptance studies, the ACCEPTH2 study expands the perspective by including an examination on willingness-to-pay to assess the economic viability of hydrogen-fuelled public transport in these countries.

The first part of this paper shortly sums up the history of hydrogen-fuelled transportation projects as well as the public acceptance studies considering hydrogen technologies in Germany and especially in Berlin. The second part concentrates on the specific hydrogen bus pilot project of the year 2004. Section four presents the lessons learned from the project.

2. Country overview: Germany

2.1 Government funding

The transport sector is one of the key economic sectors in Germany, due to the - in the European context - big size of the country and the amount of its inhabitants (82.5 million in 2004) (Statistisches Bundesamt 2006). The public transport is well organised in the German cities and especially in Berlin its importance is significant since Berlin is the capital and Germany’s largest city with 3.4 million inhabitants in 2004 (Statistisches Bundesamt 2006). In 1997, the public transportation in the German cities’ local traffic was 83 billion person kilometres (BMVBS 2000).

At present, the support for innovations in hydrogen technologies in Germany is high on the agenda. In May 2006, the German Federal Government through its Federal Ministry of Transport, Building and Urban Affairs (BMVBS, Bundes Ministerium für Verkehr, Bau und Stadtentwicklung) announced its plans to make € 500 million available for the promotion of hydrogen and fuel cell technology. The ‘National Hydrogen and Fuel Cell Technology Innovation Programme - Shaping Future Mobility’ is launched within the scope of the National Innovation Programme (the Fifth Energy Research Programme of the Federal Government). The aim of the innovation programme is

“to strengthen the application-oriented research and development activities in the fields of hydrogen and fuel cell technology with a view to deploy these technologies in transport...” (BMVBS, 2006).

The emphasis of this programme is on commercialisation and supporting research and development that have a strong focus on real-life applicability. The objective of the National Innovation Programme is “to preserve and bolster Germany’s leadership in hydrogen and fuel cell

technology by providing a substantial financial boost to hydrogen and fuel cell research in Germany". (BMVBS, 2006).

One of the motivations is the importance of the automobile industry for the German economy. It is feared that foreign competitors gain a competitive advantage and that the German car manufacturers lose market shares in the international automobile markets in the future. This would mean a loss of employment and associated negative economic implications. The German government recognises that a successful commercialisation will require financial support from the public sector since the hydrogen technologies are not yet competitive due to their high cost. Therefore, it is considered that a significant rise in funding will be required also in future.

The German governments have invested in the development of the hydrogen and fuel cell technology during the last three decades. From 1974 until 2003, approximately € 200 million funding has been available (BMVBS, 2006). Ten years ago, in 1996, the research funding was concentrated on "development and testing of automobiles with hydrogen propulsion, mainly demonstration in a fleet test of automobiles with hydrogen propulsion in Berlin ...". Then it was also stated that "a future focus of research funding in this area will ... be on the development on fuel cell technologies" (BMBF, 1996).

2.2 Hydrogen demonstration projects

The history of hydrogen demonstration projects in public transport in Germany is already long. Already in the 1980s, the first demonstration project took place in Berlin. Ten Mercedes-Benz vehicles operated as medical transporters for four years starting in 1984. During this time, the covered distance of these ten hydrogen fuelled vehicles was 250,000 km (Schmidt and Altman, 2004).

In the 1990s, there were several hydrogen vehicle demonstrations in public transport in various German cities using different hydrogen technologies ranging from gasified liquid hydrogen to the use of fuel cells. One of the demonstrations, in which hydrogen was used directly as fuel (MAN LH2 city bus), took place first in Erlangen in Bavaria and was then prolonged in Munich in Bavaria during 1995-1997. In Karlsruhe, in Baden-Württemberg, four city buses were operated in 1995 that also were directly fuelled with hydrogen. In Bavaria, a fuel cell propulsion for urban heavy duty vehicles was realised at the end of the 1990s (Wurster, 1995).

In 2001, the German car manufacturer BMW held a so-called 'CleanEnergy WorldTour' demonstration in six cities around the world (Berlin, Brussels, Dubai, Los Angeles, Milan and Tokyo). This demonstration and promotion tour introduced 15 hydrogen power vehicles for private use but not for public transport (Schmidt and Altman, 2004).

In May 2004, Berlin's public transport operator BVG (Berliner Verkehrsgesellschaft) introduced a hydrogen fuelled bus into daily operation in the centre of Berlin. The termination of the bus trial was in December 2004. This trial was accompanied by the ACCEPTH2 -study project.

The project duration of the AcceptH2 was January 1st, 2003 to June 30th, 2005 (<http://www.accepth2.com>). Public acceptance was measured in four cities, in Berlin, London, Luxemburg and Perth Australia. Berlin was the only city using buses with internal combustion engines, starting in May 2004, but the other towns demonstrated fuel cell buses between 2004 and 2006. The demonstration in Berlin terminated in December 2004 but gave good results in performance.

Both Stuttgart and Hamburg participated in the CUTE project. After the CUTE, Hamburg took a definite stand with prolonging the demonstration into the Hy-FLEET:CUTE using 12 fuel cell buses in their regular public transportation fleet. Berlin also joined the Hy-FLEET:CUTE showing progressive policy by building a fuel station that can deliver several types of alternative fu-

els and using 14 MAN Nutzfahrzeuge (www.global-hydrogen-bus-platform.com) buses with internal combustion engines.

New public surveys were made during the Hy-FLEET:CUTE in October 2006, in the same towns as AcceptH2 as well as in the other four Hy-FLEET CUTE cities: Reykjavik, Amsterdam, Barcelona and Beijing.

In order to gain the maximum international publicity to its HyFLEET Busses, Berlin introduced the first two hydrogen fuelled busses on the first of June 2006 on the eve of the FIFA world cup 2006 held in Germany. Within two years, there should be a fleet of 14 hydrogen busses operational in Berlin. The project is supposed to run until 2009. The first two busses were operated during the world cup to transport the audience to the stadium. Afterwards they will be taken in the normal line operation. The introduction of hydrogen busses - thus CO₂-free means of public transport - is a part of a larger Green Goal project around the FIFA world cup. The aim of the Green Goal project was that the FIFA 2006 is the first big event in context of the international sport that is climate neutral thus setting an example for future major events on how to design them in a climate neutral way.

In addition to HyFLEET:CUTE -succession project, some big German companies operating in the energy and transport sector formed a new consortium in November 2004 in order to demonstrate different methods of hydrogen production and develop hydrogen technologies for vehicles with a view to start series production. The Clean Energy Partnership (CEP) consists of Aral, the BMW Group, BVG, DaimlerChrysler, Ford, GM/Opel, Hydro, Linde, TOTAL and Vattenfall Europe. CEP runs a demonstration projects in Berlin testing the everyday suitability of hydrogen for transportation purposes. (Schmidt and Altman, 2004.)

This initiative is supported by the German Federal Government as a part of its Programme of Investments for the Future. The CEP-project has a total budget of € 33 million, of which € 5 million are public funds. The CEP project in Berlin is considered as the largest and technologically most advanced transport sector hydrogen demonstration project in Europe (BMVBS, 2006).

2.3 Existing studies considering the acceptance of hydrogen

In context of the ACCEPTH2 study, an extensive analysis was made about the existing studies and literature considering the acceptance of hydrogen. It was found out that only a few studies directly consider the acceptance of hydrogen as a fuel. However, Germany has been a leading country in studies focused on hydrogen acceptance of the general public. The studies suggest that the level of acceptance of hydrogen vehicles in Germany is high. However, the knowledge of the general public about this technology is rather low (Altmann et al., 2003).

Most studies mainly focus on studying individual's attitudes towards purchasing a vehicle themselves. These studies suggest that, irrespective of high acceptance levels of hydrogen vehicles, the environmental concern will not be the determining factor when deciding about the purchase of cleaner vehicles - at least not in the short term. More important will be their price and performance. However, if these two determinants become competitive, the environmental concern may act as a predictor of consumer choice (Altmann et al., 2003).

3. Summary of the H2 bus pilot project in context of the ACCEPTH2 study

The ACCEPTH2 project analysed the impacts of hydrogen-fuelled transport demonstration projects on public perceptions and examined the willingness to pay for hydrogen-fuelled transport

in Berlin, London, Luxembourg and Perth in 2003-2005. This study was the first to focus on the wider economic evaluation on hydrogen vehicles especially. Previous research has typically analysed preferences for private car ownership or looked strictly at the technical and financial feasibility of hydrogen technology. The ACCEPTH2 project on the other hand complemented and extended previous economic assessment work by focusing on hydrogen fuel busses and their environmental benefits for public.

The project was a large international study, with the goal to study the acceptance of hydrogen technologies in public transport. The project carried out two identical studies in each city: one before (*ex ante*) the introduction of the hydrogen bus and the second afterwards (*ex post*). In this case, the targeted *public* was the *local residents* i.e. the residents in these cities that could use or could have used the hydrogen bus. The repetition of the study after the demonstration projects enabled the analysis of the level of influence that the demonstration project had on public perceptions as well as the economic preferences of the public.

The European part of the ACCEPTH2 project was funded by the European Commission. The Co-ordinator of the project was the Imperial College of Science, Technology and Medicine in London, United Kingdom. In Germany, the participants were the L-B-Systemtechnik GmbH, University of Saarland and the Berliner Verkehrsgesellschaft (BVG). The main results of the ACCEPTH2 study were that the support for hydrogen and fuel cells is high in Berlin. Also the knowledge about hydrogen and fuel cells of the residents of Berlin was relatively high compared with the other cities.



Figure 3.1 *Hydrogen fuelled bus in Berlin in 2004*

According to the representative of the BVG Mr. Eberwein, the background for the introduction of the hydrogen bus (see Figure 3.1) in 2004 was the construction of a hydrogen filling station in Berlin, Usedomer Strasse in 2002. The bus was supposed to be taken into operation already in 2002 but MAN Nutzfahrzeuge AG, i.e. the bus manufacturer, was unable to deliver the bus on time. The bus was delivered in Berlin in 2004 although it was originally supposed to be operated at the airport in Munich, in Bavaria.

4. STEP ONE: Visions and objectives of the H2-project

The BVG is the public transport operator in Berlin. It is the largest German fleet operator of urban buses. It has a long experience in testing operation and promotion of state-of-the-art environmentally friendly vehicles. During the last decade, various fuels, such as natural gas or different technologies - like hybrid systems - have been tested by the BVG.

The vision of the BVG when starting the H2-bus project was to gain experiences in order to be able to introduce a large fleet of hydrogen fuelled busses in the future. The objective of the introduction of the bus in question was to test the operation of a hydrogen bus from a technical and an economical point of view.

According to the representative of the company, Mr. Eberwein, the earlier experiences have shown that the operation of natural gas powered busses is not practical from economical and technological points of view although they have been introduced also in many other countries. Therefore, the BVG has earlier retrofitted its fleet with CRT filters that reduce carbon monoxide and hydrocarbon emissions. The BVG sees that the next step in the future must be the utilisation of hydrogen as a fuel in buses. Since the 1990s, the BVG has placed a strong focus on hydrogen as a fuel in public transport and has implemented several experimental projects. The first step was the construction of a hydrogen filling station in Berlin at the Usedomer Strasse, at the BVG's depot.

The construction of the filling station in Berlin was initiated by the BVG with the financial support of the European Unions Fifth Framework Programme. The representative of the BVG Mr. Eberwein stated that since new technologies are expensive at the beginning, financial support for their introduction is very important. However, the BVG considers its role as a first mover in Germany and, therefore, the company initiates renewable energy projects also by itself. For the hydrogen bus pilot project in 2004 the crucial factor in the initiation phase was the financial support from the EU for the hydrogen filling infrastructure.

The hydrogen projects initiated by the BVG in line with the BVG's vision include:

- The first hydrogen filling station in Berlin at Usedomer Strasse depot inaugurated in October 2002.
- The hydrogen competence centre in Berlin (in cooperation with Total Deutschland GmbH, MAN and Linde).
- **The successful operation of a bus with a hydrogen internal combustion engine** in scheduled route service from April to November 2004.
- The construction of a bus with hydrogen internal combustion engine and fuel cell and energy storage system for Berlin, which is expected to be in operation by September 2006.
- HyFLEET:CUTE comprising the implementation of 14 hydrogen powered buses in Berlin starting from June 2006.
- The construction of a public filling station operated by TOTAL at Heerstrasse in Berlin-Spandau (also co-ordinated by TOTAL).

BVG's long term vision is to implement a completely hydrogen based transport system in the future. As the representative of the BVG Mr. Eberwein stated:

"The future is hydrogen."

In the future, the BVG wants to operate a fleet of hydrogen fuelled busses. The objective is to slowly introduce more and more buses until the fleet consists of hundreds of buses.

5. STEP TWO: What were the various expectations of the case?

The main actors were the BVG, who introduced the bus independently of the ACCEPTH2-study, and the L-B-Systemtechnik GmbH, who executed the study. The concrete expectations of the BVG with the bus project was to investigate the technical and operational frameworks of the hydrogen operated bus. As the representative of the company Mr. Eberwein stated, the economies of the operation are important. Environmental friendliness is also a guide line for the BVG. In the implementation environmental friendliness means that the used technology should not be more polluting than diesel fuelled vehicles because diesel has been set as a benchmark.

Therefore, the main expectation of the project was to collect different experiences of the operation of a hydrogen fuelled bus. These experiences act as background first for the HyFLEET-project and later for the operation of a larger fleet of hydrogen fuelled buses.

The ACCEPTH2 -projects objectives were:

- To analyse and compare public knowledge and perceptions of fuel cells and hydrogen vehicles, before and after the introduction of hydrogen buses demonstration projects.
- To estimate the perceived economic value of the environmental benefits of hydrogen buses, before and after the introduction of hydrogen buses demonstration projects.
- To analyse and compare intended and actual use of hydrogen buses by conducting an ex-ante and ex-post surveys.
- To assess how knowledge, perceptions, values and use vary across different population segments and across populations.
- To investigate the factors that determine the effectiveness of hydrogen buses demonstration projects in shaping public knowledge, perceptions, values and use.
- To analyse potential barriers to the introduction of hydrogen buses in terms of public knowledge, perceptions and values.
- To develop recommendations for maximising the positive influence and uptake of future demonstration and commercial projects.
- To disseminate results widely amongst companies and organisations that may in the future run hydrogen vehicle demonstration projects or that wish to introduce such vehicles into service (Schmidt, 2004).

Table 5.1 *Actors, expectations and publics*

Actor	Expectation	Speaking for public
BVG	To collect experience of the operations of a hydrogen fuelled bus in public transportation	The BVG benefits the publics as a provider of environmentally friendlier transportation.
L-B-Systemtechnik GmbH	To analyse and compare public knowledge and perceptions of hydrogen fuelled vehicles, before and after the introduction of the demonstration project.	Speaks for the benefits of the consumers and users of public transportation.
EU	To ensure that fundamental social issues related to public perception of hydrogen as a fuel are being carefully considered.	As a funding institution the EU has general concern for public interest in context of new technology used in public transportation.
Local residents	To have secure and pollution free public transportation.	Speaking for themselves as consumers.
MAN, Total, Linde AG	Business interest, to develop and participate future hydrogen fuel markets.	Not identified. Partners of the BVG. Without their input this pilot demonstration could not have taken place.

Table 5.1 lists the expectations of the main participants. In addition to the expectations of the BVG and the L-B-Systemtechnik GmbH there are expectations also from the funding institution the EU and the general public. The EU's expectations are of a general nature within its Fifth Framework Programme. Principally the EU strives to ensure that when implementing demonstration projects of new technologies the public perceptions will be considered carefully. The concern is on public interest.

Local residents are also actors in such pilot projects whether they actively recognise it or not. Their expectations certainly are to have secure and pollution free public transport with low cost. They naturally stand for their own interests as consumers and users of public transportation.

The third 'side category' of actors are the technology suppliers of the BVG: MAN, the bus producer, TOTAL, the operator of the hydrogen filling stations, and Linde AG, the supplier of the filling station technology. These actors were not actively involved with the project but without their participation the project could not have taken place. Their expectations are connected with the future business possibilities of the hydrogen fuel markets.

6. STEP THREE: Understanding 'participatory' decision-making: negotiating expectations

The participation of other stakeholders than the BVG and the L-B-Systemtechnik GmbH was very limited as mentioned above. Also the media attention of this pilot demonstration was very limited and due to this the general public was not very aware of the project at all. There were only a few mentions in the daily newspapers in Berlin considering this pilot project. Most of the few entries were not directly about the bus but about the construction and opening of the hydrogen filling station at the Usedomer Strasse in Berlin. (See Neomann, 2004; Richter, 2004) The articles that could be found emphasised the free fare of the bus instead of the new technology applied. According to the ACCEPTH2-study the main sources of information were, however, the media with the main sources magazines (47%) and TV (29%) (O'Garra, 2005).

The lack of attention may be explained also by the fact that as Berlin has almost three and a half million inhabitants and a corresponding amount of buses, the one operational hydrogen bus does not raise much interest. There is only a small chance that a randomly chosen person would ever even have encountered the bus.

There has not been any opposition against the hydrogen bus or the filling station among the local residents in Berlin. Besides the fact that most of the citizens of Berlin may not even know that there was a hydrogen bus in operation, the lack of opposition may be due to the general positive attitudes of the people in Germany towards environmental issues, which was revealed by the ACCEPTH2-study. Also the general knowledge was rather high -at least compared with the other cities involved. The awareness of hydrogen vehicles prior to the pilot demonstration was highest in Berlin (73% of bus users had heard about hydrogen vehicles) (O'Garra, 2005). The interviewed representative of the BVG Mr. Eberwein also told that while constructing the filling station, much attention was paid beforehand to the noise reduction so that the operation of the tanking station would not cause any disturbance among the local residents or in the area.

However, a very surprising observation was made in the ACCEPTH2-study. Like described above, the ACCEPTH2-study was made ex ante and ex post the demonstration project. During the first questioning, the people were informed about the new technology and asked, whether they could be contacted again after the introduction of the hydrogen bus for the second phase of the study. During the second questioning ex post the project, those people who had agreed during the first questioning were contacted again. In Berlin, the share of the 'repeat' respondents of the ex post sample was 55.5 percent. From those people, who already were informed about the hydrogen technology 24 percent acclaimed that they never had heard that companies were developing hydrogen powered vehicles! (The same was witnessed also in the other cities, with 17% in London and 15% in Luxembourg (O'Garra, 2005))

The ACCEPTH2 study suggests that these respondents did not pay full attention to the information presented in the ex ante survey. On the other hand, these results could indicate that, if initial information is not followed up with additional information, like an article in a newspaper, an advert etc. people may simply forget this new information (O'Garra, 2005).

The ACCEPTH2-study also showed that the direct experience of a hydrogen bus had no significant effect on support for the large scale introduction of hydrogen buses. In Berlin, only 4.5 percent of the sample had actually travelled with the hydrogen bus. Also the willingness to pay examination showed that direct experience of a hydrogen fuelled bus had no effect on the willingness to pay values (O'Garra, 2005).

It seems that the role of media attention is very critical when introducing new technologies if the active participation of the general public is hoped for. The attitudes of the local residents in Berlin seem to have been quite neutral towards the introduction of a new technology. Another important factor in participation seems to be to inform people thoroughly about new innovations. The ACCEPTH2-study suggests that the direct experience of the technology must be coupled with adequate information on hydrogen if the acceptance of the technology is to be influenced. This increases prior knowledge, which was found to be the key factor for an unconditional support for the new technology. Also the information about the environment influences environmental sensibilities, which were found to be the key drivers for support and willingness to pay.

In this case, the lessons learned from the negotiating experiences are limited, since the project was initiated and managed by the BVG alone and the public attention was so little. There was no network of partners, whose conflicting interests or negotiation experiences were to be studied in this section. The company TOTAL built the filling station but it was done independently of the bus project and the company MAN Nutzfahrzeug AG delivered the hydrogen bus according to an earlier agreement. However, the representative of the BVG Mr. Eberwein claims that

the basic expectations and aims of these firms are the same as of the BVG: creating and enabling the transition into a hydrogen based future.

However, there are basically two independent projects around the introduction of the bus: the actual introduction of the bus and the public acceptance study that accompanied it. There are two main actors whose expectations and objectives vary. The objectives of the executors of the acceptance study included the wish to disseminate the results among the organisations planning for future demonstration projects. They also develop recommendations for maximising the positive influence of such projects. The BVG, however, has not been interested at all about the results of the public acceptance study. It has not been applying results of the study in its operation or when planning the introduction of further hydrogen buses. This claim is supported by the fact that while he was interviewed the Head of Department 'Vehicle Management Bus' of the BVG Mr. Eberwein was not even aware that such an acceptance study was made! Therefore, there has not been any negotiations considering these different expectations.

7. STEP FOUR: From visions to actualities

Principally the demonstration from the point of view of the BVG was considered a success because their main objective was to test and gather information about the operation of the hydrogen bus. The realisation of the project was endangered through a delay in the delivery of the hydrogen fuelled bus by MAN. The bus was supposed to be in action already in 2002 when the first hydrogen filling station was built but MAN was not able to deliver the bus until 2004. Therefore, the demonstration was also of a very short nature, taking place only from May until December in 2004. There was, however, a break during the summer months because the hydrogen bus had to be updated.

The key question in the realisation of the project from the point of view of the BVG was the question how to continue after the first demonstration. The long term vision is the operation of a large fleet of hydrogen fuelled buses. The initial vision was changed through the experiences of the bus demonstration project, thus after the project. First it was considered that the hydrogen would be used in gasified form but the experiences showed that it is not practical. The practical everyday solution must be to be able to use liquid hydrogen.

The process has taken place stepwise according to the financial support that has been available. However, the BVG has had the experience that there is financial support easily available for such hydrogen demonstration projects, because the technology is so preferred from the environmental point of view. The BVG is also a recognized stakeholder in Berlin so that it easily fulfils the necessary infrastructure and financial background requirements that the funding institutions need. Still, the BVG has tried to consequently develop the technology further even without the external financial support, because the firm acknowledges that hydrogen technologies are the future.

The realisation of the ACCEPTH2-study was initially planned to take place in Munich, Bavaria but there the hydrogen demonstration project did not take place. Therefore, it was decided that the study would accompany the demonstration project in Berlin. It somewhat changed the perspective of the study. First it was thought that the attitudes and the acceptance of the local residents would be analysed in a smaller part of the city of Munich but due to the change of city the examination had to be widened to consider a major city, which naturally caused changes in the realisation. Therefore, the project was started later than planned and it lasted shorter. The ex ante questioning of the ACCEPTH2 took place from November 2003 until January 2004. The ex post questioning took place from December 2004 until January 2005.

8. Lessons learned

- The positive support of the hydrogen bus demonstration project depends on two key factors:
 - The extent to which the public has been engaged via information and communication campaigns.
 - The relative exposure of the buses, which is in direct proportion to the size of city and in relation to the number of busses.
- The above means that direct experience of the technology must be coupled with adequate information on hydrogen if the acceptance of the technology is to be influenced.
- Prior knowledge is a key factor for an unconditional support for the new technology.
- The example of the BVG shows that financial support may be gained with relative ease if the actor is significant enough.

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Personal communications

Interview with Mr. Burkhard Eberwein, the Head of Department 'Vehicle Management Bus' at the Berlin public transport company 'Berliner Verkehrsbetriebe', June the 26th 2006 in Berlin at the Potsdamer Strasse 187.

Interview with Mr. Patrick Schmidt from the Ludvig-Bölkow-Systemtechnik GmbH, June the 19th per telephone email.