

# HYLIGHTS

Hydrogen for Transport in Europe

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**The GAPS analysis – minimal user requirements for hydrogen vehicles**

**Where in Europe and who is willing to bridge the gap between lighthouse projects and early commercialization phase?**

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A Coordination Action to Prepare European and Fuel Cell Demonstration Projects on Transport

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## Disclaimer

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## Executive Summary

This study is one deliverable within the HyLights project that addresses various issues in preparation of large-scale demonstration projects in hydrogen transport in Europe. The aim of the study was to gain insights about customer opinions and perspectives on the adoption of hydrogen vehicles in the transition phase from large-demonstration to early commercialization. It has become clear in principle which markets would be most adequate and receptive to deploy a number of hydrogen vehicles and which locations in Europe provide more favourable conditions than others. Nevertheless it also became clear that some of the attractive markets are difficult to address in the ramp-up phase and thus would require further more in depth attention.

### **Research approach**

The study has been carried out based on a number of interviews with fleet operators in ten European focus regions. The interviews were conducted based on a questionnaire with a twofold aim. First, to find out general opinions and motivations of fleet operators to introduce hydrogen vehicles in their fleet. Secondly, a quantitative part focused on technical performance requirements on the current vehicles to identify the future demand level for vehicles. Different fleet operators also utilize their vehicles in different ways. Therefore a separate part of the questionnaire was seeking information on daily utilization, routines and practices. In each of the focus regions interviewees were identified from a wide cross-section of potentially interesting users from the public and private sector. Vehicles categories taken into account for the study are mainly road certified passenger cars, delivery vans, buses and specialty vehicles such as scooters and four-wheelers. In total, 63 interviews were conducted with selected individuals which play major roles in the strategy, vehicle or purchase department of their organizations. The outcomes cannot be regarded as statistical significant sample, but were intended to provide a broader outlook about the possibilities of hydrogen vehicle adoption by fleet operators.

### **Motivations for hydrogen**

As yet, a number of fleet operators have introduced corporate policies that can drive hydrogen deployment faster than elsewhere. E.g. these are policies on low-emission fleet vehicles, fossil free energy plans or technological leadership. Public transport companies have been identified as the main group for an intrinsic motivation to switch to zero emission vehicles. Reason for this are that hydrogen buses are perceived as necessary next technological step and alternatives such as hybrid diesel buses would not be cost-effective on the long-term. Some small and innovative operators such as the public transport in Soria (Spain) as well as RVK and the Vestische Strassenbahn in North Rhine-Westphalia (Germany) have signalled high interest on purchasing hydrogen vehicles. However this business case assumes the availability of reasonably priced hydrogen and only slightly higher priced hydrogen buses.

Commercial fleet operators tend to purely focus on cost effectiveness of vehicles if no other internal policy on alternative transport choices or lowering fleet emissions exists within the company. Those operators carefully watch the political developments and prefer to choose second-best alternative sources of energy (biofuels, other low-

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emission vehicles) before considering hydrogen. In general, large commercial operators tend to be hesitant towards hydrogen due to perceived higher vehicle cost. Partly it is also caused by the need for very high vehicle reliability in the business process. Another reason is often their dependence on leasing companies and their respective vehicle portfolio. Despite some pioneering operators, massive adoption of hydrogen vehicles will not occur unless the necessary investment level compared to conventional vehicles is equalised and hydrogen as a fuel is competitively priced.

The by far two largest customer groups identified in the HyLights interview activities are municipal services and public bus operators. In the municipal services group some 13 operators mainly using vans and cars are considered and in the public bus operator group some 12 bus operators are included. All other groups consist of 6 or less users.

It seems to be misunderstood by the operators that lowering fleet CO<sub>2</sub> emissions cannot be done by forcing vehicle use meeting a higher emission standard. CO<sub>2</sub> emissions are not part of the emission standards and are currently only subject of voluntarily agreements between the EU and car manufacturers. In fact, the carbon footprint is not reduced by switching to a higher emission standard (e.g. from Euro III to IV to Euro V or VI)

A further driver for the implementation of clean hydrogen propulsion technologies are the *increasing requirements for conventional pollution abatement measures* reflected in the EURO IV, V and VI emission standards which lead to significant increases in fuel consumption. Already for the switch from EURO III to EURO IV these increases in fuel consumption can lie between 12% and 18% (reported by EMT-Madrid and RVK Cologne respectively) and thus increase the carbon footprint at the same rate. The continuously growing requirements in reducing pollutants will lead to rising invest costs and complexity of technology and sooner or later might force a technology switch anyhow to intrinsically cleaner propulsion concepts.

### **Vehicle performance and daily operational characteristics**

Technical performance requirements of fleet operators do not represent a barrier for hydrogen vehicle deployment. In the relevant vehicle categories (small and medium sized passenger cars, delivery vans and Buses) the average requirements for standard indicators (speed, driving distance etc.) are lower than the maximum capacity of a conventional reference. Next generation hydrogen vehicles will achieve performance levels very similar to today's conventional vehicles as far as public information is available and are therefore perfectly suitable for daily use. Generally there are no vehicle performance related reasons to refrain from the deployment of next generation hydrogen vehicles. However few constraints might remain concerning specific requirements (space, load) depending on the vehicle type (in particular vans and buses) and need to be checked on a case-by-case basis.

Research into the driving pattern and refuelling behaviour found out that not all fleet vehicles return every day back to their home base or use only a small amount of refuelling stations in their vicinity. It needs to be distinguished between company cars, vehicles for sales personnel and maintenance vehicles. In particular commercial operators maintain increasingly 'dynamic' fleets that do not return every day to their home base. E.g. drivers of maintenance vehicles in the telecom and energy sector receive their daily tasks by means of wireless communication and start directly from their home. In this case a wide refuelling network is utilized on a national or regional

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scale and does only experience restrictions by the choice of the fuel card. Yet, still a number of vehicles will pass by certain base points on their daily route.

Not all operators refuel their vehicles every day at the same station or return every day to their base: public transport operators and municipalities in the first place. On the other hand company cars handed out to the employees often travel the same route every day to their workplace and back so that installation of infrastructure in proximity of the company could supply those vehicles with hydrogen. In addition, drivers of company cars today have to fill their cars at filling stations in the company (depends on the company) or at a restricted number of public filling stations. As in the early stages hydrogen infrastructure will be only available in the major cities and along major highways, the driving characteristics has implications for the first users. A trend to open refuelling stations in the near future (2009/2010) could be detected in Germany, Scandinavia and Spain.

### Policy

The lack of financial support is one of the most frequently mentioned obstacles by organizations for further procurement of vehicles for demonstration and first use. Hydrogen vehicles will not be anywhere close to cost parity with conventional vehicles unless a number of vehicles are produced on mass-scale and a lowering of cost comes into effect. Hydrogen vehicle funding opportunities provided by governments thus play a vital role for technology deployment. Germany is the only country that offers national level funding for demonstration projects in the study, but other countries are in preparation such as Norway and small funding possibilities in Spain. Regional funding is provided in NRW, Aragon and Rhône-Alpes. Indirect funding schemes through vehicle tax exemptions are applied in Norway, Denmark and will be likely introduced soon in Germany.

### Conclusions

Fleet operators will be one major entry point for the early deployment of hydrogen vehicles. These seem to be a good opportunity to access a large vehicle pool that can be relatively easy supplied with a limited infrastructure for hydrogen distribution. *Mass-manufacturing and economies of scale* will bring down the cost of hydrogen vehicles over time. However, until this stage is reached a number of vehicles need to be deployed first that will still be substantially more expensive. Vehicles in large numbers are supposed to be absorbed by commercial fleet operators that maintain a larger fleet than their public counterparts, depending on national and regional preferences. But those deployment opportunities should not be seen as too 'simplistic'. Changing business processes have a large impact on the way vehicles are operated that in turn influences their refuelling needs. A growing number of operators do not use only one filling station anymore. This needs be taken into account.

The expected high investment costs for hydrogen vehicles are of major concern for the fleet operators. Equal or only marginal higher procurement costs should therefore be the target. Also the operating costs need to be equal or less (due to expected higher efficiency of the fuel cell) compared to conventional fuels. It should be mentioned that most operators are not 'prepared' to adopt vehicles since announcements about the timeline for availability of vehicles connected to a price indication remain virtually

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absent up to now. A repeatedly stated request by practically all respondents was the need for the *availability of a hydrogen refuelling infrastructure*.

To absorb the expected additional costs a *two component policy support* might be necessary to lead to a successful introduction in this segment: support programs for vehicle purchase subsidies and for infrastructure build-up respectively medium to long-term preferential pricing of hydrogen as vehicular fuel.

*Deployment focus for volume vehicles* (passenger cars, vans) should be on city/regional logistics and mail & courier collection/delivery in larger cities and urban agglomerations. These operator groups typically return daily to their home depot and/or distribution centers.

As each region has its own specific characteristics concerning the fleet adoption potential, more research on the opportunities offered by regional fleet operators might be worthwhile to be performed. As a next step, regional actors should become engaged in *business plan activities* to elaborate on feasible vehicle numbers that could be absorbed and how the additional costs of hydrogen could be covered.

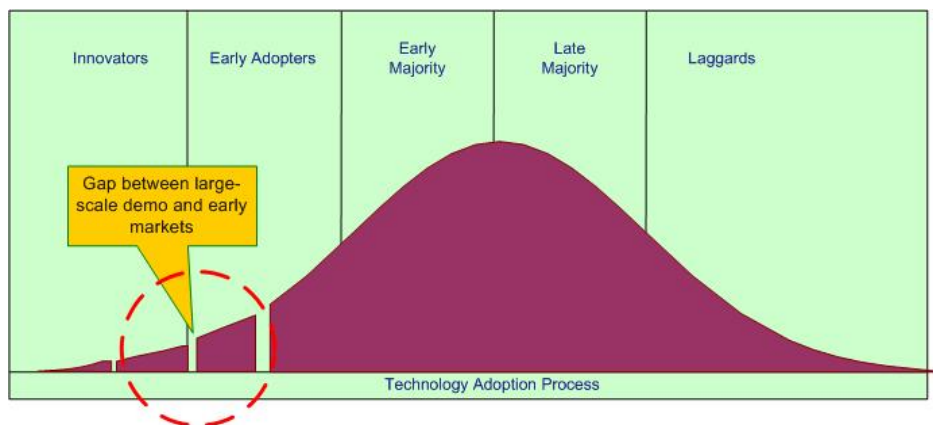
Currently it is mainly the major cities in *Norway, Sweden and Denmark as well as Germany that are increasingly becoming active in the hydrogen field*, the procurement of vehicles and the opening of refuelling stations due to availability of national or regional funding. Those regions will greatly benefit from the existence of refuelling infrastructure and are expected to absorb much quicker a number of vehicles in the early stages. In Southern Europe besides two to three metropolitan areas, it is also the small and medium-sized cities that want to achieve a pioneering position in new technologies but often lack funding.

## 1 Introduction

This report is one deliverable of the HyLights project that addresses various aspects in the preparation of large-scale demonstrations of hydrogen in the transport system. Large demonstrations are a necessary first step along the technological development trajectory in order to further test the technology and infrastructure in real-life environment for its feasibility and to prepare the entering of a commercial market environment.

The number of hydrogen vehicles has to increase gradually during the transition from large-scale demonstration projects towards early commercialization.

The adoption of hydrogen vehicles on large scale could provide the critical mass necessary to stimulate production ramp-up and thus ensure that the technology does not come to an abrupt end once the demonstration phase ends, see Figure 1.



**Figure 1: Gap between large-demonstration phase and early commercialization**

However, it has actually remained unclear which markets would be most adequate to deploy a number of hydrogen vehicles and which locations in Europe provide more favourable conditions than others.

The aim of the study was to gain insights about customer opinions and perspectives on the adoption of hydrogen vehicles in the transition phase from large-demonstration to early commercialization. High interest furthermore persists on which exact customer groups are especially interested to deploy vehicles and what is their motivation to do so.

In order to obtain a realistic picture, two issues need to be taken into account. First, the technical requirements that users demand from vehicles operated today. Under the assumption that future vehicle requirements will not differ from the today's requirements this will provide the benchmark for the performance level expected from hydrogen vehicles. Second, operational data on daily utilization such as driving and refuelling patterns that are expected to be very influential for the adoption potential of user groups given the availability of hydrogen infrastructure.

Vehicle fleets operated by businesses and government organizations are a tantalizing market for the introduction of a new drive-train technology, in this case hydrogen. Fleets are perceived to be an attractive market for various reasons. Captive fleets are professionally managed and vehicles been frequently renewed, thus making it a more

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**Full background report**

likely early adopter than the private end-consumer. It appears to be an efficient choice because a large number of vehicles are controlled by relatively few decision makers. Fleet vehicles are assumed to drive on a certain route and are refilled centrally. In addition, depending on the organization the reduction of transport emissions might be of higher interest than pure cost criteria which makes it interesting for new technologies which are still more expensive than the reference technology.

This report provides detailed results of the fleet operator study regarding the future deployment opportunities for hydrogen vehicles. The report is structured as follows. Chapter 2 provides an in-depth overview of the research approach which has been used for the study. In chapter 3 the qualitative research results broken down by focus regions are presented. The following Chapter 4 gives an overview on the technical performance requirements of fleet vehicles provided by the operators while Chapter 5 contains the analysis taking into account both qualitative and quantitative results. In the last Chapter conclusions will be drawn which fleet operator (groups) have a higher deployment potential for hydrogen vehicles than others according to the research results. Areas to be covered by future research will be indicated.

## 2 Research methodology

The study has been carried out based on a number of interviews with fleet operators in various European regions. The interviews provide insights about the motivations and limitations of hydrogen vehicle deployment, the technical performance of the most widely used vehicle in their fleet and an image about the daily use of the vehicle. Based on this information it allows to draw further conclusions on the ability of the single organization to be among the first adopters of hydrogen technology and in case this is observed more frequently it might even have implications for a certain operator group.

In total, 63 interviews were conducted with selected individuals that play major roles in the strategy, vehicle or purchase department of their organizations. It needs to be emphasized that the intention was to cover a variety of people within their organizations since it was believed that fleet managers alone would not make the final decision on the procurement of hydrogen vehicles. It also has to be mentioned that this intention could only be realized in very few cases as in most cases we were happy to get at least one representative per organization at the table for interviews.

### 2.1 Questionnaire

For the interviews, a questionnaire was utilized which has been developed jointly with the HyLights consortium. Divided into 2 major parts, the questionnaire contained a qualitative and a quantitative section. The full questionnaire can be found in Annex B.

The first part aimed on the general opinions on hydrogen of fleet operators, which policy targets it would contribute to and the reasoning for or against deployment of hydrogen propelled vehicles in the future. The quantitative survey of vehicle performance requirements was initiated to identify the demand of future user on hydrogen vehicles. Since it is assumed that their needs will not significantly change over time this demand evaluation provides the benchmark that has to be met by hydrogen vehicles and thus provides a guideline for R&D priorities towards the industry. Therefore, the survey tried to capture two types of data. First, general technical data about the most used vehicle segment of the fleet operator (see Table 2-1 for segment overview). Those are derived from the Monitoring and Assessment Framework I (MAF). The performance data of the most used fleet vehicle are captured via Key Performance Indicators from the Monitoring and Assessment Framework I. Examples of this indicators are maximum speed, acceleration and fuel consumption.

Second, the daily vehicle utilisation patterns of user groups. Different fleet operators use their vehicles in different routines and practices and that has an influence on their refuelling habits. In the early stages of hydrogen vehicle deployment in the market there will be a limited amount of filling stations, thus those data can help to ensure to serve the fuel demands of early users. The research on the daily utilization also wants to find out if the same vehicles are used for different kinds of service, for e.g. inner city delivery with low driving distance and at the same time long-distance travel.

Vehicle requirements differ greatly over the used bandwidth of vehicle classes by the fleet operators. In order to allow an objective data comparison a standardized vehicle categorization was introduced and used throughout the exercise. Later on it was possible to compare selected vehicle classes for data (see 4.1).

However, the success of hydrogen vehicles and their future market breakthrough is not only determined by cars which match (at least) the user requirements but also by operable infrastructure.

One of the objectives of the study was also to gain more insights about the infrastructure that users might currently operate to fuel their vehicles. Therefore a separate part was added concerning the performance requirements (how much fuel, how fast dispensed, how expensive) on the infrastructure. After finishing the interviews, it came out that very few responses could be actually collected on the refuelling infrastructure.

It has proven that most of the operators use public filling stations with or without the use of fuel (tank) cards. Only few operators still possess filling stations, mostly those with very high fuel demand that needs to be met in a short time to follow a certain service schedule. Examples of infrastructure operators are public bus operators and mail delivery companies.

Vehicle segments		Examples
Passenger Cars	<b>Segment A</b>	e.g. PANDA, TWINGO, SMART FORTWO, KA, AGILA, LUPO
	<b>Segment B</b>	e.g. 206, POLO, FIESTA, CORSA, PUNTO, MINI
	<b>Segment C</b>	e.g. GOLF, ASTRA, FOCUS, MEGANE, 307, A CLASS
	<b>Segment D</b>	e.g. SERIES 3, C CLASS, A4, PASSAT, MONDEO
	<b>Segment E</b>	e.g. SERIES 5, E CLASS, A6, V70, S-TYPE, A8
	<b>Segment SUV</b>	e.g. X3, RAV4, X5, TOUAREG, M CLASS, LAND CRUISER
	<b>Segment MPV</b>	e.g. TOURAN, ZAFIRA, XSARA PICASSO, FOCUS C-MAX, GALAXY, ESPACE
	<b>Vans</b>	e.g. Volkswagen Transporter, DaimlerChrysler Vito, DaimlerChrysler Sprinter, Ford Transit
	<b>Buses</b>	

**Table 2-1: Vehicle segments according to Goldman Sachs categorization [Source: Goldman Sachs: Europe Auto Sales and Production Data Book, Issue 17]**

## 2.2 Regions and interviewees

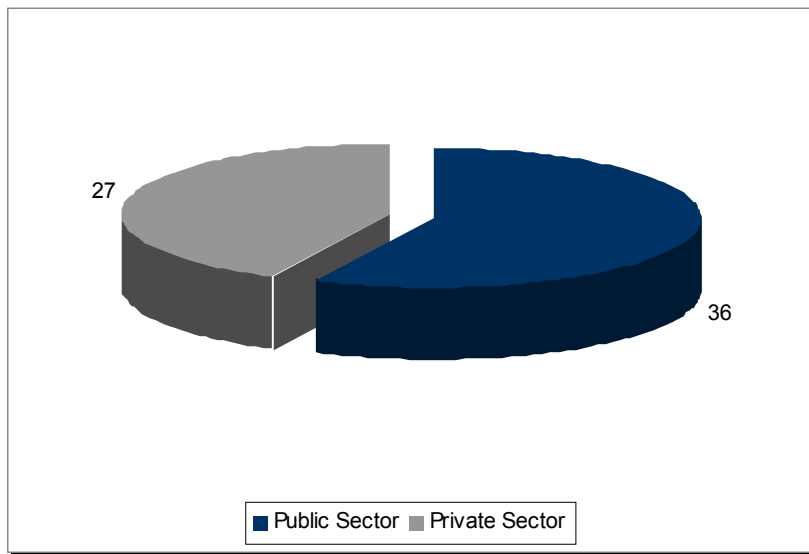
To narrow down the geographical range of the study, 10 focus regions from different European countries have been selected from a broader list based on earlier HyLights research results (Regions mapping, WP3). The regions have been chosen based on high commitment regarding the deployment of vehicles and to represent a balanced geographical view. An overview map and the list of focus regions can be found in Figure 2.



**Figure 2: Overview of focus regions**

In each of the focus regions interviewees were identified from a wide cross-section of potentially interesting users from the public and private sector. The only condition that applied was a reasonably sized vehicle fleet (more than 10 vehicles). To avoid biased outcomes it was however tried to get a well-balanced selection of public and private fleet operators in each region. Most of the contacts were selected in cooperation with the local contacts of the HyLights project partners, but also involving transport research departments at the respective local universities. Since it was assumed that not only the purchase department will make a final decision about the deployment of hydrogen vehicles, it was important to cover different angles within one organization concerning the procurement. However, in reality it differs who is responsible and depending on the size of the organization it can involve several persons or only a single one. Furthermore, it has to be stated that in most cases it was even difficult to motivate one representative per organization to answer the questionnaire and to participate in interview sessions.

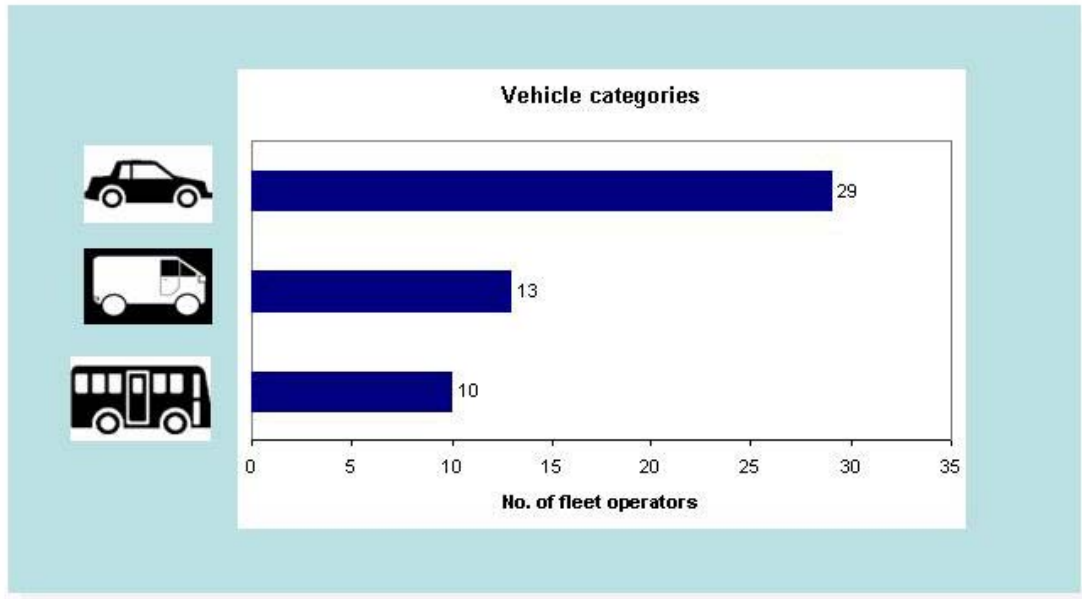
An overview of the total number of conducted interviews and the distribution between public and private fleet operators can be found in Figure 3. A full list of interviewees is provided in *Annex A*. However, one needs to consider that the total number of interviews is surely not large enough to represent a statistical significant outcome on European scale, but should be understood as an indication.



**Figure 3: Number of interviews per sector**

## 2.3 Vehicles

Vehicles categories that have been taken into account for the study are mainly passenger cars, delivery vans, buses and specialty vehicles such as scooters and four-wheeler. The vehicle needed to have a license plate. Numerous fleet operators have different vehicle categories to their disposal, however only their main vehicle fleet (i.e. most used, high numbers) was considered for the evaluation of technical performance data, see Figure 4 for an overview.



**Figure 4:** Vehicle category distribution

### 3 Results

This chapter is based on the interviews that were conducted with the fleet operators. For each interview a summary sheet on the outcomes was created according to four overarching categories that describe the fleet operator opinion on a future large-scale hydrogen vehicle deployment, existing internal policies on transport emissions or the stimulation of using alternative fuel vehicles, the drivers and barriers they see and the financial opportunities they have access to for deployment.

To create an overall picture for every region those interview summaries have been further condensed to a regional summary reflecting on the four categories for all interviewees. With those summaries it is also possible to identify regional differences and specific characteristics that prevail for or against hydrogen deployment.

A complete list of interview partners and type of organization (public/private operators) is provided in the beginning of each section. The full interview reports can be found in the end of this report as *Annex C*.

#### 3.1 Scandinavia

Organisation	City	Country	Type
City of Malmo	Malmo	Sweden	Public
Gatubolaget	Gothenburg	Sweden	Public
Sunfleet	Gothenburg	Sweden	Private
Box	Stockholm	Sweden	Private
TDC	Copenhagen	Denmark	Private
Grontmij Carl Bro	Copenhagen	Denmark	Private
Movia	Copenhagen	Denmark	Public
Posten	Oslo	Norway	Public
City of Oslo	Oslo	Norway	Public
Telenor	Oslo	Norway	Private
Ruter A/S	Oslo	Norway	Public

### 3.1.1 Introduction and strategic aspects

The Scandinavian region includes the following countries: Denmark, Sweden and Norway. Those three countries were chosen because they also form the Scandinavian Hydrogen Highway Partnership ([www.scandinavianhydrogen.org](http://www.scandinavianhydrogen.org)). Some but not all interviewed organizations are participants in the respective national hydrogen interest groups that are also working together on the hydrogen highway.

The City of Malmo was the first city in Sweden with a CNG fuelled bus fleet 20 years ago and today all buses (180) run on CNG/biogas. The city is looking forward to test hydrogen but is also strongly involved in hythane public transport in cooperation with E.ON Sweden. Malmo is member of Hydrogen Sweden. Sunfleet is a car sharing company specializing in environmental friendly vehicles. All vehicles in their fleet are low-emission vehicles, including biofuel and hybrids (Toyota Prius). Box provides delivery services on the last mile to the customer in all Scandinavian countries and Estonia. Since it is grown out of a bicycle courier service it has a strong commitment to being environmental friendly but has up to now been passive about new vehicle technologies. Currently 10% of the fleet runs on alternative fuels. Gatubolaget (member of Hydrogen Sweden) manages and operates all captive fleet vehicles in Gothenburg. Until the end of 2008 all vehicles will be replaced by environmental friendly vehicles of some kind (CNG, electric, biofuel or any other low-emission vehicle below 120gCO<sub>2</sub>/km). CNG fuelled vehicles are favoured at the moment since there are plenty of refill stations available in the city.

TDC is a leading telecommunication company in the Scandinavian countries and has also operations in Europe. They possess a large vehicle fleet for maintenance and sales personnel but have limited influence and choices due to a purchase agreement with a leasing company. A general company policy to lower transport emissions does exist. Public transport including bus services in the Greater Copenhagen region are managed by Movia. The organization itself does not own any buses. Services are tendered out and the price Movia pays to the operators is supposed to cover the gap between the fare price and the actual operating cost. The tender can require a particular bus technology by the operators. One bus line will be operated with electric buses in the city centre (to be opened soon).

Posten is the national mail company of Norway and owned by the government. Posten has a large fleet of delivery vans, however they are provided from leasing company Lease Plan. The City of Oslo maintains a vehicle fleet for various transport reasons within the city. The procurement of new vehicles is very much driven by achieving lower fleet emissions. Telenor is the biggest mobile communication company in Norway and has also strong market presence in the other Nordic countries. The company has introduced a policy to lower transport emissions by remunerating staff for choosing low emissions vehicles (less than 160gCO<sub>2</sub>/km and less than 120gCO<sub>2</sub>/km) as a company vehicle. Maintenance vans are successfully operating on GTL fuels (100). In the future, only environmental friendly vehicles will be allowed. The merger of two the public transport companies in and around Oslo has created Ruter A/S that now unifies all means of public transportation. Similar as in the Copenhagen area, Ruter is only a transport authority but not the operators of vehicles. Still under internal discussion, but Ruter will probably set the aim to become completely free of fossil energy sources by 2020.

### 3.1.2 Perspectives and experiences with hydrogen

The City of Malmö currently operates Sweden's only hydrogen vehicle (Toyota Prius Quantum retrofitted) for testing purposes. The car is used at the environmental department for services with the department personnel. Malmö already operates hythane buses (8 percent mixture) with good experiences in the past and wants to continue the success together with local transport company Skanetrafiiken. In cooperation with E.ON Sweden that is located in Malmö a hydrogen station (gaseous) has been built that also serves hythane. Gatubolaget is considering to follow Malmö in the purchase of a Quantum Toyota Prius running on hydrogen for testing and showing the technology to the public.

Ruter public transport in Oslo had a hydrogen bus in 1999 but did not continue. A hydrogen filling station is soon to be opened in Oslo (2009) within the HyNor project. Nevertheless, Ruter in Oslo has still high interest in hydrogen. Deployment of some first buses is now aimed for 2010. Oslo City has a dedicated policy to use new low and zero-emission vehicle technologies such as hydrogen but have not bought a vehicle yet. Generally the public actors see hydrogen as a long-term option to lower emissions and also as obligation to show the technology to the public and test it. Big public transport companies in scarcely populated countries can trigger hydrogen demand due to high volume procurement (e.g. Oslo). More stations and vehicles are expected in the future from participating organizations along the Scandinavian Hydrogen Highway Partnership from Norway-Sweden-Denmark.

For all interviewed commercial companies in Scandinavia it has not yet been an issue to consider hydrogen (not even for testing) because the technology still seemed too far away. Companies want to lower their fleet emissions, but either they depend on the leasing company (TDC, Posten, Box) what vehicles to choose from or the cost have to be equal to conventional vehicles. For the public transport authorities (Movia, Ruter) it seems increasingly difficult to deploy new technologies since the price for the transport service they can offer to the operators depends on their funding. However for single bus lines it is feasible to demand certain technologies in the tender procedure

The use of CNG/hydrogen mixtures (hythane) as a bridging technology towards hydrogen receives large attention in Sweden (Malmö, Gatubolaget). Reason being that use of biogas has become widespread and mixtures are easier to introduce than pure hydrogen. This is also facilitated by energy company E.ON.

### 3.1.3 Barriers and Drivers to the future deployment of hydrogen in the fleet

For both private and public operators in Scandinavia, current high cost and availability of hydrogen vehicles is a major barrier for deployment. For operators of public transport authorities, it is even more difficult because they don't own the buses but tender them out. Requesting certain technologies in the tender however requires a higher funding for the bus service from funding bodies (municipalities that are located within the bus service) behind the transport authority.

Reasons to start with hydrogen are mainly related to societal and image reasons and for the lowering emission levels on the long-term. Available surplus hydrogen from a nearby refinery is considered a facilitator (Gatubolaget). More companies have started

to include transport emissions into their environmental policies. Transport emissions are significant for most of them, either only locally or operating throughout the country.

In total, out of the 11 respondents 3 public operators (Malmo, Ruter, Gatubolaget) have started demonstrations with hydrogen vehicles and have or plan to build filling stations.

Of the 11 respondents, 5 (Box, Ruter, Movia, TDC, Posten) of them operate on a rent-or lease vehicle scheme. That is also a barrier because they depend on the leasing company what vehicles are offered. In Denmark (TDC) Nordania Leasing has shifted to offer only cars from a certain energy label (A-C) recently. One car-sharing company among the respondents is owned by a car company and has to rely mainly on their vehicles. Box operates with subcontractors that own the vehicles.

Although Denmark has a high vehicle tax for private end-consumers, this does not apply to cars used for the company. Then there is only a marginal tax. However, since hydrogen vehicles are tax-exempted in Denmark this is not beneficial for hydrogen on the large-scale. Experiences with biogas vehicles as delivery vans (Box) have shown that vehicle weight increased and that requires truck driver licences for which it is hard to find personnel. There are no incentives or tax exemptions on hydrogen vehicles in Sweden

Due to the geographic specifications of Scandinavia with populations concentrated around in capital cities and sparsely populated areas in the north of the country most of the commercial companies have service centres operating in different parts of the country. From there, service vehicles spread out in a certain radius. TDC, Telenor and Posten operate service centers across the country and technicians usually work within a certain radius. Technicians at TDC don't return their vans back to the basis but instead take them to their private home that poses problems if refill infrastructure is only available on a limited basis or at the vehicle home base. Box works with service station from where deliveries go out for 90 percent of all deliveries. Only a small amount of vehicles travels long-distance.

The car sharing requires their customers to frequently refill the car as soon as the tank is half-empty. That is a precautionary procedure due to the possible high number of users per car.

Hardly any proprietary refill infrastructure exists, only one operator (Gatubolaget) does possess infrastructure and one public transport company is actually shifting back from using public stations to proprietary refill infrastructure (Ruter A/S) for a new bus depot.

### **3.1.4 Finance & Policy**

There are no known incentives from the Scandinavian governments for fleet demonstrations or any kind of alternative fuel vehicle procurement. The hydrogen Prius in Malmo is partly financed by the Swedish Environmental Protection Agency from the Climate Investment Programme (KLIMP). This programme hands out funding to organizations that want to lower greenhouse gas emissions through long-term investments. Grants in 2008 are the last ones to be handed out.

In one case (Box), funding for biogas vehicles was received through an EU project but that was provided for the regional government to lower emissions and not directly to

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the fleet operator. Ruter in Oslo has applied for project funding at the Norwegian Research Council for a hydrogen demonstration project including one filling station and 4 buses.

Both national and EU policy makers are in the focus to facilitate the future deployment of hydrogen. A national strategy on emission reduction is seen as helpful but is absent yet. Policy for road transport focused on biofuels in Sweden. The main adviser on Energy to the government, the Swedish Energy Agency has been hesitant to push for hydrogen.

Not sufficient attention to the transport sector given by the government. Increasing bottom-up pressure from the regional level is seen as helpful. Unclear regulation about hydrogen vehicles in Sweden makes it more difficult. However, alternative fuel vehicles receive non-financial benefits in the cities such as free parking.

## 3.2 Iceland

Organisation	City	Country	Type
Hertz Car Rental	Reykjavik	Iceland	Private
City of Reykjavik	Reykjavik	Iceland	Public
Iceland Excursions	Reykjavik	Iceland	Private
Reykjavik Energy	Reykjavik	Iceland	Private
Straeto	Reykjavik	Iceland	Public
Landsvirkjun	Reykjavik	Iceland	Private

### 3.2.1 Introduction

Hydrogen energy has a long history in Iceland. It was one of the first countries in Europe that considered the technology for large-scale application and opened a hydrogen production and filling station in 2003. Within several EU projects (Ectos, Cute, Hy-Fleet-Cute) a number of fuel cell buses and hydrogen vehicles were operated in Reykjavik area.

Smart H2 is an ongoing demonstration project (2007-2010) for hydrogen fuelled vehicles and vessels in Iceland. The project tests various types of hydrogen-fuelled company cars (20-30 cars on the road in 2009) and other equipment that runs on hydrogen. The project also aims to demonstrate the operation infrastructure for compressed hydrogen and develop the distribution system for hydrogen, for example by organizing and running a small-scale hydrogen transport service. Icelandic New Energy (INE), a promotion company for the use of hydrogen in the transport sector is the initiator of the project. Smart H2 is funded domestically by Vistorika (facilitator in the green energy

sector) and the Icelandic government. Currently there are more than 20 organizations participating in the project. However, the vehicles still need to be purchased or leased from the participants and will not be financed from the project. Finance is provided only for infrastructure and technological investments. The hydrogen filling station (Shell) that has been already in operation since 2003 has been now opened to the public.

Landsvirkjun is the largest electricity producer in Iceland. The fleet includes about 100 vehicles that are used in the rough conditions of Iceland (4x4). Around Reykjavik a hydrogen Toyota Prius (Quantum) and a fuel cell Daimler A-class (shared with Reykjavik Energy) are in operation from the Smart H2 project. At six of their power plants conventional refueling stations exist but they are operated by another company. The company has the policy target to compensate all carbon emissions by 2010. In the future this policy is likely to demand the whole fleet running on alternative fuels. Landsvirkjun is willing to invest with own financial resources into a larger fleet of hydrogen vehicles, but also considers a broader portfolio of innovative technologies.

Reykjavik Energy is another energy company that operates in the capital city region in the west and southwest of Iceland. Their fleet is about 220-270 vehicles large and those are usually rented to users within the company. Due to a particular strong policy on using renewable energy in their transport four hydrogen Toyota Prius and one fuel cell Daimler A-class (shared with Landsvirkjun) are operating (Smart H2 project). Besides this, also 5 methane cars and 2 electric vehicles are operated. Further 15 methane vehicles are ordered.

Rental Car company Hertz has 1200 passenger cars for renting out in Iceland. Almost all vehicles are supplied from Toyota due to a close link with the importer. Hertz has been involved in the hydrogen activities in Iceland for a long time and is well aware of the technology. Based on this knowledge Hertz has bought 3 hydrogen Toyota Prius within the Smart-H project. The Prius can now be rented from everyone for an extra fee.

The municipality of Reykjavik and its department of Environment and Transport purchase every year products at substantial financial volumes and if asking for special environmental products it can have a large impact on supply and society. All vehicles of the internal fleet are rented with 3-year lease contracts.

Icelandic excursions is a privately owned company that offers a wide range of excursions for tourists by vans and buses. They always buy new buses with the highest available emission standard (Euro 5 or Euro 6). The largest part of their fleet consists of Mercedes Sprinter.

Strateo is the bus company that performs bus services in the city of Reykjavik and the nearby villages. 120 buses are operated in total, but of that only 73 are owned by the company, the rest is subcontracted. Currently two buses are running on methane that has proven to be reliable. It is likely that soon more methane buses are purchased as investment cost can be earned back quickly.

### **3.2.2 Perspectives and experiences with hydrogen**

3 private (Landvirkjun, Reykjavik Energy and Hertz) companies in Iceland are participating in a project that involves the Toyota Prius retrofitted as hydrogen ICE vehicle. With those vehicles, technical problems have been experienced in the beginning (wa-

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ter-oil mix in the engine) but those problems have largely been solved with the installation of engine heaters. However for a large application the ICE Prius is not seen mature enough, especially not for use as rental car (Hertz).

Expectations prevail that technology will become more mature over time. Also hydrogen buses were operated for 3 years but had an unsatisfactory performance due to technical problems resulting in a high amount of out-of-service hours (but also due to monitoring, measuring and testing efforts).

The use of methane for cars and buses as fuel is currently seen as more promising on the short term by a majority of the respondents; however there is also limited methane production capacity which is also concentrated in the capital (Strateo, Reykjavik Energy) Mixtures of methane and hydrogen would increase the combustion. Renting of methane cars is considered (City of Reykjavik). Hydrogen and methane are only supplied in the capital. For the rest of the country electric and hybrid cars would work better unless the hydrogen and methane supply is not extended.

The majority of the interviewees are in favour of electric vehicles (Strateo, Reykjavik Energy, Landsvirkjun) due to the abundance of renewable energy in Iceland. Hydrogen could become an option on the long-term and could have a good co-existence with electric vehicles, also depending if electric vehicles will enhance their performance or not. There is still interest to join demonstration projects but on the large scale only if purchase prices come down or the vehicles are financed from a third party (one respondent has allocated funds for procurement from own funds). More communication towards the public is necessary to inform about hydrogen.

Reykjavik Energy does foresee possibilities for the deployment of hydrogen in maintenance vans in the Reykjavik area (delivery vans such as the Renault Kangoo) because their driving range does not have to be very large.

### 3.2.3 Barriers and Drivers

High purchase cost and availability of hydrogen (filling stations) are the biggest barriers mentioned by the interviewees. Distribution of hydrogen is not yet available throughout the country. Some respondents were even disappointed by the present performance and regret their decision considering the financial investment they took for the hydrogen Prius (Hertz).

For the use of hydrogen in public transport the buses are not reliable enough and a short refuelling time of 9min is necessary. Competition with other fuels may impose also another barrier. Due to the large energy losses in the production of hydrogen, it should be wiser to focus on electric vehicles for Iceland (Strateo).

Iceland excursions are not able to finance new technologies on their own. However, their vehicles are equipped with GPS that also feeds data on driving pattern and consumption back to the driver. This data-control could be very handy in monitoring new technologies.

Due to the abundance of cheap and renewable electricity in Iceland this should be directly used in electric vehicles in the most efficient manner. Short driving ranges in Iceland also suit better electric vehicles. Hydrogen has not yet achieved high-level political

support, methane and electricity as fuels have priority so far. Lack of communication about the advantages of hydrogen to the public does prevail.

For a small public transport company such as Strateo the introduction of a complete new technology is connected with a lot of efforts, education of employees and so on. Therefore, only the introduction of a larger number of vehicles makes sense from the economical point of view.

High prices of fossil fuels are seen as a driver towards hydrogen, people are watching fuel alternatives closely. Generally, everything that makes imports of fossil fuels to Iceland obsolete would be welcome. The availability of renewable electricity for hydrogen production poses a benefit (but also a barrier). Low requirements for speed and distance are beneficial. If electric vehicles don't become competitive hydrogen is an option.

Seen from an overall emission reduction perspective, this is surely a point to take into account for hydrogen. The existing knowledge and experience makes Iceland a good place for further hydrogen projects. Hydrogen has a positive image and people are aware of the technology and largely accept it. Iceland is a relatively small community with interest in high technology and a small decision layer.

### **3.2.4 Finance & Policy**

No financial possibilities to finance alternative fuel vehicles in Iceland are known to any of the interviewees. All organizations have financed their alternative fuel vehicles themselves (in case they have) or they don't have the financial possibilities at all. All public organizations use rental cars and also the bus fleet is likely to be outsourced completely in the future (trend in national policy). In that case Strateo would depend on the bus technologies that the operators use. For a large application of hydrogen, the government needs to build the needed infrastructure for hydrogen. Via other policies the government or municipalities could also require to start using hydrogen (Strateo).

However, there is an overall target of the state of Iceland having the complete vehicle fleet running on renewable energy in 2050 with some in between targets. Most of the interviewed organizations have introduced some sort of environmental policy regarding their vehicle fleet in different levels. They range from demanding environmental friendly cars, offsetting emissions to more concrete targets of a certain number of cars based on renewable energy in their fleet. Reykjavik energy specifically supports innovative technologies by trying them out in an early phase as a societal duty. The government needs to put more policy pressure on commercial players and start also themselves to use more environmental friendly cars as role model to the public.

### 3.3 Berlin

Organisation	City	Country	Type
Berliner Verkehrs-Betriebe AG (BVG)	Berlin	Germany	Public
Berliner Stadt-reinigungsbetriebe (BSR)	Berlin	Germany	Public
Total Deutschland GmbH (TOTAL)	Berlin	Germany	Private
Vattenfall Europe (VE)	Berlin	Germany	Private

#### 3.3.1 Introduction and strategic aspects

*Berliner Verkehrs-Betriebe AG (BVG)* is the public bus operator of metropolitan Berlin owned fully by the city government (Senat von Berlin). BVG operates its buses 1350 buses mainly themselves. The purchasing policy of BVG since some years is to acquire 1/3 of the new buses as solo buses with 12 meters length and about 100 passengers capacity, 1/3 partly as 15 meter three wheeled buses and partly as articulated 18 m buses and the remaining 1/3 as double deck buses with typically three wheels.

This BVG approach towards H<sub>2</sub> has to be understood under the expressed position by BVG that they do not want to enter into intermediate alternative fuels like LPG, biofuels or CNG but since about a decade have the declared will to directly switch to the final solution: hydrogen. In this approach, BVG is very similar to HHA of Hamburg which follows the same attitude since about a decade, both having communicated this at several occasions publicly.

BVG sees no advantage in operating Diesel-electric hybrid buses as they realistically will save only between 10 and 15% of fuel. In view of the high additional costs of at least 120k€ per bus compared to a conventional Diesel bus BVG sees no chance every to recover the higher investment costs. On the other side, BVG can very well imagine to operate hydrogen ICE buses which in series manufacturing would be comparable in additional costs to CNG buses (only slightly more expensive) and could be operated close to being economic with hydrogen produced economically at large scale, although their fuel consumption would be higher than for conventional buses.

*Berliner Stadtreinigungsbetriebe (BSR)* is a type of a holding organisation which plans and purchases the vehicle park of all passenger cars, vans, garbage collection trucks, street cleaning trucks and machines and rents/ leases the vehicles to the operative units. Presently BSR operates 1670 vehicles. BSR thus practically provides the fleet management function.

In this function BSR is naturally in search for functioning technology and therefore prefers series manufactured or close to series manufactured solutions.

For its vehicles BSR at its various locations operates 18 own refuelling stations, one of them being a CNG station for refuelling of the 50 CNG vehicles.

BSR aims at compliance with the Berlin clean air plan although not obliged to fulfil it and is future technology oriented. BRS therefore has signed a cooperation contract with the state of Berlin regarding its voluntary contribution to Berlin clean air plan.

Expectations from a use of hydrogen as alternative fuel are reduction of fossil fuel use and better control of fuel costs in the future.

*Vattenfall Europe (VE)*, pro-active in hydrogen projects since about 20 years, expects a much more efficient powertrain from FCVs operated with H<sub>2</sub>. More stable or better predictable fuel costs are expected by the use of hydrogen in the future and less political dependency (security of supply). All other technologies except electric powertrains are seen as transitional technologies. Battery electric vehicles are seen as vehicles for short distance transport and H<sub>2</sub>-FCVs for all longer distances and heavier transport needs.

VE as company is driven by environmental compatibility. VE as producer of electricity would be eager to support hydrogen derived from electricity as a future fuel option.

*TOTAL* with its subsidiary *Total Deutschland GmbH*, operates its hydrogen competence center located in Berlin, Germany, since 2002. Due to the difficulties of getting hydrogen vehicles and hydrogen refuelling stations [HRS = Hydrogen Refuelling Station] approved and operative in the public arena in France, TOTAL has taken this decision in order to be able to advance hydrogen technology. Some years ago, in October 2002, TOTAL together with BVG and MAN tested its first hydrogen refuelling station (HRS) in Berlin. Followed by this HRS, TOTAL has built a 2<sup>nd</sup> HRS in Berlin at the Heerstraße in March 2006.

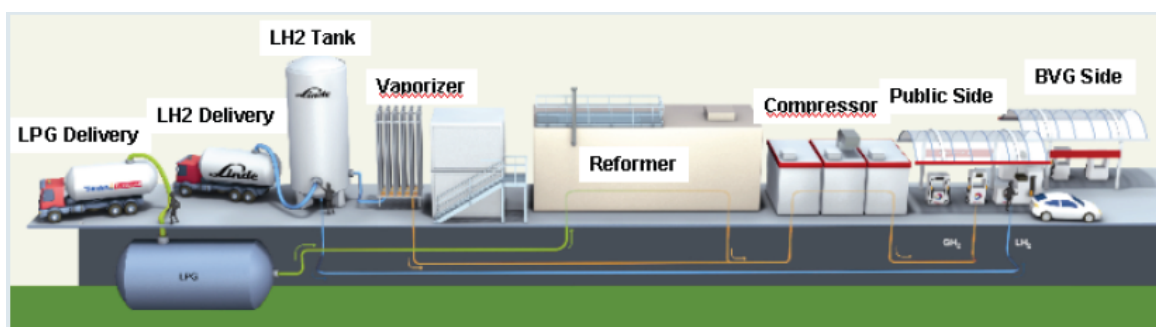


Figure 5: Principle view of components of the Total multi-fuel station at Berlin Heerstraße [Total]



**Figure 6: Photograph of public refuelling section of Total multi-fuel station at Berlin Heerstraße [Wurster, 29 Nov. 2007]**

This refuelling station offers all conventional fuels as well as LPG, CGH<sub>2</sub> and LH<sub>2</sub>. 60% of the hydrogen dispensed at this station is derived from LPG via reforming, the remainder (8 t) is trucked in as LH<sub>2</sub> with trailer. In 2007 the annual sales of hydrogen were in the order of 20 t. Due to the much larger number of CGH<sub>2</sub> buses to be refuelled in 2008, the weekly sales of hydrogen presently are at about 1 t. The sales price of hydrogen at this TOTAL HRS is fixed at 8€ per kg. The CGH<sub>2</sub> buses with about 40 kg on-board storage mass are refuelled in between 10 and 12 minutes, thus requiring close to 3 h to refuel all 14 buses.

→ BVG, TOTAL and VE have a clear strategy on advancing hydrogen as transport fuel.

### 3.3.2 Perspectives and experiences with hydrogen

BVG like any other bus operator is suffering from the increased Diesel fuel prices. But in contrast to other operators BVG sees an opportunity to become independent from conventional fossil fuels like crude oil and natural gas while cutting fuel costs in the medium and long term by changing to another fuel like hydrogen.

From the experience in refuelling times for CGH<sub>2</sub> buses of 40 kg storage capacity, being in the range of 10-12 minutes and operating ranges being in the range of up to 200 km, and from its experience with the prototype articulated hybridised hydrogen ICE bus (with the Ford V10, 7.8l engine) with LH<sub>2</sub> storage, BVG prefers the faster refuelling with LH<sub>2</sub> and the longer operating ranges feasible. BVG furthermore sees no disadvantage for fleet vehicles to be operated with LH<sub>2</sub> ("boil-off") every day, as long as LH<sub>2</sub> will be made available as hydrogen supply media anyhow.

In the German website section of BVG this strategy is outlined in more detail and more up-to-date at:

<http://www.bvg.de/index.php/de/Bvg/Detail/folder/860/id/70675/nb/1/name/Berliner+Wasserstoffankstellen> than in English version.

BVG furthermore has started a study together with TOTAL on how to produce hydrogen sustainably for Berlin.

BSR has no practical experience with hydrogen and FCVs beyond the experience of driving a Ford Focus FCV in the frame of the CEP Berlin project.

BSR operates 150 passenger cars which travel only 20-30 km per day and return home every day. For a few hydrogen vehicles, BSR can imagine cross-financing the expensive vehicles, but as numbers would grow overall economics have to become comparable to existing competing technologies. Also a refuelling infrastructure would have to be available to refuel these vehicles.

VE in a transition phase is prepared to cross-subsidize hydrogen/ fuel cell vehicles. In case of availability of cold start capable vehicles, VE would be prepared to operate immediately up to 6 Mercedes B-class FCVs. The same would count for 4 mail delivery vans of the VW T5 size.

VE operates 1350 passenger cars and vans (50:50 distribution) all over Germany. It operates no refuelling station in Berlin, but 3 stations in Hamburg and 10 stations in its eastern German mining locations in the Lausitz. The mail delivery vehicles in Berlin return to the home base every day.

The technical availability of the present TOTAL HRS lies in the order of 95%. The high availability at the hydrogen bus refuelling station onsite the BVG bus depot (directly adjacent to the public CGH<sub>2</sub> and LH<sub>2</sub> dispensing island) is facilitated through two dispenser posts with two dispenser hoses each with a max. refuelling pressure of 45 MPa. Thus usually at least three dispensers are operative. The 14 buses can be refuelled in less than 3 hours (10-12 minutes per bus).

Soon the refuelling station will be equipped with a 85 MPa pre-cooled refuelling system which will allow the filling of 70 MPa onboard storage vehicles with 5 kg of CGH<sub>2</sub> with max. 3 minutes.

Furthermore, it is under discussion that the TOTAL station for the public refuelling of passenger cars at the Heerstraße is located too far outside the city center and might be relocated or complemented (most likely to/ by the TOTAL station near to Berlin's East Trains Station). The HRS onsite the BVG bus depot though seems remain at Spandau.

Recently (June 2008), TOTAL has entered into an agreement with windpower producer ENERTRAG focusing on the production of wind-hydrogen and its supply to Berlin.

→ Hydrogen refuelling infrastructure in Berlin exists and will be extended over the next few years and some end-users are prepared to start driving FCVs.

### 3.3.3 Barriers and Drivers to the future deployment of hydrogen in the fleet

For the moment BVG's biggest concerns are that the cost of the technology have to become accessible, meaning additional costs need to be in a range which can be justified, and the technology has to be as mature as to allow a handling comparable to con-

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ventional technologies. The availability of the CGH2 ICE buses operated by BVG in the framework of the HyFLEET:CUTE project already lies in the order of 95% and thus at least as high as for CNG buses. Diesel buses reach an availability of 97%. Taking into account the experience with the HRS to date the combined availability of buses and infrastructure drops to around 90%.

*BSR's* main motivation to become active in hydrogen are that is a public enterprise with a certain forerunner function, *BSR's* commitment to reduce CO2 emissions as well as its commitment to participate in innovation projects.

Potential barriers would be: non-availability of refuelling infrastructure and too high costs of both hydrogen as a fuel and FCVs as the vehicle technology.

As *VE* sees the present developments in the energy market as a paradigm change, change management is urgently needed. Arguments why hydrogen makes sense have to be widely spread. The preparation of the people/ population requires quite some lead time in order to materialise public awareness and proactive support and has to be done with substantial efforts ("education"). The stakeholders interested in hydrogen and fuel cells have to show that the technology functions well and provides better performance characteristics than present technologies ("demonstration"). Infrastructure has to be built up and become available cost effectively ("infrastructure").

Funding by the German NIP is regarded necessary for the transitional period. Compressor and storage technology are regarded as by far too expensive and have to be reduced in their unit costs.

*TOTAL* regards itself as a key player with respect to hydrogen infrastructure in Germany and Europe. *TOTAL* is ready to assume a pioneering role in the developing hydrogen market. It sees hydrogen becoming market relevant in the medium term. Next to the production of sustainable hydrogen, national and international legislation with regards to the hydrogen market remain the biggest challenge.

→ The players interviewed see some issues to be successfully resolved but are very confident to become active in the market already at medium term.

### 3.3.4 Finance & Policy

In Germany the 1.4 billion € 10 year National Innovation Program (NIP) has created a positive political and financial environment for hydrogen and fuel cell projects during the next years.

*BVG* in the recent years always has tried to obtain public funding for various demo projects (MAN-TOTAL, HyFLEET:CUTE) in order to advance its strive in getting closer to a commercial use of hydrogen buses. *BVG* will also be partner of the NIP's CEP11 project (the present Clean Energy Partnership demonstration activity in Berlin is on the way to be extended to the CEP11 funded within the National Innovation Program for Hydrogen and Fuel Cells and will encompass Berlin and Hamburg as main focus points) and operate more hydrogen buses in the future (see above). *BVG* for the time being needs public funds to operate hydrogen city buses but sees the chance jointly with industry partners and government to carry forward the technology to a commercial state

where no subsidies will be needed anymore and the technology will achieve comparable performance parameters as today's conventional technologies.

In a transition phase towards a real market, *VE* and *BSR* can imagine to cross-subsidize limited numbers of FCVs to be operated in their vehicle park.

For the time being, *BVG*, *BSR*, *TOTAL* and *VE* regard public funding from *NIP* or other sources as necessary to bridge the cost risk towards a more commercial market.

Within the framework of the existing funding schemes by *HyFLEET:CUTE*, *TOTAL* is project partner for the hydrogen supply. After *BP/ARAL* stepped out from hydrogen demonstration activities and thus also closed down its Berlin station at the Messedamm, the need for a new "2<sup>nd</sup> station" persists. This station most likely will be a station by the new *CEP* partner *Shell* which will become operative in 2009.

Within the *NIP*, two main regions of focus for vehicle demonstrations seem to be agreed upon: Berlin and Hamburg. The highway *HRS* planned between Berlin and Hamburg most likely will be supplied with renewable hydrogen from wind power produced via electrolysis. It is also most likely that *TOTAL* will also be the operator of this station in Mecklenburg-Vorpommern supplying vehicles at the Autobahn connecting Berlin and Hamburg.

→ The practical *PPP* approach taken by the industry together with government in the frame of German *NIP* (and possibly also the European *JTI*) facilitates the implementation of hydrogen infrastructure and vehicles in urban centers as well as to establish the first highway links over the next five years.

### 3.4 Hamburg

Organisation	City	Country	Type
HySOLUTIONS/ HHA	Hamburg	Germany	Public
Universitätsklinikum Hamburg-Eppendorf (UKE)	Hamburg	Germany	Public
Hamburg Airport	Hamburg	Germany	Public
Hamburg Wasser	Hamburg	Germany	Public
HHLA Frucht- und Kühlzentrum GmbH	Hamburg	Germany	Private
TÜV Nord	Hamburg	Germany	Private
Deutsches Kraftfahrzeuggewerbe Hamburg (Hamburg KFZ-Innung)	Hamburg	Germany	Private

### 3.4.1 Introduction and strategic aspects

Hamburg has a local Hydrogen Association founded in 1989. The awareness in Hamburg of hydrogen matters dates back to this year when also the Euro-Quebec Hydro-Hydrogen Pilot Project had started and remained active for about one decade, besides creating theoretical background analyses and feasibility study work it also brought the first hydrogen demonstration projects to Hamburg in the early 1990s.

Besides the CUTE and HyFLEET:CUTE bus demonstrations several other hydrogen and fuel cell related activities take part in Hamburg. One of these is the hydrogen project at the Hamburg Airport. It comprises at present two fuel cell driven tugs by Linde-Still and one Fiat Dobló. A skid mounted compressor dispenser unit refuels these vehicles from hydrogen bundles. The onboard storage pressures are 20 MPa (Fiat) and 35 MPa (tugs).

The establishment of a company intended to better promote the use of fuel cells and hydrogen in Hamburg, called *hySOLUTIONS*, has been initiated in July 2005. and accomplished by *HHA* and partners (Vattenfall Europa AG, Germanischer Lloyd, Hamburg Chambers of Craft Trades and of Commerce) by October 2006.. *hySOLUTIONS* assists its project partners in the use and commercialisation of fuel cell and hydrogen technologies.

*Hamburger Hochbahn AG (HHA)* respectively *hySOLUTIONS* are involved in a number of hydrogen and fuel cell projects on fuel cell road transport, fuel cell ship applications for inland water ways and maritime ship APU applications, fork lifts, tugs etc. in logistic companies, the deployment of fuel cells in the aviation sector and on stationary CHP fuel cell applications and FC research.

*HHLA Frucht- und Kühlzentrum GmbH (HHLA)* considers the use of hydrogen fuel cell driven industrial trucks (e.g. fork lifts, tugs,etc.) in their 80,000 m<sup>2</sup> warehouse.

*TÜV Nord* is a third party certifier involved in hydrogen since more than a decade and thus will become active in this area as hydrogen use extends.

The *Hamburg KFZ-Innung* monitors the hydrogen and fuel cell developments in the Hamburg area in order to be prepared to install the necessary curricula in due time for the training of the technicians maintaining and repairing hydrogen vehicles.

It has to be mentioned that both the airport tugs as well as the future industrial truck to be used by HHLA are vehicles not certified for road operation and thus strictly speaking do not fall into the HyLights analysis matrix and thus run "out of competition".

The *UKE* as operator of a large hospital has become aware of hydrogen and fuel cells through the local H<sub>2</sub>/FC promotion agency *hySOLUTIONS*. The medical director of UKE seems to be a strong supporter of hydrogen use. As modern medical concepts pretend to focus on preventive health protection, the concept of hydrogen and fuel cells providing a clean and potentially renewable closed circle energy supply system very well fits into this approach as a means of preventive climate protection. UKE tries to avoid visible traffic by already installing a so called AWT in its new 450 M€ hospital

complex (i.e. an automatic underground goods transport system which is a battery-electric-based propulsion with recharging stations automatically used by the transport vehicles). A clean complementary transport system for visitors (i.e. a H<sub>2</sub>/FC shuttle bus) and above ground cargo transport bike (e.g. Cargo Bike type) for outside internal road use and indoor corridor use would ideally fit into and complement this philosophy. The innovative approaches are seen as ideally suited for a university hospital and its educational/ teaching mandate.

A further component of this integrated approach is to consider the layout of the planned refuelling station to supply the H<sub>2</sub>/FC shuttle buses not only to be the easiest concept of CGH<sub>2</sub>-trailer delivery, CGH<sub>2</sub> bottle onsite storage and dispensing but rather to install an electrolyzer unit for onsite production of hydrogen and oxygen and to feed the oxygen into the hospital-internal O<sub>2</sub>-supply system for medical uses, thus aiming at a synergistic use of the invested certified renewable electricity both from the product stream aspect as well as from the energetic and economic point of view.

*Hamburg Wasser* is composed by two companies, the Hamburger Wasserwerke GmbH and Hamburger Stadtentwässerung AöR. Both companies are subsidiaries of the Free and Hanseatic City of Hamburg. The companies have a common car pool.

→ The comparatively long “tradition” and experience in hydrogen and fuel cells in Hamburg over almost two decades and the number of active players seems to have prepared a fertile ground for H<sub>2</sub>&FC applications in the short and medium term as well as market preparation and introduction.

### 3.4.2 Perspectives and experiences with hydrogen

It is the clear goal of the City of Hamburg to become a hydrogen metropolis. Without this clear commitment and the corresponding strong political will the already existing hydrogen activities (CUTE, HyFleet:CUTE, ZEMSHIPS, hySOLUTIONS, etc.) would not have been realised.

The *Hamburg Airport* already operates several hydrogen vehicles, one also on public roads (the Fiat Dobló). The main motivation for hydrogen vehicle use is to contribute to securing the airport location close to a densely populated city center. Although hydrogen at short term is seen as an exotic technology its long-term potential is well recognized.

The speciality vehicles in use at the airport due to their low manufacturing volumes are comparatively expensive and the additional hydrogen conversion expenses are comparatively moderate and make these types of vehicles particularly suitable for early market use (statement by the airport representatives).

*TÜV Nord* and *Hamburg KFZ-Innung* stated that it is important to train future generations and to start now with school kids. Parallel actions on technology development and technology demonstration in order to increase the public perception and acceptance are required.

*HHLA* plans to move towards hydrogen vehicle demonstrations.

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Up to the present days, *UKE* has not yet accumulated any H<sub>2</sub>/FC knowledge or practical experience. The internal strategic decision to depart into a hydrogen fuel cell shuttle bus demonstration activity at the UKE would add another H<sub>2</sub>/FC demonstration activity in Hamburg, besides the airport hydrogen vehicle project, the 7 ex-CUTE fuel cell buses in regular public bus service, the EADS FC activities in airbus aviation application and various research and development initiatives.

*HHA/hySOLUTIONS* sees the medium and long term implementation of hydrogen technology. Currently one Diesel-hybrid bus is in test operation at HHA. For public transport hydrogen will be the fuel of choice already in the medium term, as for this application the infrastructure can be realised easily. As soon as the technology is available at fair conditions HHA will start the procurement process presumably via the bus alliance ([www.hydrogenbusalliance.org](http://www.hydrogenbusalliance.org)). Though, at short term the potential of hydrogen is seen as limited. The efforts to adapt the infrastructure are regarded as too complex. Therefore from an economical point of view the application of hydrogen and fuel cell vehicles is not attractive yet besides testing and demonstration of prototype vehicles.

If oil prices will further increase, this may pave the way to the further extension of additional hydrogen infrastructure. The big advantage of the other alternatives mentioned (biofuels and hybrid systems) is based on the adaptability of existing internal combustion engine systems. Consequently less complex infrastructure adaptations are required. Therefore they outmatch hydrogen as a fuel in the short run with regard to economical calculations. In the long run, in the view of *hySOLUTIONS* the perspective for hydrogen has to be regarded as very positive despite its technical complexity.

For all projects *hySOLUTIONS* is supporting they expect economic viability. If a project idea is not judged as economically viable it would not get support of *hySOLUTIONS*.

*Vattenfall Europe* together with partners will build a new hydrogen only refuelling station in the Hafen City (commercial urban area). This HRS will be a self-service station open between 07:00 and 18:00 working days. The estimated annual sales of hydrogen (calculated) should lie in the order of 200,000 kg. Besides 35 MPa CGH<sub>2</sub> also 70 MPa will be dispensed later on.

*Hamburg Wasser* as one of the future technologies topics addresses the question of optimising the utilisation of sewage gas, which is currently used thermally. Various projects in this regard are already on their way.

*Hamburg Airport* besides the hydrogen powered vehicles (1 Fiat Dobló & 2 Still R 07-25 tugs) operates several CNG-powered vehicles. Currently 27 CNG tugs (26 Mulag / 1 Rofan) are in use for the luggage transport between the terminals and the planes. That also includes indoor operation inside the luggage hall. The CNG tugs are in 100% commercial application. Furthermore, there is a Skoda Oktavia CNG in use. Currently Hamburg Airport is investigating the purchase of CNG buses. Besides the hydrogen refuelling station Hamburg Airport operates 2 CNG refuelling stations (1 public / 1 private) as well as 2 LPG stations (1 public / 1 private). Currently no battery powered vehicles are in use. The planning horizon with regard to vehicle procurement and fuel choice is about 10 years.

→ The perspectives for hydrogen and fuel cells in Hamburg are seen as very promising.

### 3.4.3 Barriers and Drivers to the future deployment of hydrogen in the fleet

As the biggest barrier perceived appear the still very high costs of the H<sub>2</sub>/FC end use technologies, their limited availability and the missing infrastructure (HRS, maintenance workshops, support). Consequently political commitment and financial subsidies are regarded to be indispensable for the transitory period towards a real market. Technical availability, economic accessibility and safe operation are key requirements mentioned by the interview partners.

As driving motivation, the positive image of the clean H<sub>2</sub>/FC technologies and that they promise to provide social, technical and acceptance-related improvements and alternatives compared to today are mentioned.

Answers to the following questions have to be found: How does future mobility look like? / Which power trains will be used in the future? / How to substitute fossil fuels?

Buses used in public transport are from hySOLUTIONS' point of view one of the first exemplary and near real-world applications for hydrogen and fuel cells as they are weighing 15 tons and therefore are a tough field of application not suited for battery electric traction. With its experience, HHA urges the vehicle manufactures for starting the series production. By showing strong commitment and participating in demonstration projects HHA supports massively the start of this series production.

Public acceptance of hydrogen and fuel cells seems to be a minor issue. It seems that it is rather the other way round: It would be nice if the technology would already have adequate market readiness. The financial framework conditions should smoothen out as soon as mass production starts.

There is the massive need for adaptations of the infrastructure on the one hand and the broad creation of trained jobs as well as the supplement to already existing job training programs (e.g. adaptation of the current job description of mechatronics) on the other hand. A fast diffusion of the required knowledge has to take place. Furthermore, there is the need for sound public relation efforts.

Cost targets have to be met, which makes the implementation of the technology economically viable.

→ The perceived opportunities definitely seem to outweigh the observed potential barriers.

### 3.4.4 Finance & Policy

In Germany the National Innovation Program (NIP) has created a positive political and financial environment for hydrogen and fuel cell projects during the next years.

Hamburg has a strong involvement in climate and resources protection (this already was a main motivator to start into the EQHHPP in 1989). This situation has intensified since Hamburg is governed by a coalition of the conservatives and the Green party (first time in Germany) in the State Senate (since 2008). Consequently Hamburg's distinctive activities in the field of hydrogen technology are a deeply rooted element of the political agenda. They are understood as instruments for environment protection as

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well as catalysts inducing the implementation of know-how based high tech industries. Thus, hydrogen contributes largely to reaching the political goals of the City of Hamburg. Hamburg has set itself the target to become a hydrogen metropolis. The already existing hydrogen and fuel cell projects would not have been realised without the strong political will.

Hamburg for two decades is aware of hydrogen and has repeatedly undertaken initiatives in this field, purely privately funded activities as the former W.I.T.E. project, the publicly co-funded projects like CUTE and HyFLEET:CUTE and finally the privately funded operation of 9 CUTE fuel cell buses of which today still 7 are in operation in the frame of the HyFleet:CUTE project.

It seems that both the Hamburg Airport as well as HHLA are confident to acquire local Hamburg funding for their existing respectively for their planned hydrogen demonstration activities.

The micro fuel cell shuttle bus project proposed by UKE (starting with one Hydrogenics bus; to be extended possibly by a 2<sup>nd</sup> one later) with hydrogen refuelling station is intended to start operation beginning of 2009. Budget allocations for this approx. 900k€ project have been installed in the Hamburg municipal annual budget. UKE has also already submitted a funding request to the German NIP/NOW recently. UKE also is prepared to bring own financial resources into the project.

→ The political and financial environment in Hamburg seems to be well prepared and promising for H2&FC.

### 3.5 London

Organisation	City	Country	Type
EDF Energy	London	UK	Private
Tesco	Cheshunt	UK	Private
Thames Water	Reading	UK	Private
E.ON	Coventry	UK	Private
BT Fleet	Birmingham	UK	Private
London Borough of Camden	London	UK	Public

### 3.5.1 Introduction and strategic aspects

As the capital of the UK, London is a large city having to cope with CO<sub>2</sub> emissions, local air pollution and a congested city centre. As one of the few cities in Europe, London introduced a congestion charge to battle the congestion of the inner city. The congestion charge applies to all vehicles entering the city centre, with an exception for electric (including hybrid) and hydrogen vehicles. Although the congestion charge was initially set up to reduce the congestion, the discussion in recent years was to make the charge CO<sub>2</sub> dependent. With the election of a new mayor recently, this was put on hold.

London (Transport for London) took part in the CUTE project. It demonstrated hydrogen buses and refuelling stations during the project and the London Hydrogen Partnership was set up in 2002. The aim of this partnership is to

- establish and maintain dialogue among all sectors/actors relevant to the hydrogen economy
- prepare and disseminate relevant materials
- develop the London Hydrogen Action Plan as a route map for clean energy
- provide a platform for funding bids and initiation of projects

Up to now there has been no demonstration project of hydrogen in transport in London, however a contract has been signed for 10 buses (five fuel cell buses and five internal combustion engine buses), a depot refuelling station, and two central filling facilities. These buses together with 4 small vehicles will become operational throughout 2009, however some permits have to be taken care of in the mean time.

The interviews conducted will give further insight in the preferences of the interviewed stakeholders, as well as the drivers and barriers and financing and policy needs.

EDF Energy is an energy company (daughter of Électricité de France) producing and providing electricity in the UK. The aim of EDF is to reduce CO<sub>2</sub> emissions (20% by 2012 compared to 2006), but also work on the security of supply as well as affordability of electricity. EDF in France is testing electric vehicles, while EDF Energy is (together with NICE Car Company) setting up a recharging network for vehicles in London.

Tesco (a retail chain of groceries and other merchandise) use some electric vehicles in amongst other London for the delivery of products ordered online at tesco.com. Their goal is to reduce their transport emissions by 50% in 2012 (compared to 2006). They hope to achieve this by using their fleet more efficiently (double-decker trailers and reducing transport of empty trailers), using other modes of transport and by using biofuels. By informing and promoting green sustainable products to their customers they hope to persuade the general public to become more sustainable as well.

Thames Water (the largest water and wastewater services company) is concerned by the climate change. It will alter their way of business (provide clean drinking water) and therefore reducing CO<sub>2</sub> emission is important to the company. Thames Water's fleet is leased from BT and currently the biggest reduction of CO<sub>2</sub> emission of the fleet comes from using the fleet more effective in stead of using alternative technologies.

E.ON (an electricity, gas and energy service company) has a fleet running throughout the UK of which a small part is running in London. E.ON is looking into reducing the carbon footprint of all the companies activities, meaning in production of electricity but also their fleet. They already had efficiency gains of 10-20% by giving the drivers a 'clean driving' course, but also tested flexifuel vehicles and B30. E.ON is looking into fly-wheels. Initial insights show a 20-25% efficiency gain during low refs in urban cycles.

BT Fleet is a subsidiary of the British Telecom Group. BT Fleet leases vehicles to BT, but also other companies. Since BT Fleet is a leasing company it does try to reduce the environmental impact of the vehicles, but on the other hand respects the requests of its customers. The customer is the driver behind the demand for alternative vehicles.

London Borough of Camden is a borough in the inner city of London. Topics related to transport are local air quality, CO<sub>2</sub> emissions and congestion. On all fronts the Borough of Camden tries to achieve the best for the inhabitants. The fleet of the borough, providing services for those in need (disabled, elderly, etc), is using alternative fuels, like LPG and natural gas. There is also an electric vehicle used.

### **3.5.2 Perspectives and experiences with hydrogen**

In London there is currently no demonstration of hydrogen, but there was a demonstration of hydrogen fuelled buses and refuelling stations during the CUTE project. For most companies interviewed however, hydrogen is still seen as a long term option. It would fit in their corporate and social responsibility programme, but at the moment is to long term (and some think too costly). Surprisingly there are quite some trials and interests in electric vehicles. Some interviewed stakeholders test electric vans for several purposes and there are even plans to set up a recharging grid throughout London. Setting up a new infrastructure for electric recharging is seen as less of an obstacle then setting up a hydrogen refuelling infrastructure.

Most companies are focusing on what they can do right now to reduce their carbon footprint. Looking into EURO V and VI for diesel vehicles, using biofuels and sometimes natural gas or LPG are the options at the moment. The sustainability discussion concerning biofuels discourages companies to fully switch to biofuels, while the uptake of LPG is stopped due to the sudden abandonment of the support scheme for the LPG infrastructure.

Hydrogen is seen by some as the ultimate end solution, but is in competition with other options. If the electric vehicle is proven to be successful hydrogen would have a hard time getting into the market. The technological development of alternative technologies thus is a risk for hydrogen. Also, often mentioned by the stakeholders is the infrastructure. There has to be a sufficient infrastructure before fleets will shift to hydrogen. Most fleets do not start at a depot anymore, but start from the home of the operator. A larger infrastructure is thus required in order to get the fleets interested.

### **3.5.3 Barriers and Drivers to the future deployment of hydrogen in the fleet**

The driver for almost all interviewed stakeholders to look into alternative technologies is to reduce the CO<sub>2</sub> emissions of their own transport operations as part of reducing their overall carbon footprint. Some stakeholders even set clear goals for them selves. The

biggest challenge is to reach reductions at affordable cost. Therefore most interviewed stakeholders are looking into currently available technologies instead of long-term options.

The whole sustainability discussion around biofuels causes some companies to rethink their strategy. The sudden abandonment of the support scheme for LPG on the other hand lowered the trust in the government support. The government does not have a clear vision on the future and this proves to hinder new technologies to enter fleets.

The sudden interest in electric vehicles is interesting. There seems to be no logical exploitation why this interest exists, but the fact is several interviewed stakeholders are actively looking into electric vehicles and even are setting up a recharging network throughout the UK, including London. That electric vehicles are exempted from the congestion charge is only playing on the background.

### **3.5.4 Finance & Policy**

In London electric vehicles are exempted from the congestion charge. Hydrogen fuelled vehicles are considered electric and therefore do not have to pay the charge. This does provide an incentive, but only for those who travel to and in London at a daily basis.

The incentives put forward to promote other fuels have not proven to be reliable. The UK government had a scheme to support the infrastructure build-up of LPG. Some oil companies invested in the build-up of LPG refuelling facilities, but deployment came to a halt when the government stopped the support overnight. Now there is a limited infrastructure and quite a lot of money invested which probably will not be repaid.

In London there is also a 'powershift grant' for vehicles. It used to be for LPG vehicles, nowadays also natural gas and hybrid vehicles are included. The grant refunds a small part of the additional cost for such a vehicle. The incentive is only limited and does not apply for fleets.

The reliability of government support is necessary and especially after what happened with the LPG scheme the stakeholders do not have very much trust in the government. Hopefully with the hydrogen action plan the government will clearly outline what the ideas are and how they will contribute, because the difficulty with these long term transitions is the politicians change and therewith often the commitment. With the recent election of the mayor of London there is a new discussion whether or not hydrogen vehicles (cars) will be procured or not. The mayor for example also stopped the congestion charge to become CO2 dependent.

### 3.6 Rotterdam

Organisation	City	Country	Type
TNT Post	The Hague	Netherlands	Private
DCMR Milieudienst Rijnmond	Schiedam	Netherlands	Public
Eneco	Rotterdam	Netherlands	Private
KPN	The Hague	Netherlands	Private
Port of Rotterdam	Rotterdam	Netherlands	Private
Rabobank	Rotterdam	Netherlands	Private
RET	Rotterdam	Netherlands	Public
Roteb Lease	Rotterdam	Netherlands	Private

#### 3.6.1 Introduction

Rotterdam is a city with one of the largest harbours in the world. There also is a large industrial site where amongst other refining and chemical processing plants are located. Within the region of Rotterdam there is one of the world's largest hydrogen pipeline networks, which has connections to Belgium even. Recently within the Rotterdam area the Rotterdam climate initiative (see <http://www.rotterdamclimateinitiative.nl/>) was launched. This initiative aims to reduce CO<sub>2</sub> emissions in the Rotterdam area by 50% in 2025 compared to 1990 emissions. To reach this goal the municipality of Rotterdam, Port of Rotterdam, DCMR Milieudienst Rijnmond and Deltalinqs work together and other organisations are free to join or submit their ideas.

The working group Hydrogen as part of the energy transition taskforce worked together with the Dutch industry on a hydrogen vision for the Netherlands. In the report published in 2007 the working group envisages Rotterdam as one of the three hydrogen regions in the Netherlands. Rotterdam should serve as one of the test regions for public applications (i.e. buses and cars). To generate interest and create commitment (in all the three regions) a regional hydrogen manager is appointed.

There is no demonstration of hydrogen in transport as of yet in spite of the hydrogen availability and use by the refining and chemical industry in the Rotterdam area. The conducted interview will however give insight into the perspectives, drivers and barriers and financing and policy needs on hydrogen by companies with different fleets.

TNT post (a postal delivery company) has a fleet (leased from ING Lease) running in the inner city mainly collecting mail from the mailboxes and dropping these at a centralised sorting depot. The use of these vehicles can be characterised as 'stop-and-go'.

Large trucks than transport the mail to and between the sorting depots (7 in the Netherlands). They are looking into natural gas and also participate in a research project focussing on diesel hybrids. The company policy is to reduce their carbon footprint (manager bonuses are dependent on these and drivers are monitored by a device on their vehicle use) therefore they look into these currently available options.

The Environmental Protection Agency (Dienst Centraal Milieubeheer Rijnmond, or DCMR), is responsible for the regulation of environmental permits for amongst others industry in the Rotterdam area. Their fleet is used to measure emissions and other pollutant (8 measuring vehicles) and visit customers (30 passenger vehicles). The passenger vehicles can be used by all the employees for business trips and are always returned to the DCMR office. Some of these vehicles are hybrids or flexi-fuel vehicles.

ENECO (a utility company) has a large fleet with service vehicles. These often are equipped with tools and gear related to the work, which engineers can pick up at a depot during the week. The vehicles have a special interior in order to transport all the equipment. ENECO looked into NG around 2002 but ended the project due to technical difficulties. The vehicles were equipped with NG tank, etc, but the build-up of the infrastructure took too long, putting a halt to the project before it actually started. Currently ENECO tries to reduce their CO<sub>2</sub> emissions by leaving out luxury in vehicles (airco, pre-heater, etc).

KPN (a telecom company) has their biggest fleets for their engineers in big cities. The business approach changed from having a centralised fleet at the depot to delivering equipment to their engineers overnight at home (where the vehicle is). KPN also looked into natural gas, but had difficulties setting up the project with partners dropping out.

The Port of Rotterdam is the authority developing, managing and operating the port of Rotterdam. Their fleet (50 company vehicles) has some biofuel vehicles (10% of the total fleet) and they also have an electric shuttle to transport guests. Currently they are looking into if they can equip this electric shuttle with hydrogen and fuel cells.

The Rabobank (a bank) has a fleet of company vehicles (80 vehicles) that can be used by employees to visit customers and a special (small) fleet for the employees maintaining their ATMs. The Rabobank is stimulating the reduction of CO<sub>2</sub> by changing their business approach. They do this not only by leasing cleaner vehicles (A-label), but also by for example, allowing employees to work from home, providing employees with a public transport pass, etc.

The RET (public transport company in Rotterdam) leases 50 service vehicles, operates 220 buses, 130 trams and 170 metros within Rotterdam. Some of the buses are already Euro V or diesel EEV and from 2009 onwards all buses reach this standard. The RET tests bioethanol blends (up to 7.7%) in some buses, looks into diesel hybrid buses, use green electricity for their trams and have given their drivers a course in ecodriving to reduce emissions further.

Roteb Lease (a lease company) leases (and specialises in) special vehicles besides normal vehicles. Specialised vehicles are for example cleaning vehicles, garbage vehicles, vehicles with cranes, etc. Within Rotterdam Roteb leases and services 1500 vehicles. They however serve their customers and do not influence their customs demands. They are however well aware of the new technologies entering the market and will draw their customers attention to these new developments.

### 3.6.2 Perspectives and experiences with hydrogen

In the Rotterdam area no hydrogen vehicles are being or have been demonstrated in a project. There is however interest in hydrogen and fuel cells from some companies since it contributes to their corporate and social responsibility programme or fits with their strategy to reduce their carbon footprint. For example the bus company would like to start switching towards hydrogen around 2015, while the RET already operating an electric vehicle is looking into equipping that vehicle with hydrogen and fuel cells. Rotteb lease is mainly interested in hydrogen as a power source in their specialised vehicles for operating their cranes, garbage vans, etc.

For most companies hydrogen is seen as a long term option, while companies are focusing on what they can do right now to reduce their carbon footprint. Already most companies are switching towards Euro V and EEV diesel vehicles (vans and trucks), which are available and affordable and provide no challenge concerning a new infrastructure. Most interest for the short term at the moment is on natural gas, hybrids, electric and biofuels, although the sustainability discussion concerning biofuels discourages companies to fully switch to biofuels, while on the other hand the municipality of Rotterdam is in favour of biofuels. Most companies have an internal policy for their lease vehicles (leased to their employees). This policy is that the employee is free to choose from all vehicles with an A, B and C label (sometimes also D label).

The switch to hydrogen will be dependent on a few things. Firstly, if other alternatives will have technological breakthroughs before hydrogen vehicles become available, the switch to hydrogen will be questionable although most interviewees see hydrogen as the ultimate future fuel. Secondly, before company fleets will switch to hydrogen there has to be a refuelling infrastructure in place. This means a couple of refuelling stations throughout Rotterdam. Most of the company vehicles operate starting from the employees home (instead from a depot) and run throughout the city. Besides TNT all vehicles do not operate on the same track every day, increasing the need for infrastructure. Lastly, the costs of hydrogen need to be clear (i.e. vehicle cost, excise duty, but also cost per kilogram). For a demonstration project almost all companies are interested and have some funding available. It however has to be clear what will happen after the demonstration project. If there is no clear outline for future introduction, companies tend to be less interested to participate in a demonstration project.

### 3.6.3 Barriers and drivers

Clear driver for all the interviewees is their goals to reduce their CO<sub>2</sub> emissions from their own operations. The availability and affordability of vehicles is however a barrier. Already most of the interviewees are switching towards Euro V and EEV vans / trucks, despite policy is running behind and not providing incentives.

The companies leasing the vehicles or purchasing them for the automotive industry sometimes want to do more than they are 'allowed to' according to their lease contracts. For example a few companies wanted to go beyond the 7% bio-ethanol blend, but the warranty would expire immediately if they would do so (even the warranty on parts which have nothing to do with the fuel).

The barriers most mentioned are the cost of the vehicle and the lack of infrastructure (often referring to the past experience with natural gas and the current experiences

with biofuels). For example, some companies tried to set-up a demonstration project for natural gas, but the infrastructure build-up provided such a problem that either the project did not start altogether, or was stopped due to infrastructure build-up delays. Companies now fear the same thing can be happening to biofuels and in the future hydrogen if they are not careful. The only refuelling station in Rotterdam that provides biofuel is often referred to as an example. This refuelling station provides very expensive (€ 1.90) bio-ethanol due to the (sudden increase of) excise duty. It is also under very strict supervision by customs since by law bio-ethanol is an alcohol in the Netherlands. This does not accelerate the distribution of biofuels by other refuelling station.

Fleet vehicles, or company vehicles, are nowadays operated differently than before. Fleet vehicles for all companies used to be gathered at a depot at the beginning and end of the day. They gather their equipment and work assignments there and headed off to work. Some of the depots had a refuelling facility where the cars could be refuelled. Nowadays, most of the fleet vehicles are taken home. The employee will get its work assignment electronically, the equipment will be delivered one a day (during the night) or can be gathered at a depot once a week (whenever the employee wants) and the vehicle can be refuelled everywhere with a multi-tank card. This means, in order for hydrogen to be successfully demonstrated there is a need for a couple of refuelling stations throughout the region of Rotterdam.

The lack of a uniform government vision on future fuels and commitment is also mentioned as barriers. The city of Rotterdam favours biofuels, while the state of Zuid-Holland promotes natural gas. This provides unclear signals to the market and companies.

#### **3.6.4 Finance and Policy**

In the Netherlands there are no incentives for hydrogen and fuel cells, besides the exemption for road tax (BPM). However, since company vehicles pay lower road tax, this provides a minimal incentive and will certainly not cover the cost of a demonstration project.

The uncertainty in taxation like excise duty also poses companies to think twice before they decide to switch to another fuel. The sudden increase in excise duty for biofuels is a good example of how governments can hamper the introduction of a new fuel.

Other policies (or regulations) can also pose problems and have to be looked into preferably before hydrogen is introduced. Regulations concerning if hydrogen can be used indoors are a good example. The experiences with CNG show that vehicles cannot enter the maintenance shop due to regulations. This poses a real problem.

Government together with bus companies are currently looking into the public transport tendering/procurement procedure to review if this could include a sustainability requirement. This however seems quite hard to do, since the procedure cannot obligate the use of a certain technology, but however can obligate a maximum CO<sub>2</sub> emission. The idea at the moment is to extend the operating licence of a bus company whenever they use a new innovative way to reduce their emissions (like hydrogen).

Policies like a congestion charge can help the introduction of hydrogen, but not in the demonstration phase. There already is a good basis for the introduction of such a pol-

icy since Rotterdam already has environmental zones for heavy duty trucks. However, companies operating throughout the Netherlands insist they prefer such a system to be introduced nationally and not let every city design its own system.

### 3.7 North-Rhine-Westphalia/Arnhem

Organisation	City	Country	Type
City of Herten – Hertener Stadtwerke (HS)	Herten	Germany	Public
Environmental Authority	Bottrop	Germany	Public
Bayer AG	Leverkusen	Germany	Private
Infraserv-Knapsack, Chemiepark Knapsack,	Hürth	Germany	Private
Regionalverkehr Köln GmbH (RVK)	Cologne	Germany	Public
Municipality of Arnhem, Arnhem, Netherlands, assisted by HyGear B.V	Arnhem	Netherlands	Municipality Arnhem – Public HyGear - Private

#### 3.7.1 Introduction and strategic aspects

The North-Rhine-Westphalia/ Arnhem region includes the following locations/ countries: NRW south: Hürth near Cologne (HyCologne), NRW north: Bottrop and Herten, Arnhem: city of Arnhem as part of Arnhem-Nijmegen metropolitan region, some 100 km from Düsseldorf.

Arnhem has close ties to the Amsterdam/ Rotterdam hydrogen alliance as well as to the NRW cluster. It was decided that it is analysed together with NRW as it lies in the eastern part of NL and adjacent to the German border.

The *City of Herten* lies in the Ruhr area in NRW and has about 60,000 inhabitants.

The strengths as seen by the City of Herten are the vicinity to fuel cell manufacturers like Rittal and to users like e.g. T-Com. Furthermore the availability of suitable industrial grounds and infrastructures which usually were mines and mining installations formerly

and which now shall be recycled to deal with future oriented new energy technologies like H<sub>2</sub>&FC. The former mining complex of "Ewald" is the one chosen for such a development activity in Herten. It will also be the location for the HRS to fuel the hydrogen vehicles/ bus.

The Rhine-Ruhr area is one of the largest European population centers and thus a potential mass market. The declared political will for transformation to H<sub>2</sub>&FC has been manifested at several occasions. Focused networking and technology transfer through the competence network Fuel Cells and Hydrogen NRW is an important supportive activity by the state government of NRW.

In this endeavour of transforming old industry into new employment opportunities, the City of Herten in the newly to be erected Hydrogen Competence Center plans the construction and operation of a Blue Tower demonstration plant (10 MW<sub>th</sub>) for the hydrogen production via biomass gasification to a synthesis gas, the development of technologies to produce highly pure fuel gases, the installation of a HRS, the research and development of H<sub>2</sub>&FC technologies and the build-up an information and qualification center for hydrogen technologies. The City of Herten pretends to have found a powerful investor (Solar Millenium) to put financial resources into the Blue Tower plant

The City of Bottrop lies in the Ruhr area in NRW and has about 120,000 inhabitants. During the last years, the Emscher Genossenschaft, a regional and community supported body which deals with water supply and treatment issues in the area since more than half a century has become active in environmental improvement projects which also have a link to hydrogen. The Emscher Genossenschaft operates the sewage treatment plant in the south of Bottrop. The methane gas produced in the anaerobic stage of the plant is being burnt in 4 CHP ICE motor plants presently. In order to use the methane gas also as a hydrogen source, a conversion and purification stage has been installed, a 900 m long pipeline been constructed to a school center close by and a hydrogen adapted CHP ICE motor plant be installed in order to produce electricity and heat for the school. The supervised test trials will start in late summer 2008. As soon as it is clear if the hydrogen quality supplied is high enough, also a fuel cell CHP plant may be operated in the future. Bottrop is also passed by the Air Liquide hydrogen pipeline on its way from Marl to Cologne-Wesseling. Additionally, one of the few still operative coke gas plants is run in Bottrop. Since years, this plant has a hydrogen purification stage which never was put into operation and waits for a use to purify the synthesis gas to pure hydrogen.

Bottrop thus has three potential sources of hydrogen.

Adjacent to the sewage treatment plant, the City of Bottrop operates a CNG refuelling station with the methane gas produced and also plans to add a hydrogen refuelling option.

*Regionalverkehr Köln GmbH (RVK)* is a public transport operator in the Cologne area. Its operating area extends 200 km north/south and 100 km east/west. RVK operates 330 own city buses (290 solo buses of 12 m and 40 articulated buses of 18 m length) and has subcontracted another 300 buses.

Increasing costs of the finite energy carrier crude oil and the thereto related cost explosion of Diesel fuel are an increasing motivation to think about the introduction of hydrogen buses. Furthermore, environmental aspects and the increased acceptance and

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gain of positive image on the side of the clients and the public transport authorities by the use of hydrogen powered buses.

*Bayer* has to enforce a company internal goal of reducing CO<sub>2</sub> emissions by 20% within 3-5 years. Hydrogen fuel cell vehicles would help in reducing the CO<sub>2</sub> emissions drastically and thus could contribute to achieving the internal company goal. Bayer operates about 4,500 passenger cars and vans at about 250 locations in Germany. Also some light truck up to 7.5 t and some fork lifts.

Several of the passenger cars which Bayer would aim at converting to hydrogen under favourable conditions do not drive more than 50 km per day, return every day to the home base and have to be refuelled only twice per month.

*Infraserv Knapsack* is a chemical park infrastructure operator and also drives small numbers of passenger cars and some more station wagons and vans of the MB Sprinter type. The average daily driving range of the cars lies between 10 and 100 km when used on the company grounds or driven in the vicinity, and in rare case 300 km per day are accumulated when the vehicles leave the company grounds.

The *City of Arnhem* in the eastern Netherlands close to the German border has organised several administrative and service oriented issues under the frame of the city region of Arnhem/Nijmegen (approx. 750,000 inhabitants), e.g. the public transport authority.

On the other hand, A/N is aiming at becoming a member of the national hydrogen alliance (Nationale Waterstof Coalitie) formed so far by the cities of Amsterdam and Rotterdam. Arnhem is one of the very few of the 400 communities in the Netherlands traditionally having hydrogen industry in its city limits. Therefore, Arnhem also intends to promote "new hydrogen" applications like H<sub>2</sub> cars, trucks and possibly buses. FC buses could become a flexible complement to the clean trolley already used in larger numbers on the busiest city bus lines. Furthermore, Arnhem is home of several hydrogen and fuel cell companies, among them Nedstack (a PEMFC manufacturer) and HyGear (an onsite NG reformer manufacturer).

The goal of the Arnhem municipality is to put hydrogen in use where it has its best benefits, and this is in polluted city centers. Therefore vehicles driving in the urban area are regarded as the best application technologies. Arnhem envisages to use passenger cars respectively light trucks (as the one developed in the HyTruck project) and FC buses as the one envisaged by a consortium of NRW and NL companies (VDL bus company, Vossloh-Kiepk electric traction and hybridisation, and Nedstack for the fuel cell system).

Although at short term Arnhem sees biofuels and potentially reforming of these, at the long term (beyond 2030) it sees hydrogen and fuel cells as having the largest impact. ICE hybrid vehicles are seen only as temporary solution.

→The awareness, interest and first project activities are convincing in Bottrop, Herten, Hürth and Arnhem. In most cases even traditional chemical industry hydrogen experience forms the basis and provides to ground to depart into new H<sub>2</sub> application activities.

### 3.7.2 Perspectives and experiences with hydrogen

The *City of Herten* does not yet have practical experience with hydrogen vehicles. In November 2007, in the frame of HyChain it has ordered two VEM utility trucks which will be delivered later in 2008. The city so far operates 20 CNG cars.

Also Herten will order one of the Hydrogenics microbuses for operation most likely on a tourist line as any use in regular bus service is not feasible with the slow bus.

The City of Herten is extremely conscious of energy matters and expects from the use of hydrogen technology a reduction of fuel costs and becoming less dependent from crude oil in the future. Also employment creation is an important expectation attributed to the use of hydrogen technologies.

The responsible administrator in the construction department (Baudezernent) of the *City of Bottrop* is of the opinion that some more substantial actions for the practical demonstration and use of hydrogen in the area have to be done and supports this also politically. A very interesting feature of the local political process in the municipality of Bottrop is that actions into hydrogen are advocated by literally all political parties in the city council. Thus political support is unanimous.

The communities of Bottrop (120,000 inh.), Gladbeck (65,000 inh.), Marl (80,000 inh.) and Herten (60,000 inh.) together with the Emscher Genossenschaft and the Vestische Straßenbahn (public bus and tram operator) have formed a *working group* for the improvement of cooperation, communication and project definition. Leader of this WG is the responsible administrator in the construction department of the City of Bottrop. In this joint activity, the Vestische Straßenbahn (VS) considers to operate between 10 and 15 standard (12m) hydrogen city buses. The group has already issued a feasibility study to the same engineering office which had realized the CNG refuelling station at the sewage treatment plant.

For the time being in the framework of the HyChain project also Bottrop has purchased one Hydrogenics microbus in November 2007. Presently Bottrop together with VS tries to identify a suitable operating profile/ line for the Hydrogenics bus. This turns out to be quite difficult as the maximum speed of the bus is only 35 km/h which makes the bus an obstacle in city bus service on regular bus routes. One option is to use the bus as school shuttle bus or as a tourist bus serving the stop at the tetraeder outlook on top of a coal mine debris mountain (65 m high). Also Herten considers a similar operating profile. Also the annual festivals in Marl might be a good opportunity for the use of the bus.

*RVK* and *HyCologne* have approached MAN in the past in order to get acceptable conditions for the purchase of 10-15 turbocharged MAN H<sub>2</sub>-ICE buses. Infraserb chemical park in Hürth ships 60 hydrogen tube trailers per day. This represents a volume sufficient to operate about 2,000 hydrogen city buses. Hydrogen available on the spot without long additional transport involved (ideally dispensed at the company fence/ limits) could be made available for very attractive prices, facilitating a close to competitive bus operation.

For the bus services of the community of Hürth, at the latest by 2010 new buses have to be purchased – and these could be hydrogen buses. The window of opportunity presently is open for about 1.5 years. Three potential locations for the installation of the

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HRS have been analysed. Adjacent to the Chemical Park Infraserp Hürth, at the Luxemburger Straße about 1 km from the chemical park or at the bus depot, about 1.7 km distant, the latter two locations to be connected by pipeline. Approval issues would not arise as the community is experienced with hydrogen infrastructure approvals.

*Bayer* expects a clear commitment by the EU and regional government to hydrogen solutions and a clear commitment to ensure that there will be an infrastructure available in due time. An overall EU approach to ensure a hydrogen network within Europe would increase the awareness for the solution. Further demonstrations will help the development of the technology and distribute the knowledge about the technology.

But it should be respected where hydrogen is available – the new demonstrations should have in mind the locations where hydrogen is directly and economically available without any needs for transport by trailers to a fuel station.

*Infraserp Knapsack* has hydrogen experience in its chemical installations but not yet in operating vehicles. Infraserp is interested to drive one FC passenger car in the near future and would adjust the profile of use according to the capabilities of the vehicle.

*Arnhem* plans to build a permanent hydrogen refuelling station based on HyGear's on-site reforming technology with at the beginning 5 Nm<sup>3</sup>/h production capacity and to be extended as demand increases. As a start it is planned to purchase Prius hybrid ICE vehicles converted to hydrogen by Quantum. Depending on how many customers can be found scenarios with up to 10 or even more vehicles have been analysed. If a customer can already be found for the hydrogen FC truck then the capacity of the refuelling station would have to be stepped up from the beginning. The largest hydrogen PR event in the region at which to focus in the foreseeable future is the World Hydrogen Energy Conference WHEC18 in Essen in May 2010. HyCologne and Arnhem are discussing the development and purchase of up to 10 FC buses (see above VDL/Vosslöh-Kiepe/Nedstack).

→The HyChain project activities are progressing – although slower than originally planned. Larger (RVK) and also cross-border activities (NRW/Arnhem) are under consideration.

### 3.7.3 Barriers and Drivers to the future deployment of hydrogen in the fleet

#### Barriers

*Herten* sees financial feasibility of hydrogen energy and fuel cell technologies as the main barriers. A start is needed now in order to collect experience and to bring cost and benefit into a more acceptable and justifiable relation.

The *City of Bottrop* has identified as one of the big barriers for the wide dissemination of hydrogen technology the missing level of knowledge/ information on the technology in wide areas of the population, media and decision makers. Earliest possible curricula for hydrogen and fuel cells already in schools are suggested as well as demonstration and use of the technology in real life in order to show to the public that the technology is here, functioning and safe.

A further main difficulty in introducing H<sub>2</sub>&FC technologies presently (especially by a municipality) is that the potential operator additionally to bearing the higher investment costs for the more expensive vehicle technology has to pay very high fuel prices for hydrogen. A way has to be found to offer hydrogen more economically viable – then also the higher investment costs for the cleaner technology can be easier justified when trying to convince authorities and funding bodies (e.g. a model similar to the German feed-in tariff for renewable electricity).

In view of *RVK*, the barrier is the extremely high access costs to the technology which in a public transport sector exposed to competition allows the participation of municipal transport operators only if suitable subsidies are available. The use of the hydrogen technology through subsidies has to reach the level of Diesel technology.

*Bayer* from the today's perspective see as *barriers* the missing infrastructure for fuel stations with H<sub>2</sub>, that the costs are still too high and that there are too few cars available in the market.

*Arnhem* sees cost and cost effectiveness as well as the difficulty to find sponsors for the acquisition of H<sub>2</sub>&FC technology as the biggest hurdles.

## Drivers

*Herten* expects to locally implement hydrogen as clean end-use fuel as well as storage component allowing gradually to become independent from energy to be carried to the location. Renewable energies shall play an increasing role in this approach.

The clean, non-polluting, odourless and quiet end-use technologies seem to provide a major benefit to the user and the population. *Herten* pretends to become an early starter and a leader in H<sub>2</sub>&FC and sees the investment as a business development measure and a chance to attract more investors and technology suppliers to the region/city.

The main driver in *Bottrop* is the clear political conviction that much more has to be done for hydrogen now (more that the state government of NRW does for hydrogen presently – NRW seems to be much more focussed on fuel cells than on hydrogen). The creation of sustainably stable employments with potential for the future is the main driving force of the region around Bottrop.

*RVK* assumes that the *chances* of hydrogen technology are increased in the pace as the cost of the conventional energy carriers crude oil and natural gas grow. The hydrogen and fuel cell technology still has to struggle with difficulties in storage and transport of the energy carrier hydrogen. Also the production of hydrogen in the future has to be achieved without the use of fossil energy resources in order to advance the technology substantially.

*Bayer* sees as *opportunities* that the market will start to think about alternative fuel solutions, thereby the market will change faster than in the past. New solutions will be developed and presented to the market. But as there are still very different views what will be the future technology (obviously also in Bayer's view) there is no clear picture what will be the future solution and the customers consequently needs to get a proper perspective how the future will look a like,.

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For *Arnhem* as opportunities are seen, political, societal and business support for meaningful demonstration projects supporting a sustainable energy policy perspective in public private partnerships. As an opportunity is also seen that the local players start into small scale demo/ project activities directly in their home yard which helps to enter the market faster than doing it far away.

Although in theory legal/ regulatory questions could be seen as a hurdle, authorities in the region are very supportive and will assist in finding pragmatic solutions. Example: the Arnhem municipality has already obtained an analysis for the siting of the planned HRS from TNO which also has received the consent from the fire brigade.

→ Astonishingly enough for a traditional hydrogen area in same locations (Bottrop, Herten) information deficits have been observed and need to be addressed. On the other side, some operators even can imagine to stabilise their fuel costs due to opting for hydrogen buses driven with cheap chemical by-product hydrogen. For other locations a subsidising of hydrogen fuel is advocated by some interviewees.

### 3.7.4 Finance & Policy

The boundary conditions for the funding of H<sub>2</sub>&FC technologies in Germany are not bad as on federal level the NIP is starting now and NRW is one of the three focus areas already named by NIP. Also the NRW state government through its operating agent Energy Agency NRW is supporting fuel cells and also hydrogen.

*Herten* has placed the so-called Herten Fund (via Inhaberschuldverschreibungen = bearer bond) which is offered to its electricity customers and from which the participation in renewable energy projects is financed, e.g. an offshore wind park. It is imaginable that part of the return from this fund will also be used for the funding of hydrogen and fuel cell technologies.

Although the Energy Agency NRW is very supportive, HS would expect more support from the state government of NRW. According to the conviction of HS in the policy the hydrogen sector has a too low significance/ importance.

As seen by the *City of Bottrop*, the NRW support for hydrogen needs to be enhanced as hydrogen is seen as an energy carrier which would allow the region to become less dependent on conventional fossil fuels like crude oil in particular in the transport sector.

Although support programs on both state (NRW) and national level (NIP) exist in Germany, the funding of the project aimed at by *RVK* (operation of 10-15 hydrogen buses) still is completely unclear. Hydrogen production, infrastructure and hydrogen vehicles have to be funded equally according to the perception of *RVK*. The difficulty at present is that NIP is not eager in funding H<sub>2</sub>-ICE buses and presently has its main focus on Berlin and Hamburg. NRW would like to fund innovation projects and thus would be eager to fund the development of a hydrogen fuel cell bus (VDL/ Vossloh-Kiepe/ Nedstack). This might not meet the time window open for the bus purchase in Hürth due at 2010.

*Bayer* concedes that there is support available, but it is very complex to get this support. A support by policy from the European perspective (as e.g. the JTI) would be helpful to have a clear statement about the future importance of and structure for hydrogen appli-

cations and support, otherwise there will be a lot of small activities without any coordination.

*Arnhem* has already articulated its interest on hydrogen development projects of up to 19 million € towards the national funding bodies. *Arnhem* itself has already committed 300k€ for the HRS to be built. Also funds from the EFRO innovation budget shall be tapped by defining and submitting a suitable project proposal.

→ Several interviewees in NRW welcomed the NRW funding on fuel cell technology but also mentioned that NRW does not sufficiently address funding of hydrogen infrastructure and technology. In general, the NRW and national Germany funding opportunities in place or soon in place are appreciated and regarded as very necessary to bridge towards a market introduction.

### 3.8 Piemonte/ Lombardia

Organisation	City	Country	Type
Regione Piemonte	Turin	Italy	Public
CarCityClub	Turin	Italy	Public
Zincar	Milano	Italy	Public
Milano Car Sharing	Milano	Italy	Public

#### 3.8.1 Introduction and strategic aspects

Both the Northern Italian regions of Piemonte and Lombardy have been selected as focus region. Piemonte and Lombardy signed a Memorandum of Understanding in 2007 envisioning a close cooperation in hydrogen fuel cell R&D.

In 2001, Milano Car Sharing was started by Legaambiente (an environmental association) as a pilot project that later on joined also the Italian network of Italia Car Sharing (ICS). As of 2008 Milan Car Sharing operates 63 vehicles and a few vans (less than 10). All vehicles in the fleet match Euro4 standard. Currently 4 Toyota Prius are operated and the customer responses are very positive.

Zincar, a joint venture between electricity company Edison and the City of Milan was created to develop zero emission vehicles. Zincar today is fully owned by the City of Milan. A gaseous hydrogen filling station was erected as part of the project and is one of three operating in Italy at the moment. For a demonstration, three hydrogen ICE were retrofitted to operate on hydrogen. During the Olympic Winter Games in 2006 BMW used the filling station for demonstration of its hydrogen cars.

CarCityClub is the car sharing initiative of Turin and was established as a joint project of Fiat and the City of Turin. As in Milan, the Turin car sharing joined the Italian Car

sharing initiative. ICS also provides co-financing to stimulate growth of the car sharing. Presently the fleet has about 100 vehicles and the average ride is about 30km. The vehicles are procured through long term lease contracts that cost up to 400€/month.

The regional administration of Piemonte is responsible for improving urban air quality in the region through policy and regulation and directly sponsors investments on infrastructures and research. The municipalities are responsible for vehicle procurement, but depend on the administration for financing up to 70% of the total budget.

### **3.8.2 Perspectives and experiences with hydrogen**

In the region of Piemonte, a bus was retrofitted with fuel cells in 2001 but it took almost 5 years to obtain number plates and the permission to operate it. As of today, the bus is decommissioned, but there are plans to turn it into a moving laboratory for testing hydrogen technologies. However, there is little industrial activity in this field in Italy. Fiat is experimenting with hydrogen-methane vehicles that make it more interesting to have a look into this technology. The region of Piemonte procured more than 250 hydrogen-methane buses. At the moment every municipality in Piemonte operates a methane fuelling station. Moreover it is planned to procure 100 hydrogen-methane FIAT Panda for the regional fleet.

Some of the vehicles in the fleet of the Car Sharing in Turin have a petrol and a methane tank. The customers however can only refill the petrol tank. Electric vehicles are not considered suitable because of logistic problems in charging the batteries. It is planned to operate 10 methane powered Fiat Doblo vans soon.

Zincar chose hydrogen because the progress in battery technologies was considered unsatisfactory. At the moment hydrogen fuel cells are considered a risky option and ICE hybrid vehicles are preferred as bridging technology towards hydrogen fuel cells. Zincar envisions two demonstration projects for hydrogen hybrid minibuses. One is for transport to the Milan Expo, where 50 minibuses are required with a max. range of 100km. The other one is a fleet of vans for the last-mile delivery within the city center. Hybrid ICE technology is considered reliable for public use once regulatory issues are solved.

### **3.8.3 Barriers and Drivers to the future deployment of hydrogen in the fleet**

Hydrogen is surely a radical break with the prevailing engine technology and a crucial step forward also for FIAT (headquarters in Turin). In this respect, the administration seems to pursue multiple policy objectives and hydrogen is considered a mean to reduce emissions and to stimulate economic growth, fuel diversification and penetration of renewables. However, the technological readiness is an important factor and the Region of Piemonte wants to understand what is currently possible at acceptable cost.

The flexible use of car sharing vehicles is perceived as the biggest barrier to the diffusion of innovative technologies such as hydrogen and fuel cells (CarCityClub Turin). Untrained users must be familiar with the vehicles operation including refueling. Filling stations must be available at multiple locations to guarantee a flexible service. Nonetheless, hydrogen is considered interesting for small scale demonstrations. It contrib-

utes to the image of the company and its mission statement: reducing emissions and the consumption of fossil fuels.

Overcoming regulatory issues is the main barrier for deploying hydrogen at Zincar. At the moment hydrogen cars cannot be licensed by the car registry and have to circulate with special number plates. Hydrogen is seen mainly as instrument to promote economic growth and the image of the city of Milan.

The Milan Car sharing would consider procuring one or two hydrogen vehicles mainly to improve its image. However, ease of use and realibility of the technology are perceived as substantial barriers. Many different users should be able to drive the car with minimum restrictions and the vehicle should have access to many filling stations within the city.

### 3.8.4 Finance & Policy

There might be a funding opportunity via the Italian car sharing consortium – through the municipality or the region. The municipality is responsible of the sustainable mobility projects and there are funds available through the Municipality, the region and the Ministry for the Environment.

Sustainable mobility will play an important role in the new transport and energy plan of Piemonte and considerable budget is available for research and deployment. Other funds might be available from the state government and the region administration is well positioned to act as coordinator of major hydrogen projects.

## 3.9 Spain

Organisation	City	Country	Type
Empresa Municipal de Transporte (EMT)	Valencia	Spain	Public
Bombers Consorci Valencia	Valencia	Spain	Public
Ayuntamiento de Soria (Municipal Government of Soria)	Soria	Spain	Public
Ayuntamiento de Zaragoza (Municipal Government of Zaragoza)	Zaragoza	Spain	Public
EXPOZARAGOZA 2008	Zaragoza	Spain	Private/Public
TUZSA (Urban bus operation),	Zaragoza	Spain	Public

Madrid Municipal Transport Company S.A. (EMT)	Madrid	Spain	Public
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### 3.9.1 Introduction and strategic aspects

*Empresa Municipal de Transporte de Valencia (EMT-Valencia)* is the public bus operator of metropolitan Valencia owned fully by the city government (Ayuntamiento de Valencia). EMT operates its buses all themselves and has no subcontracting or outsourcing policy. EMT operates 480 buses, out of which about 100 are operated with a 30% biodiesel/ Diesel mixture, some 70 are CNG buses and the remainder are Diesel buses. In general two types of buses are operated: 12m solo buses and 18 m articulated buses. Due to increase in passenger volume more articulated buses will be bought in the future as solo buses cannot be extended as no higher frequencies are feasible anymore. The buses are based in two bus depots. The CNG buses are in one depot with a refuelling station for overnight slow-fill of all 70 buses (refuelling time 5.5 h). In an EC DG Environment funded project EMT has tested biodiesel mixtures of 10, 30 and 100% together with the Polytechnical University of Valencia. The 30% mixture turned out to be without too severe impacts on the engine and was adopted. As biodiesel recycled used vegetable oil is used which is obtained from a biodiesel plant "BioCom" in Valencia. Very recently EMT had operated hybrid-diesel buses in the civic center but was not happy with their reliability in view of the high costs and therefore stopped the service with these units.

Of the 480 buses in average about 360 units are in operation at one time. Operating ours, depending on the lines start at 4 o'clock or 6 o'clock in the morning and extend on some lines until 3 o'clock in the morning. Consequently some vehicles are in the depot only for 3 hours. All buses, except the CNG buses, are always refuelled when returning to the bus depot in order to have them always prepared for operation. Though the average daily operating distance of the buses is about 120 km and this is also about the maximum as no peripheral lines outside metropolitan Valencia are served.

In contrary to the municipal firebrigade which serves the city of Valencia, the *Bombers Consorci Valencia* is the consortium of provincial firebrigades which serves the 10,000 km<sup>2</sup> province of Valencia (about 100 x 100 km). The vehicles are stationed in 23 firebrigade parks distributed all over the province. The consortium operates 52 heavy fire-fighting trucks, 58 all terrain vehicles (type Nissan Pathfinder and Land Rover Discovery) and 6 Vans. Usually the vehicles are replaced after 10 years. The management is centralized whereas the maintenance is decentralized in the fire parks. Only irregular service is done outside. The vehicles are refuelled at the nearest service station to the base. None of the parks has its own refuelling facility. The vehicles used by the fire watch guard and the one used by the fire park chief are operated daily. Others are not. Some are reserve and moved only here and then, but have to be maintained and kept fully operative as well for auxiliary/ back-up.

Soria is the capital of the province of Soria and with approximately 40,000 inhabitants the 2<sup>nd</sup> smallest capital city in Spain. The province of Soria counts with about 93,500 inhabitants and an area of 10,287 km<sup>2</sup>. Soria is the declared sustainable city in Spain and wants to apply for this recognition also at the United Nations. Soria, with this endeavour, will be one of the HyChain demonstration sites including the Hydrogenics mi-

crobuses, the VEM small cargo transport vehicles, the Derby scooters and the BESEL wheelchairs. The driver in Soria is the *Ayuntamiento de Soria (Municipal Government of Soria)*.

Soria operates 4 bus lines with in total 7 conventional buses. Three lines are radial and one line around the city center is circular. The entire trajectory of all four lines added up amounts only to about 10 km. Due to its size, the configurations of the bus lines and the decision by the Soria municipal government to push out conventional vehicle traffic from the city center more and more through converting it to pedestrian areas, the visibility of the clean and quiet hydrogen and fuel cell technologies will be prominent and omnipresent.

To enhance this and to improve the quality of life and also to attract the youth to stay in Soria or to return after their studies, the municipal government plans to establish an education center with help of outside universities (e.g. University of Valladolid). For the education center as well as for the HRS Soria has already made available the ground for construction free of charge.

As Soria in the past always was left aside in the various phases of industrialization in Spain, Soria tries to become more visible and leading. As Soria sees the leadership in another technological area, becoming the first city in Spain to convert completely to digital television in 2008, supporting an advanced technology for clean and sustainable mobility (being also the sustainability “capital” of Spain) like H<sub>2</sub>&FC seems only consequent to them.

*Ayuntamiento de Zaragoza (Municipal Government of Zaragoza)* and EXPO-ZARAGOZA 2008: In Zaragoza, a city of almost 700,000 inhabitants, from 14 June 2008 for 93 days the World Expo 2008 (EXPO ZARAGOZA 2008) will take place. The key theme of this world exhibit will be “water”. As already 2005 in November the European Hydrogen Energy Conference, EHEC2005, took place in Zaragoza, and as the Foundation for the Development of New Hydrogen Technologies in Aragon [Fundación para el Desarrollo de las Nuevas Tecnologías del Hidrógeno en Aragon] is located near Huesca (some 70 km from Zaragoza) and acts as a facilitator to advance hydrogen in Aragon, nothing was more convincing than also to include hydrogen and fuel cells into the World Expo concept.

Also in Zaragoza it becomes clear that without governmental support/ subsidies no hydrogen technologies will be introduced in the foreseeable near term future. All actors interviewed, the public bus operator (TUZSA – Transportes Urbanos de Zaragoza, S.A.U.), the EXPO Zaragoza 2008 operating organisation as well as the municipal government (Ayuntamiento de Zaragoza) made clear that without the governmental support through the Government of Aragon (and its Foundation as H<sub>2</sub>/FC operating agent) no activities in hydrogen and fuel cells could be realized.

Nevertheless, EXPO ZARAGOZA 2008 has built a hydrogen refuelling station (HRS) in Zaragoza-Valdespartera. The HRS allows the filling of 6 kg of hydrogen to the Hydrogenics microbuses to their 20 MPa onboard storage pressure within 6-8 minutes. The duration to fill 35 MPa storage systems with a max pressure level of 44 MPa is not yet determined, but will take somewhat longer.

The most interesting feature of this HRS is that it is committed for an 8 year operation. The operation and maintenance contracts have already been concluded for this period

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of time. Consequently it seem to be the station world-wide with the longest term assured operating perspective. The HRS station is the presently only operative station in Spain. The HRS integrator is Air Products' Spanish subsidiary Carburos Metálicos.

From the industrial point of view it is valuable to know that Zaragoza is a manufacturing location of GM/Opel with a lot of automotive suppliers in the region.

The EXPOZARAGOZA 2008 is also a political and infrastructure development event.

The total electricity consumption of EXPO2008 over its operations is produced from renewable sources (wind and PV) and also the electricity used for the electrolyser for on-site H<sub>2</sub> generation at the HRS is supplied from this contingency.

The regional government through the Foundation for the Development of New Hydrogen technologies in Aragon pursues advancement of hydrogen technologies. The activities of the government do not yet have an impact which would already filter down to the operators and allow them subsidised operation of H<sub>2</sub>/FC buses.

TUZSA as public bus operator in Zaragoza has to run its business economically. It also has to follow any political guidelines and order. If the policy mandates e.g. hydrogen buses and makes available the necessary funding, TUZSA immediately will consider the introduction of hydrogen buses.

The interview with the Madrid Municipal Transport Company S.A. (EMT) was held with the Environmental Department (Departamento de Medio Ambiente) of EMT which is a subdivision of the Sustainability Directorate (Dirección de Sostenibilidad). EMT with about 100 million km travelled and more than 200 lines in service is the largest urban surface transport company in Spain and one of the largest in Europe. A detailed description of the buses in operation can be found on the EMT website at: <http://www.emtmadrid.es/data/comun/FLOTA-2005.pdf> and the status of 2006 at: <http://www.emtmadrid.es/about/ourbus.html>.

The more detailed and up-to-date figures of the vehicle park in use communicated by EMT in the frame of the interview activity are of 31 May 2008: 787 Diesel buses (38.6%), 881 BioDiesel buses (43.2%), 351 CNG buses (17.2%), 5 BioEthanol (0.25%) and 16 Electric micro buses (0.78%). The total number of buses is around 2040. In 2007, still 814 buses were of the EURO II classification, 855 Diesel buses and 351 CNG buses of the EURO III classification and 5 buses of EURO IV classification. The average consumption of the EURO IV buses lies at 62.6 l/100 km whereas that of the EURO III buses at 55.7 l/100 km. Under Madrid driving conditions (i.e. long hot summer with air condition use) the cleaner newer Diesel buses have an in average 12.4% higher fuel consumption. The CNG buses are fuelled with fast fill equipment. The 10 Gulliver battery electric buses are operated 8 h/day (summer) and 10 h/day (winter).

→ Some regional/ local activities have significant potential for further impact on small but very visible scale (Soria) or on medium to large scale (Zaragoza, Madrid).

### 3.9.2 Perspectives and experiences with hydrogen

*EMT-Valencia* is fighting the increase of fuel costs, views hydrogen as a far distant technological solution and can imagine the use of hydrogen technology only if it is sub-

sidized and of hydrogen as fuel if it is competitive. Their users, the citizen of Valencia, in first line requires a well functioning and reliable transport system and does not care too much in which type of vehicle he/she is transported if comfort, punctuality and economic fares are ensured.

*Bombers Consorci Valencia* is always looking for reducing the operating costs. Until today they have never thought about hydrogen vehicles for their own use. Economics are overriding but Bombers is not generally objecting a potential use of such vehicles.

*Ayuntamiento de Soria* has no practical experience with hydrogen and fuel cell technologies yet but seems very motivated and wants to carry their HyChain involvement to a success. In case the trial/ demonstration period of a little more than 2 years will be successful and H<sub>2</sub>&FC technologies thereafter gradually becoming more cost effective/ competitive, Soria also intends to participate in first market applications. Soria even thinks about a FC driven boat for the river Duero or for one of their lakes (outside the HyChain project).

*Ayuntamiento Zaragoza and EXPOZARAGOZA 2008*: Besides three Hydrogenics microbuses purchased by EXPO2008 also one VanHool/UTC FC bus has been rented for the duration of the EXPOZARAGOZA which also will be refuelled at the HRS. Furthermore, 5 FC scooters built by Ajusa (with metal hydride storage system) are operated and refuelled only inside the EXPO2008 grounds.

After the 93 days of EXPO ZARAGOZA 2008, the HRS, the three Hydrogenics microbuses and the 5 Ajusa scooters will be transferred into the ownership of the municipal government of Zaragoza. As the HRS is committed for 8 years, the municipal government will have to figure out how further mobile hydrogen end-use technologies will be brought into operation in order to make optimum use of the 1.5 M€ investment into the HRS as well as of the three microbuses with also a total investment of 1.2 M€.

*TUZSA* had considered operating a H<sub>2</sub> bus during the EXPO2008 but the purchase of such a bus did not turn out feasible as one manufacturer at the end did not enter into a contract.

*EMT-Madrid* was driving 3 CUTE Citaro FC buses during 2003 and 2006 and a IVECO FCB in 2003. From this time EMT still has the hydrogen onsite generation, storage and refuelling infrastructure installed in its depot. This could be revitalised for further bus demonstration projects. Due to the lower price of ICE powertrains EMT envisages H<sub>2</sub>-ICE-Hybrids as economically more feasible than FCBs. The problem with FCBs is the life time of FC membranes and the costs of the FC system ("We want buses that can last some years at an affordable price"). EMT sees no near term market for H<sub>2</sub>/FC at the moment, except for some image projects. EMT certainly is prepared to switch to FCBs as soon as they become more affordable and longer term stable.

→ Soria and Zaragoza/Aragon have already made available first initial funding, Aragon has even developed a "Hydrogen Master Plan in Aragon" in 2008 foreseeing further extension of demonstration activities and infrastructure. EMT-Madrid as an operating company can imagine further hydrogen bus activities.

### 3.9.3 Barriers and Drivers to the future deployment of hydrogen in the fleet

#### Barriers:

For the moment, the cost, operating distance and availability of vehicles indicate to *EMT-Valencia* that this technological option is still far in the future. Therefore for time being EMT has not proactively considered hydrogen and fuel cell vehicles an alternative.

For the moment, the cost and availability of vehicles indicate to *Bombers* that this technological option is only feasible with subsidies. In case political and economic boundary conditions are favourable and a refuelling station would be available close to one fire park and thus would allow *Bombers* operation of firebrigade first responder vehicles they have not objections to operate them in one of their fire parks.

The biggest preoccupation of the *municipal government of Soria* now is that the Hy-Chain technologies to be put in operation gradually from October 2008 function well and that all safety aspects are properly covered and the technology therefore will be well accepted by the final users.

*Ayuntamiento Zaragoza and EXPOZARAGOZA 2008*: For the moment, the cost and availability of vehicles seem to be the biggest stumbling stone also for Zaragoza. Even if governments have the best will to advance hydrogen they will not be able to do this at all costs. Bus operators cannot justify purchasing hydrogen buses of at least five times the cost of conventional buses. Also governments cannot justify to subsidize many of these expensive buses at present. Social acceptance seems comparatively easy to resolve in the present case through more communication and PR.

For *TUZSA* in Zaragoza safety and perception of safety, lacking knowledge about technology and need of technical training are seen as potential barriers. In principle the environmental department of *TUZSA* is responsible but as subsidies will be needed not even the CEO can justify/ decide on H<sub>2</sub>/FC technologies due to their excessively higher price at present (bus at least five times the price of a diesel bus).

For *EMT-Madrid* as main barriers today are seen financial (investment costs) as well as technical (price/duration of FC membranes) barriers.

As an additional barrier is the high cost of the hydrogen fuel seen. Hydrogen as a fuel should be cheaper than conventional fuels and a way to facilitate this is seen through providing grants for the purchase or the manufacture of the fuel (a statement also mentioned by *EXPO Zaragoza*, who mentioned the renewable electricity feed-in law in Germany and Spain as an example to be adopted for the pricing of hydrogen fuel → see similar statement in NRW).

#### Drivers:

On the other side, the *municipal government of Zaragoza* as well as the regional government of Aragon are well aware of the difficult situation arising through the continuously rising crude oil prices and of the problems recently incurred with biofuels and their competition with other uses of biomass. The municipal government is utmost uncertain how to bridge the next years, as all presently available alternatives (hybrids,

autogas, biofuels) seem not to provide a final long term solution. This long term solution is only perceived in hydrogen.

EMT-Madrid sees opportunities for research firms to invest into more economic types of FC and membranes. EMT suggests mandatory close down of city centers for polluting vehicles thus facilitating the use of hydrogen buses/ FCBs with unlimited access in these areas. This could enhance the purchase of such vehicles.

→ Cost and availability of vehicles are seen as major obstacles, whereas even the uncertainty of potential users which way to go in the next years with regard to advanced/ cleaner propulsion technologies seems to act in favour of hydrogen, as the alternatives of the recent past are not as obvious anymore as they were.

### 3.9.4 Finance & Policy

In Spain, the Spanish government via the Hydrogen Technology Platform is actively pursuing hydrogen and fuel cells. Furthermore, IDAE (Instituto para la Diversificación y Ahorro de la Energía – Institute for the Diversification and Saving of Energy) assists in advancing energy savings and efficiency increases as well as alternative fuels.

On a national level in the *Province of Valencia*, AVEN (Agencia Valenciana de Energía) assists in advancing energy savings and efficiency increases as well as alternative fuels. As in Valencia no infrastructure hardware is available AVEN has difficulties in promoting hydrogen as a fuel. As furthermore in the Valencia region a decree or other type of legal requirement is missing which would mandate clean or zero emission vehicles or limited city access or similar incentives or requirements, it seems difficult to get a process started which would justify to go beyond the next cheapest least polluting technology. Until recently biofuels were the best bet which is now in shambles as also the EU has scrapped subsidies for first generation biofuels. For EMT-Valencia the closest 'clean' technology seems to be CNG as this is also preferentially taxed, experience exists, buses are offered at reasonable prices (55k€ more expensive than Diesel buses {220k€} seem acceptable to EMT).

It seems that as long as a top down policy approach is not in place in Spain, the Valencia region and its players cannot be convinced to become actors in hydrogen and fuel cells or only through heavy subsidies covering most if not all additional costs incurred by the new technology.

Contrary to other locations in Spain, *Soria* takes the decision first to raise the money for participating in HyChain and then gradually tries to tap national, regional, European and industrial funding opportunities in order to recuperate some of the municipal investments taken. By converting the mere city center into a pedestrian area and by allowing in the future only clean H<sub>2</sub>&FC vehicles for delivery and circulation, Soria plans to achieve two things: assisting use of the clean mobility and to provide a good example by using these technologies initially by the municipal service, police, etc. thus gradually convincing other users to enter as well.

Soria municipal government representatives clearly stated that they intend to convert Soria to a center of reference for hydrogen and fuel cell technologies in Spain. This means that Soria not only wants to demonstrate H<sub>2</sub>&FC technologies and extend their use into every day life but also to take care of educating the public and in particular ex-

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perts in the technology. Soria can imagine to convert completely to renewable energies and hydrogen in the foreseeable future. Soria is well aware of the limitations in conventional fossil fuels.

Contrary to other locations in Spain and similar to Soria, also *Zaragoza/Aragon* takes the decision first to raise the money for participating in a demonstration activity like the EXPO ZARAGOZA 2008 and then gradually tries to tap national, regional, and industrial funding opportunities in order to recuperate some of the municipal investments taken. EXPO2008 has applied for funding by autonomous regions (and IDAE) supporting funds for the HRS and the three microbuses. In this endeavour EXPO ZARAGOZA 2008 has obtained some subsidies for the HRS (40,000€ of 1.5M€) and for the microbuses ( $3 \times 42,000\text{€} = 126,000\text{€}$  of  $3 \times 400,000 = 1.2 \text{ M€}$ ).

By having committed the operation of the HRS for at least 8 years (with an option to more than double its capacity over the next years by installing a more powerful 2<sup>nd</sup> electrolyser equipment, a 2<sup>nd</sup> larger compressor unit as well as additional storage containers) it has created a stable and sustainable component facilitating more demonstration activities over the next years.

*Zaragoza*, the *Government of Aragon* and the *Foundation for the Development of new Hydrogen Technologies in Aragon* see the chance over the years to come to implement a type of hydrogen highway in Aragon. The Foundation located near Huesca is presently building wind-electrolysis capacities which over the next 2-3 years might be extended by a HRS, thus allowing local shuttle service as well as gradually allowing inter-urban circulation.

Also as similar approach like the feed-in tariff for renewable energies in Spain (adapted from Germany) is discussed by EXPO ZARAGOZA 2008 as a preferable solution to be applied to HRS dispensed fuel.

TUZSA-Zaragoza explained its perception that there is a national plan for hydrogen in preparation. Furthermore, the department of industry of the Government of Aragon (also providing the funds for the Foundation) has to become involved. Consequently there is hope that the funding situation in Spain for the support of H<sub>2</sub>/FC technologies will improve.

EMT-Madrid policy wants to support hydrogen use in transport and EMT has also financial support available. Furthermore, EMT still has the CUTE HRS available which can be revitalized and brought into new bus demonstration/ market preparation activities.

→ Although Spain has no large governmental H<sub>2</sub>&FC funding scheme, local bodies (Foundation in Aragon) or municipalities (Soria, Zaragoza) take the lead within their capabilities to advance the technology and concept.

### 3.10 Rhône-Alpes

Organisation	City	Country	Type
Région Rhône-Alpes (RRA),	Charbonnières-les-Bains Cédex	France	Public
Rhônealpennergie-Environnement (RAEE)	Lyon	France	Public
Mayor of Saint Egrève	Saint Egrève	France	Public
Mayor of Sassenage	Sassenage	France	Public

#### 3.10.1 Introduction and strategic aspects

The *Rhône-Alpes Region (Region Rhône-Alpes - RRA)* is founding member of Hy-RaMP as it thinks that France has to create better awareness for its needs on the European level. In France the representation of hydrogen on the national or agency level is very poorly. Only 1.5 persons at ADEME (Agence de l'environnement et de la maîtrise de l'énergie, Agency for environment and energy management) work full time on hydrogen. Of the regional agencies the only agency in France paying ½ a person for H<sub>2</sub>&FC is the Region Rhône-Alpes.

Demonstrators are very important in order to bring the technology to the awareness of the public. Exchange of knowledge is utmost important in particular in the RCS field where RRA thinks that France is significantly lagging behind which sooner or later will result in an economic and employment disadvantage in the European context. In the opinion of RRA, France needs European assistance in progressing in RCS matters and avoid the above mentioned disadvantage/ set back.

The RRA is working on a strategic orientation of H<sub>2</sub>&FC matters in the regions by trying to align the different interests and stakeholders: Energy policy, Economic development and risk management, Environmental management policy, Transport policy and Agricultural policy including forest biomass utilization for gasification projects. This initiative is taken in order to ensure coherence between the decisions taken on different levels and in different areas of responsibility and in different regions in France. Also the interest of research and industry should be taken into account avoiding a "CEA or Air Liquide" only strategy orientation.

As results are expected: project oriented actors, creation of new employments, technology transfer and demonstrations proving the feasibility of the entire hydrogen production, supply and end-use chain in the context of the Rhône-Alpes requirements.

As an energy agency, the focus of *Rhônealpennergie-Environnement (RAEE)* is typically more on stationary applications. Furthermore, goal of RAEE is to provide a benefit to

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local authorities and users in the near term (0-5 years) and not 5 or 10 years from now. Therefore hydrogen is not in the immediate focus of RAEE.

A primary criteria for evaluation of energy solutions is LCA (life cycle assessment and thus the overall energy and emission balance). Energy efficiency has to be guaranteed and feasibility and maturity of the technology are a precondition for RAEE. All energy projects have to be linked to the local/ regional context and stakeholder involvement on regional or local level is a challenge with regard to all new energy technologies.

With regard to vehicles, RAEE pursues support with the following priority: efficient conventional cars, hybrid cars, E85 cars, locally produced plant oil driven cars. FCVs might be an interesting solution but RAEE has not thought about it and not defined a position yet.

The *municipality of Saint-Egrève* is part of Metro Grenoble, the Grenoble Metropolitan area. Saint-Egrève has its own Agenda 21 and all actions decided have to be organised according to the principles of sustainable development. The gradual substitution of imported energy used in the transportation sector, both in public or in private use, besides the reduction of CO<sub>2</sub> emissions is an important political goal.

Hydrogen technology and hydrogen as a fuel is seen as a starting point for other energy source developers to find new options with which to compete in the energy sector through hydrogen as an energy vector.

The mayor of the *municipality of Sassenage* is very well aware of hydrogen as France's largest hydrogen technology company, Air Liquide, has its research and technology department in Sassenage. Therefore, the municipality of Sassenage is prepared to participate in new hydrogen technology projects like e.g. HyChain. Hydrogen is seen as the most competitive fuel in the long run as it can substitute practically all fossil fuels and can be produced from any energy source.

The mayor, Mr. Coigne, advocates an urban vehicle fleet policy e.g. for captive fleets aiming at 10% of these fleets to be converted to hydrogen. For his municipality he can imagine a replacement of a part of his fleet (presently consisting of 4 mini buses and 52 cars) by hydrogen vehicles as soon as purchase prices go down. According to Mr. Coigne's experience it is more a question of awareness and consciousness which decides about if a technology will come – a value added has to be proven ("valorization").

→ The Rhône-Alpes region is very conscious of environmental and climate change issues. Furthermore the regions seems actively supporting renewable energies and energy conservation. Preparedness to participate in first hydrogen vehicle demos is widely present, some communities are already HyChain project partners.

### 3.10.2 Perspectives and experiences with hydrogen

Public transport buses by *RRA* are seen as one of the early demonstration and market opportunities. Also centrally hosted fleets of bicycle-type small vehicles for 1-2 persons are envisaged, which will be kept at assigned location like the *velos* (bicycles) in Lyon today and will supplement conventional public transport at low demand locations. These captive fleet small vehicles and buses are seen as the first and easier feasible concept for realisation in France.

The primary interest of the RRA is stationary residential applications. All new apartment building planned and built in the region will be energy plus building (producing more energy than they consume). Thus H<sub>2</sub>&FC are seen as an important component of this approach.

H<sub>2</sub>&FC in transport is 2<sup>nd</sup> priority on the agenda and HyChain is a first start on low scale. Besides HyChain, RRA also invests in a local project called HyBird producing a PV/FC aircraft (by local company Lisa Airplane).

RAEE has been involved in trying to implement a PAFC ONSI CHP plant in the outskirts of Lyon several years ago which finally failed due to the private partner losing interest. RAEE in general is more interested in stationary applications as the mandate of Mr. Six is cogeneration. In this context he was waiting for years that the Sulzer Hexis SOFC would become available – which also did not materialize. Due to these experiences with fuel cells the energy agency is now more cautious with hydrogen and fuel cells as fuel mix in transport sector has to be changed and the clients of the energy agency need solutions in the near term horizon.

Hydrogen is seen as very positive in the overall energy efficiency balance (LCA)/ the input energy is important with regard to its environmental benignness/ its advantage is the highly efficient end use/ biofuels have shown a doubtful outcome in many cases, only leaving pure plant oil as a locally feasible solution.

The *mayor of Saint-Egrève* was interested in the HyChain project from the very beginning and wanted to test the usefulness of hydrogen vehicles in municipal use. Saint-Egrève wants to give an example and if successful enter into a new phase also including cars and vans.

Outside of *Sassenage* is a regional park in the mountains which offers a good application field for zero emission and quiet vehicles. Water protection was one main goal of the past and persists to be, air quality protection will be the next goal.

→ In particular the communities in the Grenoble/ *Sassenage* area are supportive of hydrogen vehicle applications. The agencies are either actively analysing the opportunities (RRA) or hesitant (RAEE).

### 3.10.3 Barriers and Drivers to the future deployment of hydrogen in the fleet

Barriers:

RRA is of the opinion that the operating range of hydrogen vehicles has to improve respectively be acceptable. Cost of refuelling/ H<sub>2</sub> fuel has to drop. Refuelling stations need to be installed and HRS-specific RCS problems be solved soon.

The lack of harmonised standards and regulations for the approval of hydrogen and fuel cell technologies in France are seen as a major obstacle for the progress of H<sub>2</sub>&FC technologies and as a possible reason why France may fall back in the international arena in these technologies and thus loose economic opportunities. RRA sees the need that Europe helps France in leaving this deadlock situation.

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Total + Air Liquide + PSA could form a strong alliance in H<sub>2</sub>&FC for vehicle applications and exercise pressure on the government and authorities to take this area more seriously.

*RAEE, St. Egrève and Sassenage* are of the opinion that the cost of hydrogen technology are still too high, full maturity is not yet seen, infrastructure is not yet set up, acceptability may lack (fear factor – many do not know about hydrogen, the perception is probably wrong and based on a lack of information) and competing technologies (e.g. electric drives) are less expensive than hydrogen technologies (“we always have ways to pollute less by using other technologies than hydrogen”).

Drivers:

*RRA* sees opportunities for hydrogen and fuel cells derived by the Kyoto Protocol obligations as well as by the national agreement “Grenelle de l’environnement”. Particulate matter concentrations in Lyon and Grenoble will be of growing concern and reach unacceptable levels in the next years, for which hydrogen is seen as a solution. In particular municipal vehicles will become cleaner and quieter. The technology can and needs to be adapted to small vehicles, scooters and bikes.

*RAEE* suggests to considered market segmentation in the transport sector - captive fleets might be the first way to go.

*St. Egrève* sees rising cost of petrol forming a new consciousness of public and political decision makers. This supported by the conviction that GHG emissions have to be reduced. Both facilitated by phasing in of sustainable new energy sources. Participation of municipalities and citizens should be enabled by setting up programs to help reduce costs for municipal and also private users.

*Sassenage* firmly believes in hydrogen as the future energy. Therefore a participation in demonstration projects is clearly intended. There exists a policy to make everybody sensitive, including the entire city council. This is more an attitude derived from awareness than a policy imposed top down. Increased consciousness will lead to understand added values (in French: valorization).

→ Lack of harmonised RCS, and absent key players in the automotive / fuel sector are seen as an obstacle, besides the high cost level. The growing consciousness on environmental issues and energy/ fuel cost respectively availability issues seem to be supportive for the consideration of hydrogen and fuel cells.

### 3.10.4 Finance & Policy

In the *Region Rhône-Alpes* some 300 researchers work on H<sub>2</sub>&FC and some 100 SMEs produce or use H<sub>2</sub>&FC-related components. Renewable energy clusters do exist as well as technology and research clusters. As hydrogen is seen as a very important energy vector for the storage and distribution of renewable energies and only H<sub>2</sub> being in the position to provide an added value (French: “valorization”) to the renewable energy investments already taken it is top priority in the agenda. The Rhône-Alpes region is the region with the highest per capita installation of PV in France.

In order to achieve a better coherence and alignment with policy goals, RRA has tendered a strategic study and called 40 organisations to participate with a submission deadline of 18 August and the candidate to perform the study to be selected beginning of September 2008. The study shall start on 13 October 2008 and deliver results by 1<sup>st</sup> February 2009. Before the regional elections in 2010, a regional decision on how to proceed with H<sub>2</sub>&FC in the regions shall be taken.

The main objectives of this 60 k€ study are: to improve the knowledge in the regional sector, to define an ambitious demonstration unit development program (in cooperation with other European regions), to identify relevant actions in the frame of regional policies in order to encourage the emergence of new regional players and to promote hydrogen as energy carrier at the user level and to gain social acceptance.

The total budget for renewable energies and H<sub>2</sub>&FC in the RRA is 1 million € annually and will grow over the years to come. In the region HyChain is being supported, also financially.

RAEE is convinced that on a case by case decision in the region council projects (also H<sub>2</sub>&FC) can receive funding, depending on the quality of the project proposal.

National government only supports research and not demonstration.

Large national research organisations according to RAEE seem always want to reinvent everything anew and thus not necessarily are helpful in advancing H<sub>2</sub>&FC.

Government should allocate by far more financial resources. Furthermore, the availability of appropriate research partners are a problem with regard to the usefulness of their results.

*St. Egrève* provided the information that Metro Grenoble (metropolitan agglomeration) is deciding on specific help for hydrogen vehicles comparable to the one already existing for electric vehicles/ regional level funding is available/ national funding goes only in research and not into demonstration or market preparation.

For *Sassenage*, like for many others, the participation in hydrogen vehicle application depends on the vehicle price, the fuel price and the available support (maintenance and funding). Which price is acceptable in comparison to other competing solutions? Subsidizing cannot be carried in the future forever!

National funding for demonstration activities practically does not exist. Therefore only regionally organised projects might be able to tap regional funding.

Remark: In the frame of talks with Air Liquide and the mayor of Sassenage it seemed that also Air Liquide might be prepared to play a more impacting role close to its company seat in Sassenage, e.g. via providing refuelling infrastructure in the Grenoble metropolitan area. This is not a commitment but obviously a possible concept idea under consideration.

→ Any attempt to fund H<sub>2</sub>&FC in the Rhône-Alpes region comes from municipalities or from the regional council. Frequently criticism was heard that French national programs only support fundamental research and there mainly large research centers and have no funds at all for demonstration or market preparation.

## 4 Fleet vehicle performance requirements

This chapter describes the aggregated technical performance data of the most popular fleet vehicle within an operator's fleet. It is purpose of this study to find out the actual technical requirements that operators demand from their fleet vehicles and how they can be related to the performance level that is commonly used in the respective vehicle class by today. A range of 20 indicators concerning the vehicle performance was included in the questionnaire that can be found in the Annex B.

Even though most of the interviewees did provide the data requested in the questionnaire, some respondents could not give an indication for either technical or other reasons. For e.g. if the companies fleet vehicles vary a lot it was not possible to define the most used vehicle class. In other cases the data were not made available due to proprietary reasons.

Moreover, even the interviewees that were willing to provide data could not always provide all data that was asked for. Therefore it is not possible to compare all 20 indicators. Another impact that limits the data evaluation is the response rate per vehicle segment. Some vehicle categories are not used in sufficient quantities that allow an objective comparison, so the focus further on the most popular vehicle segments. These are the Passenger Cars B and C, as well as Vans and Buses. In those segments several indicators can be compared with the reference data. Also, data can be analysed on the driving and refuelling patterns across different categories. For a full overview of the collected data see Table 4-1.

Vehicle segments		Responses
Passenger Cars	Segment A	1
	Segment B	9
	Segment C	15
	Segment D	0
	Segment E	0
	Segment SUV	2
	Segment MPV	2
	Vans	13
	Buses	10
		52 TOTAL

Table 4-1: Collected data according to vehicle segments

## 4.1 Comparison of selected indicators

In the following, those performance indicators that achieved sufficient responses will be summarized to provide an impression on what is typically required by the operators in the respective vehicle class. This feedback from real-life deployment is considered as valuable input for the automotive industry to evaluate the future performance level that needs to be achieved by hydrogen vehicles. The technical data for the reference vehicles can be found in Annex D.

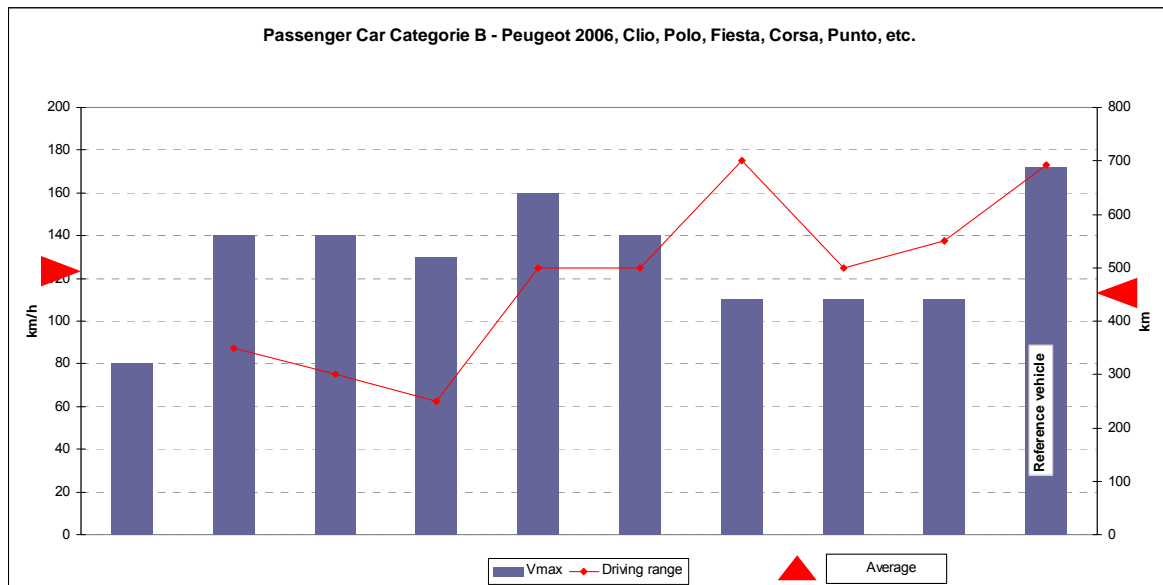
### 4.1.1 Passenger Car B

The small passenger car (Segment B) has received 9 nominations as main fleet vehicle. Fleet operators in the study who utilize a car from this segment range from municipalities and car sharing to commercial companies in the telecom and electricity sector.

The key performance indicators are as follows:

Maximum speed:	Typically between 110 and 150 km/h
Driving range:	Typically between 350 and 550 km
Average daily driving range:	Typically between 50 and 100 km/day
Maximum daily driving range:	Typically between 250 and 500 km/day
Average Driving distance to office:	Varying between 30-50 km/ office and 120-240 km/office
Refuelling frequency:	Typically between once and twice per week
Refuelling locations:	Typically between 5 and 10

In Figure 7, the indicators maximum speed and driving range are compared against the reference vehicle for this class (VW Polo 1.4). Clearly, the requested performance is well below those of the reference vehicle. On average a maximum speed of 130 km/h and a driving range of about 450 km are required.



**Figure 7: Performance indicators Passenger Cars B**

#### 4.1.2 Passenger Car C

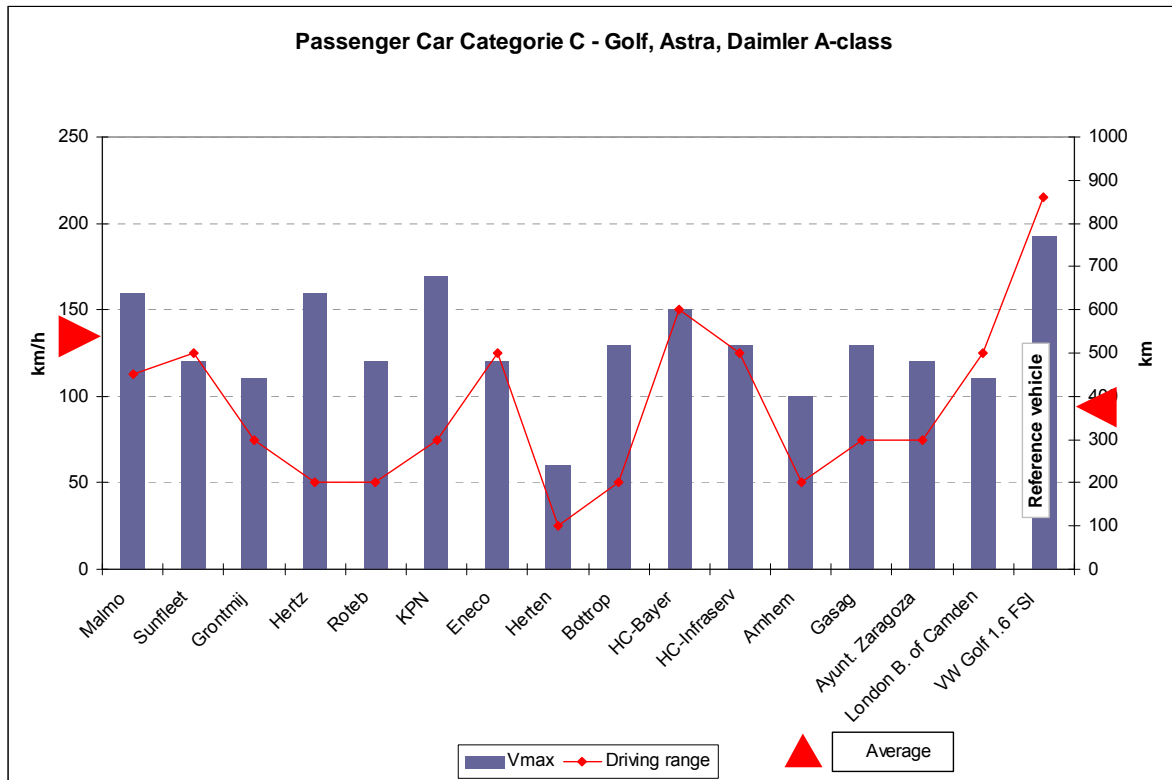
The segment of compact cars (Segment C) such as the VW Golf and Opel Astra received the highest number of nominations (15) as fleet vehicle from all categories. The key performance indicators are as follows:

Maximum speed:	Typically between 100 and 160 km/h
Driving range:	Typically between 300 and 450 km
Average daily driving range:	Typically between 60 and 100 km/day
Maximum daily driving range:	Typically between 250 and 500 km/day
Average driving distance to office:	Varying between 50 km/ office and 200 km/office
Refuelling frequency:	Varying between once and twice per week and twice per month:
Refuelling locations:	Typically between 5 and 10

The indicators maximum speed and driving range are compared to the reference vehicle in

Figure 8. The respondents indicated that also in this vehicle segment, significantly lower performance than the conventional car are demanded. The comparison shows

that the average of both indicators is well below from the possible maximum of the reference. A top speed of 125 km/h and a driving range of slightly above 350 km are considered to be sufficient to fulfil the duties of fleet operators.



**Figure 8: Performance Indicators Passenger Cars C**

### 4.1.3 Vans

Vans are mainly utilized for delivery and maintenance purposes by a wide range of fleet operators, but mainly from mail delivery, energy companies, municipalities, hospitals and food retailers. The key performance indicators are as follows:

Maximum speed:	Typically between 80 and 110 km/h
Driving range:	Typically between 250 and 550 km
Average daily driving range:	Typically between 60 and 200 km/day
Maximum daily driving range:	Typically between 200 and 500 km/day
Average driving distance to office:	Varying between 70 km/ office and 250 km/office
Refuelling frequency:	Varying between once per day and once per week
Refuelling locations:	Typically between 1-4 and 20-30

Similar to the previous comparisons, maximum speed and driving range are juxtaposed to the reference vehicle. Performance level of the reference are higher than the requirements. On average, maximum speed for a delivery van is sufficient at 90km/h with a driving range of 350 km.

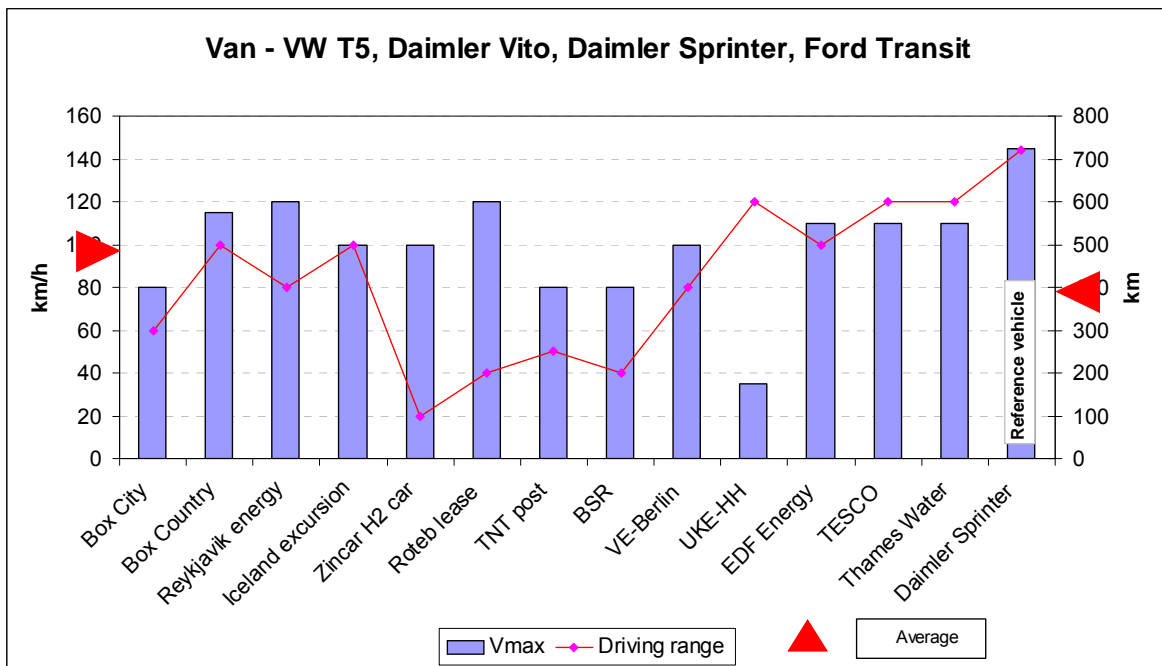


Figure 9: Performance Indicators Van

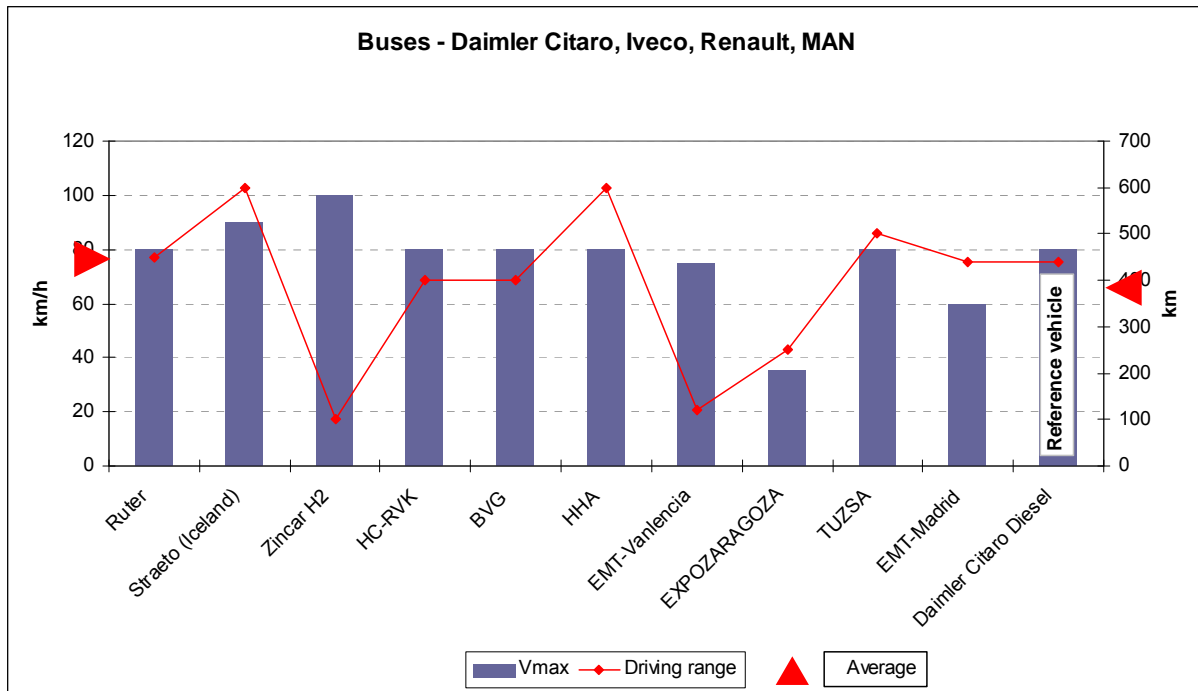
#### 4.1.4 Buses

City buses are generally operated under public authority and with public subsidies, but a trend exists to privatize the bus operations. Some operators own the buses or some operating companies are owned by the public body responsible for the public transport services. The operations are tendered out to a commercially operating company which drives under the public authority requirements/ frame.

The key performance indicators for buses are as follows:

- Maximum speed: Typically between 80 km/h
- Driving range: Typically between 400 and 500 km
- Average daily driving range: Typically between 200 and 300 km/day
- Maximum daily driving range: Typically between 300 and 400 km/day

Average Driving distance to office: Varying between 20-50 km/ office  
 Refuelling frequency: Typically once per day  
 Refuelling locations: Typically at the station of the bus depot



**Figure 10: Performance Indicators Buses**

#### 4.1.5 Comparison of indicators across vehicle categories

In the following, the results for the different vehicle classes presented in subchapters 3.2.1 through 3.1.4 are compared within the indicators *Driving range*, *Average daily driving range*, *Maximum daily driving range* and *Refuelling frequency and location*.

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**Table 4-2: Comparison of Vehicle Indicators across Categories**

Vehicle Indicator	Unit	Passenger Car B	Passenger Car C	Van	Bus
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[all indicator values shown are  
'typical' ones]

Maximum Speed	km/h	110-150	100-160	80-110	80
Driving range	km/h	350-550	300-450	250-550	400-500
Average daily driving range	km/day	50-100	60-100	60-200	200-300
Maximum daily driving range	km/day	250-500	250-500	200-500	300-400
Average driving distance to office	km/office	30-50 resp. 120-240	50-200	70-250	20-50
Refuelling frequency	per day	/	/	1	1
	per week	1-2	1-2	1	/
	per month	/	2	/	/
Refuelling locations	-	5-10	5-10	1-4 resp. 20-30	1 (at depot)

**Driving range:**

Possible driving ranges for the vehicle classes *Passenger Car B*, *Passenger Car C* and *Van* typically lie between 300 and 500 km. *Buses* range a little higher but still quite comparable at between 400 and 500 km.

**Average daily driving range:**

Average daily driving ranges for *Passenger Car B* and *Passenger Car C* are between 50 and 100 km whereas *Vans* extend to up to 200 km. *Buses* lie typically between 200 and 300 km.

**Maximum daily driving range:**

Maximum daily driving distance, not used every day, come very close to the possible driving range determined by the fuel tank volume and range between 200 and 500 km for *Passenger Car B*, *Passenger Car C* and *Van*. The maximum daily driving ranges for *Buses* with 300-400 km lie in between those for *Cars* and *Vans*.

**Refuelling frequency and location:**

The majority of the users in the vehicle classes *Passenger Car B*, *Passenger Car C* and *Van* seem to use their vehicles under the "average daily driving range" pattern as they refuel once to twice per week. Only some *Van* users have to refuel daily as they seem to use their maximum daily driving range frequently. *Cars* and *Vans* typically are refuelled at between some 5 and 10 refuelling stations with exceptions that require fully operational infrastructure across the country. Virtually none of the operators possesses refuelling infrastructure. Mostly for cost reasons, the majority of operators has switched to use public refuelling stations.

*Buses* in general are refuelled once per day (even if not used all day long) and always at the station in the bus depot.



## 5 Analysis

Based on the data presented in the previous chapters it is now possible to draw some conclusions about possible future user groups of hydrogen vehicles. A variety of factors needs to be taken into account. One of the first ones extracted from the interview reports is the existence of drivers for the switch from conventional technologies to hydrogen. If internal drivers are virtually absent, what needs to be undertaken to raise interest? Linking together user groups and vehicle categories will bring up patterns of preferred vehicle choices. Another factor are operational characteristics such as refuelling frequency and locations. In the early stages of hydrogen infrastructure build-up it is advantageous if fleet operators utilize a smaller number of refuelling locations or those that are located in a certain area. Further information are provided through an overview of expected upcoming refuelling stations and available funding schemes in different countries that can help to overcome the initial high cost of hydrogen vehicles.

### 5.1 What are possible future customer groups and why?

Fleet operators have very different motivations for using hydrogen but even more so, for not using it. Also, at this stage it is unsurprisingly very difficult for practitioners to make forecasts about the possible adoption of an upcoming technology that is not yet available at the market and price indications remain virtually absent. In the perception of the operators hydrogen vehicles will come at higher cost than conventional vehicles. Nevertheless, a number of organisations have concretised plans for lowering fleet emissions and also the introduction of zero-emission vehicles due to various motivations. While this does not necessarily imply a shift to hydrogen vehicles, it shows that strong motivations exist in case the technology will enter the market. Those motivations and the organizations are summarized in the table 5-1. Even more so, most operators link the utilization of hydrogen to the fulfilment of conditions that are summarized under four main headings explained later on in this paragraph.

**Table 5-1: Motivation for consideration of hydrogen use**

Motivation	Company	User group
Low emission vehicle company programs	Gatubolaget, Göteborg, Sweden: $\leq 120$ gCO <sub>2</sub> /km by end of 2008	Municipality
	Telenor, Oslo, Norway: $\leq 160$ gCO <sub>2</sub> /km and $\leq 120$ gCO <sub>2</sub> /km	Telecom Company
	TDC, Copenhagen, Denmark: purchases only cars with energy efficiency labels A-C	Telecom Company
Fossil free energy plan	Ruter, Oslo, public transport operator – goal: 2020	Public Transport
	Landsvirkjun, Iceland – by 2020	Energy Company

Motivation	Company	User group
	Vattenfall Europe (Berlin, Hamburg), Sees paradigm change in the energy/ fuel system ahead/ active in hydrogen since 20 years !	Energy Company
Technological leader	<p>BVG Berlin, gradual conversion of bus fleet to hydrogen (instead of intermediate steps like CNG) – foreseen interconnection of Berlin hydrogen vehicle trials with Hamburg through a highway HRS to be installed about half way between both metropolitan regions [All buses hydrogen as soon as possible (15 buses in operation - cost competitive within medium term)]</p> <p>HHA Hamburg, gradual conversion of public bus fleet to hydrogen (instead of intermediate steps like CNG) supported by a city state strategy to implement hydrogen and fuel cell technologies on a wider scale [All buses hydrogen as soon as possible (7 FC buses in operation – Hamburg has a regional network of several H<sub>2</sub> minded players since years and growing – regional support)]</p> <p>Ruter, Oslo, start of hydrogen bus fleet implementation by 2009</p> <p>RET, Rotterdam, Start switch to H<sub>2</sub> buses by 2015 (perform demo trials from 2008?) [most companies in the Rotterdam area have some funding available for activities]</p> <p>NRW:  RVK, Cologne, Interested in near-term purchase of 10-15 H<sub>2</sub> buses (latest by 2010 as replacement of conventional old buses)  Vestische Straßenbahn, Herten, Interested in near-term purchase of 10-15 H<sub>2</sub> buses</p>	<p>Public Transport</p> <p>Public Transport</p> <p>Public Transport</p> <p>Public Transport</p> <p>Public Transport</p>

Motivation	Company	User group
	TOTAL, Berlin, H <sub>2</sub> seen as medium term business/ pretends to take pioneering role in developing H <sub>2</sub> market	Energy Company
	Soria Municipality, Spain, Gradually demonstrate and introduce small H <sub>2</sub> vehicles and buses / gradually closing down city center, accessible only for H <sub>2</sub> vehicles	Municipality
	Zaragoza Municipality, Spain, HRS committed for 8 years up to 2016	Municipality

However, for most of the respondents the adoption of hydrogen vehicles is still depended on the fulfilment of a number of conditions. In case those requirements are to be met no reasons are foreseen why hydrogen should not become their preferred choice of transport.

Requirements for future adoption of hydrogen by customer groups:

### 1. Technical (maturity, life time, availability of infrastructure)

- a city bus operator (EMT-Madrid) mentioned that there is a need for improving the lifetime of PEMFC membranes/ stacks in order to meet the requirements of bus operators
- several respondents outlined that they consider the use of hydrogen vehicles to become part of their future vehicle park only if the technology is series manufactured and mature providing comparable technical availability figures as today's technologies (the closer a potential operator is with its decision to go for hydrogen, the more this requirement applies, as e.g. for HHA, BVG and RVK)
- for rental car companies the maturity of the technology is of utmost importance (e.g. Hertz Iceland which used a Quantum retrofitted Prius H<sub>2</sub>-ICE hybrid and encountered certainly difficulties and was quite unhappy with the performance)

### 2. Conditions for an operation (commercial operation or enhanced demo in LHPs)

- higher funding for bus service when better/ cleaner technology is to be tendered out
- chemical by-product hydrogen regarded as facilitator (Gatubolaget, HyCologne, ..)
- for some public operators only the introduction of a larger number of vehicles makes economical sense
- high fossil energy prices are seen as a driver towards hydrogen (Iceland, NRW, ..)

- availability of refuelling station infrastructure is an important facilitator or even a prerequisite (mentioned by all respondents)
- availability of cost competitive hydrogen fuel is another important facilitator (early adopters/ users are not prepared to pay a significantly higher invest cost for the new technology and for the new fuel – hydrogen)
- public subsidies and political commitment during the transition phase towards a commercial market are required (therefore funding programmes like NIP in Germany and JTI for Europe are welcomed)
- trained personnel is regarded an essential ingredient
- harmonised, clear and reliable excise tax structure needed
- requirements for sustainable vehicle procurement can be very helpful
- availability of harmonised regulations for the approval of hydrogen specific technology is a prerequisite (not yet given for all countries, e.g. missing for France and Italy)
- restricted city access only for zero emission vehicles can be a powerful driver for fuel cell vehicle applications

### **3. Corporate policies driven (leasing, rental, car sharing)**

- some operators are bound to certain leasing companies and depend on their vehicle mix offered/ on the other side several of them have clean, energy efficient or carbon reduced vehicle procurement strategies/ if they want to rent/lease cleaner more expensive vehicles/ buses they have to pay higher fees (these consideration e.g. are applicable for 5 out of 11 Scandinavian respondents)
- internal resistance in companies/ organisations, low or zero-emission vehicles did not yet receive enough attention within the decision level of some organizations

### **4. Availability and accessibility of vehicles**

- practically all respondents mentioned the missing availability (not offered in sufficient numbers) and accessibility (not offered here, or not offered at acceptable prices) of hydrogen vehicles

## **5.2 Which vehicle categories and how many?**

The by far two largest customer groups identified in the HyLights interview activities are *Municipal Services* and *Public Bus Operators*. In the municipal services group some 15 operators mainly using vans and cars are comprised and in the public bus operator group some 13 bus operators are included. All other groups consist of 6 or less users (6: utilities services, 4: Car sharing/ rental operators, captive fleets; 3: telecom; 2: delivery services, mail collection/delivery services, fleet vehicle managers; 1: hospital operators, airport operators and vehicle leasing).

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Municipal Services	Public Bus Operator
City of Oslo (N)	City of Malmö (S)
City of Malmö (S)	Ruter (N)
BSR (D)	BVG (D)
DCMR (NL)	HHA (D)
Herten (D)	RET (NL)
Bottrop (D)	RVK (D)
Arnhem (NL)	EMT-Valencia (E)
Zincar (I)	EMT-Madrid (E)
Bombers-Valencia_(E)	TUZSA_(E)
Soria_(E)	EXPOZARAGOZA_(E)
St.Egrève (F)	Strateo (IS)
Sassenage (F)	Zincar (I)
Gasag (D)	Movia (DK)
Gatubolaget (S)	
London Borough of Camden (GB)	
Vans Cars	Buses

15	13	Number of interviewees
1	2	Ranking

Delivery Services	Telecom Services	Mail Collection/Delivery	Car Sharing/Rental Cars	Fleet Vehicle Managers	Utility Services	Hospital Operator	Private Captive Fleets	Airport Operator	Vehicle Leasing
Box (Scandinavia) Tesco (GB)	TDC (DK) Telenor (N) KPN (NL)	Posten (N) TNT (NL)	Sunfleet (S) Milano Car Sharing (I) Car City Club (I) Hertz (IS)	Port of Rotterdam (NL) BT (GB)	VE (D) ENECO (NL) Reykjavik En. (IS) Thames Water (GB) E.ON (GB) EDF Energy (GB)	UKE (D)	Rabobank (NL) Bayer (D) Infraserv (D) Icel. Excursion (IS)	HH Airport (D)	Rotelease (NL)
Vans	Cars	Vans	Cars	Cars	Vans Cars	Vans	Vans Cars		Vans Cars

2	3	2	4	2	6	1	4	1	1	Number of interviewees
6	5	6	4	6	3	7	4	7	7	Ranking

Table 5-2: Vehicle classes vs. user groups

### 5.3 Driving/refuelling patterns (differences between user groups)

In the early stages of hydrogen vehicle deployment the infrastructure will not be comparable to the conventional fuel infrastructure of today. In the beginning, it is planned to build a number of hydrogen stations around the major cities and major highways (Hy-Ways Roadmap, 2008). In order to find out which are potential first customers also their refuelling patterns need to be taken into account. If the vehicles of a organisation are always refuelled at the same station (can be also located at the headquarter of the organisation) the limitations of an early hydrogen infrastructure are certainly better manageable for those organisations because a shift to another nearby station that offers hydrogen supply or even the build-up of a dedicated station seems feasible. If the vehicles do not follow a certain schedule and different fuelling stations are used from day to day or several refuellings take place during the day and over a larger geographical area it conflicts with the available early refuelling structure. This also means that for certain user groups large fleet deployment of hydrogen goes along only with the extension of a hydrogen refilling network. In Figure 11 fleet operators are placed within a graph with the parameters refuelling frequency and number of distance refuelling locations (more than 5km from the base).

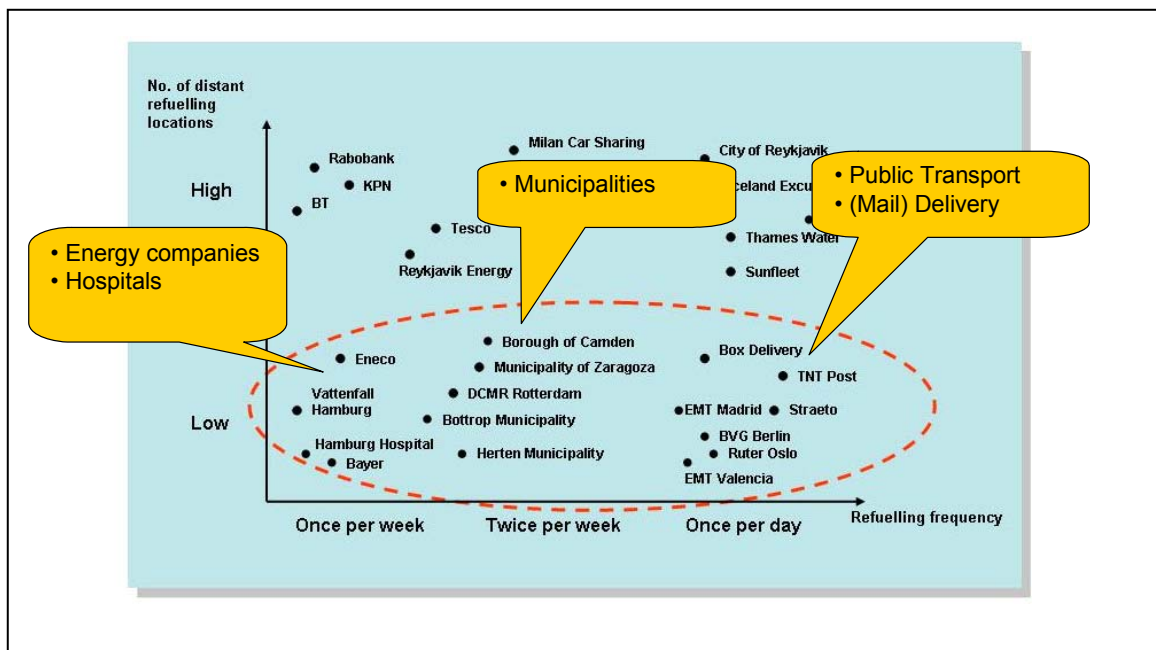


Figure 11: Refuelling locations vs. Refuelling frequency

Three groups of operators with low infrastructure needs are recognizable. The group of public transport operators normally refill their vehicles every day. The same holds for the (mail) delivery services. Not every day, but about twice per week refuelled are the vehicles of municipalities including cleaning services. The least amount of refuellings is done by operators that drive only small distances or have little transportation needs. Among this group are hospital, energy companies and a captive fleet from industry. A

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similar study applying a higher sample number could provide much more detailed results per region.

**Table 5-3: Hydrogen Refuelling Stations in Europe through 2010**

<b>Hydrogen Refuelling Stations</b>	
<i>HRS operative</i>	<i>Opening Year</i>
Berlin (BVG, Total, Spandau) (D)	2006
Berlin (ARAL/BP) (D)	2004-2008
Hamburg (CUTE station, VE, HHA) (D)	2003
Frankfurt-Hoechst (Zero Regio/ AGIP) (D)	2006
Malmö (S)	2003
Milano (Biccoca) (I)	2005
Collesalvetti (I)	2006
Mantova (I)	2007
Reykjavik (Shell, INE)	2003
Ringkøbing (DK)	2008
Grenland (N)	2007
Stavanger (N)	2006
Soria (E)	Late 2008
Zaragoza (E)	2008
<i>HRS soon available</i>	<i>Opening Target Year</i>
Oslo (N)	2009
Drammen (N)	2009
Bottrop (D)	2009
Göteborg (S)	2009
Herning, Aarhus, Copenhagen (DK)	2009
Berlin (Shell) (D)	2009 or 2010
Hürth (HyCologne) (D)	2009 or 2010

<b>Hydrogen Refuelling Stations</b>	
<i>HRS operative</i>	<i>Opening Year</i>
Arnhem (NL)	2009 or 2010
Herten (D)	2009 or 2010

## 5.4 Clear company strategies towards H2&FC

**Table 5-4: Availability of government funding in European countries a/o regions**

<b>Government funding available</b>	
<i>YES</i>	<i>NO</i>
Iceland – Smart H2 (only for infrastructure)	Sweden and Finland
City of Hamburg	Iceland – no funding for vehicles
North-Rhine Westphalia (Energy Agency NRW)	France – no funding for demo, deployment or market preparation (only basic research)
Germany – NIP	
Piemonte Region/ Municipality of Milano	
Aragon Region	
Rhône-Alpes Region	
Spain (only very limited funds)	
Norway (under preparation)	
Denmark (co-funding of vehicles and infrastructure and sales and luxury tax exemption for privately used H2 vehicles through 2025)	

## 5.5 Implementation of vehicles into fleets

Previously, various beneficial and disadvantageous factors for using hydrogen in fleet vehicles at different operator groups and locations have been presented. Each of the

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factors has an influence on the fleet operators and their ability to be among the first adopters of hydrogen vehicles, either in demonstration projects or early series deployment. This however does not yet provide a very clear picture and thus needs to be put into perspective.

In order to make more distinguished statements concerning those operators in Europe that are more or less suitable (based on the collected data) all previously presented factors have to be taken into account. Operators or operator groups which unify more than one factor are more likely to be among the first adopters.

The strategic orientation of some fleet operators is supportive for hydrogen (all others would need policy support to become 'motivated'), however overall targets such as lowering emissions could still be achieved by other technologies. In practice, this could lead to the purchase of the next best clean proven alternative technology/fuel instead of hydrogen. In particular public transport bus operators see hydrogen and fuel cells as the final solution (and would prefer to avoid intermediate technology steps if possible).

In general, large commercial operators tend to be hesitant towards hydrogen, partly caused by the need for very high reliability of the vehicle in the business process. Another reason is often their dependence to leasing companies and the respective vehicle portfolio. Some small and innovative operators such as the public transport in Soria (Spain) and RVK and the Vestische Strassenbahn in NRW (Germany) have signalled high interest on purchasing hydrogen vehicles. Without significant 'external' policy pressure (for e.g. on purchase obligations or negative incentives on conventional vehicles) it is not expected that the majority of commercial fleet operators will become early market adopters of hydrogen.

The by far two largest customer groups identified in the HyLights interview activities are *Municipal Services* and *Public Bus Operators*. In the municipal services group some 13 operators mainly using vans and cars are comprised and in the public bus operator group some 12 bus operators are included. All other groups consist of 4 or less users. The results are biased in a way that more commercial operators declined enquiries to take part in the research and are hence less represented.

Research into the driving pattern and refuelling behaviour found out that only certain fleet vehicles return every day back to their home base or use only a small amount of refuelling stations in the vicinity. It needs to be distinguished between company cars, vehicles for sales personnel and maintenance vehicles. In particular commercial operators maintain increasingly 'dynamic' fleets that do not return every day to their home base. E.g. maintenance vehicles in the telecom and energy sector receive their daily tasks by wireless communication and start directly from the home of the driver. In this case a wide refuelling network is utilized on a national or regional scale and does only experience limitations in the choice of the tank card. Operators who refuel their vehicles every day at the same station or return every day to their base are limited: public transport operators and municipalities in the first place. On the other hand company cars handed out to the employees often travel the same route every day to their workplace and back so that installation of infrastructure in proximity of the company could supply those vehicles with hydrogen. As in the early stages hydrogen infrastructure will be only available in the major cities and along major highways, the driving characteristics has implications for the first users. A trend to open refuelling stations in the near future (2009/2010) could be detected in Germany, Scandinavia and Spain.

Performance requirements in all vehicle categories that are in high demand from operators have evidently lower requirements in the daily utilization as with the conventional reference vehicle. The collected requirements also provide an indication what is desired in real-life and has to be fulfilled by the next generation hydrogen vehicles. As a moving target, it is not possible to compare this directly.

Scandinavia, Germany and Spain have ongoing fleet or vehicle demonstrations and infrastructure build-up programs or are planning new or larger ones. In certain countries with high-vehicle purchase taxes there are tax exemptions of hydrogen vehicles (DK, NL, N and soon to be introduced in Germany)

For fleet operators, it is rather difficult to make predictions that go beyond a 2-3 year cycle and even increasingly if the technology in question is not available yet on the market and little experience exists concerning the technical performance. Mixed feelings therefore prevail about short and medium term availability of vehicles. Besides this, operators are reluctant to utilize vehicles that might not be technically mature.

A high-influence factor on decision making is the cost aspect. To introduce larger numbers of vehicles into fleets, the hardware cost cannot exceed the cost of a conventional vehicle. In some cases a premium would be acceptable, notably from the public sector operators. That is mainly since it seems to be understood that clean and innovative vehicle technologies will not appear instantly at comparable prices. Eventually operators spending public funds still have to stick to economical principles and price levels of factor two to the next competing vehicle are not feasible. The same holds for the fuel: hydrogen needs to be priced competitively to conventional fuels. Currently the lack of financial support from ANY political level makes the use of hydrogen vehicles not feasible, with the exception of certain regions that enjoy a support scheme such as Germany (NIP) or Denmark (purchase tax exemption).

For some speciality vehicles due to small manufacturing volumes already for conventional versions high unit costs apply – add-on hydrogen costs are comparatively moderate.

Operators that unify a number of beneficial factors for hydrogen vehicle deployment are summarized below, see Table 5-5. However this overview should not be perceived as guarantee for the safe deployment of hydrogen vehicles, but as indication at which operator(s) and at which locations a deployment is more likely than elsewhere.

Operators	Government Funding	Company Strategy	HRS-Infrastructure	Level of Compliance
Vattenfall E. – Berlin/ Hamburg	YES	YES	YES	☑
BVG – Berlin	YES	YES	YES	☑
Total – Berlin	YES	YES	YES	☑
Ruter - Oslo	YES	YES	YES	☑
HHA - Hamburg	YES	YES	YES	☑
RVK - NRW	YES	YES	YES	☑
Vestische SB – NRW	YES	YES	YES	☑
Zincar - Milano	YES	YES	(YES)	v
Zaragoza	YES	YES	YES	☑
Soria	YES	YES	(YES)	v
RET - Rotterdam	NO	YES	NO	?

**Table 5-5: Influential factors accelerating hydrogen vehicle deployment**

Further on, a number of possible scenarios for the introduction of larger numbers of hydrogen fuelled vehicles into fleets could be drawn from the study results (illustrated with examples of operators interviewed by HyLights):

### By-product hydrogen and city buses

Case study: RVK (Hürth), RET (Rotterdam), HHA (Hamburg/ Stade) All NRW locations having by-product hydrogen (i.e. Infraserb Hürth, Bottrop) at hand had stated that this source could be used cost competitive for bus fleet operation. The same applies to Rotterdam. Also for Hamburg considerations exist to deliver by-product hydrogen via pipeline from Stade (Dow Chemical) to Hamburg (approx. 50 km) as soon as sufficient users would request it.

### Speciality vehicle applications

Case study: Airport Hamburg (ground transport vehicles), BSR Berlin (street cleaning equipment, garbage collection trucks, etc.), UKE-HH Hamburg and EXPO Zaragoza (slow speed shuttle buses), HHLA Hamburg (warehouse moving and hoisting equipment)

In case a bundled articulation of interest would materialise (comparable to the initiative of the hydrogen bus alliance) it might be attractive to convert speciality vehicles in larger numbers to hydrogen (Linde Material Handling has already started with a H<sub>2</sub>-ICE fork lift in the 3 tonne class). Street cleaning truck and machines as well as garbage collection trucks which have high emissions (pollutant or noise) typically due to their operating cycles are further candidates. The Hydrogenics micro bus is an example for a shuttle bus.

### Lead bus operators aiming at volume replacement of vehicle park

Case study: BVG (Berlin), HHA (Hamburg), RET (Rotterdam), Ruter (Oslo), (EMT-Madrid – HRS available), RVK (Hürth/HyCologne) and City of Arnhem

Several bus operators are convinced of H2&FC buses being the future. Some of the HyLights interview partners are members of the Hydrogen Bus Alliance. The majority of the operators interviewed needs not to be convinced of the advantages and would operate H2&FC buses as soon as they are close to lifetime of conventional buses and accessible at reasonable prices (not 3-5 times those of a conventional bus). Berlin, Hamburg, Madrid and Oslo already have HRSs respectively will soon have one (Oslo).

#### **Municipal operators with a strategic orientation towards clean urban (utility) vehicles**

Case study: BSR Berlin (cars, vans, street cleaning equipment, garbage trucks), UKE-HH Hamburg (slow speed shuttle buses, small goods transport vehicles), DCMR Schiedam (cars), Zincar (hydrogen hybrid mini shuttle buses), Municipality of Soria/ Spain (small shuttle bus, scooters, boat, cars), Municipalities of St. Egrève and Sassenage/ France (interest in cars and vans).

#### **Private operators with a strategic orientation towards clean vehicles**

Case study: Vattenfall Europe Berlin/ Hamburg (cars, vans), Telenor (cars) Reykjavik Energy (vans), Port of Rotterdam (shuttle bus), EXPO Zaragoza (availability of a HRS committed through 2016 and need for vehicles)

#### **Mail collection services with a strategic orientation towards clean vehicles**

Case study: TNT Post The Hague (vans), Posten Oslo (vans)

In case these operators having an internal company strategy aiming at the reduction of emissions of carbon footprint could come to an agreement with their leasing companies to offer hydrogen vehicles and with their municipalities at some selected locations (TNT in Rotterdam and Posten in Oslo) to share HRSs with the buses as a starter option then this type of fleet operation should be feasible and attractive.

## 6 Conclusions

The objective of this report was to provide more information about the deployment opportunities for hydrogen vehicles in the early commercialization phase. Industry will need the prospects to deploy large numbers of vehicles before and during the ramp-up of production. It is assumed that those vehicles will first be adopted by fleet operators before the end-consumer. As a preparation for the early application period, this report wanted to find out more about the demands of different user groups, their needs regarding the vehicles and what is required from the users in the sense of technical performance of the vehicles. Yet, it is unclear who will use a technology that is new to the market and under which motives. A wide range of interviews with operators from municipalities, public transport, commercial companies, car sharing provided the basis for this report.

Fleet operators will be one major entry point for the early deployment of hydrogen vehicles. There seems to be no other choice in order to access a large vehicle pool that can be relatively easily supplied with a rudimentary infrastructure for hydrogen. *Mass-manufacturing and economies of scale* will bring down the cost of hydrogen vehicles over time. However, until this stage is reached a number of vehicles need to be deployed first that will still be substantially more expensive. Vehicles in large numbers are supposed to be absorbed by commercial fleet operators that maintain a larger fleet than their public counterparts. But those deployment opportunities should not be seen as too 'simplistic'. Changing business processes have a large impact on the way vehicles are operated that in turn influences their refuelling needs. A growing number of operators do not use only one filling station anymore. This needs to be taken into account.

The expected high investment cost for hydrogen vehicles are of key concern for the fleet operators. Even counting in the beneficial aspects of zero-emission vehicles it represents the biggest obstacle. Equal or only marginal higher procurement cost should therefore be the target. Also the operating cost need to be equal or less (due to expected higher efficiency of the fuel cell) compared to conventional fuels. It should be mentioned that most operators are not 'prepared' to adopt vehicles since announcements about the timeline for availability of vehicles connected to a price indication remain virtually absent up to now.

To absorb the expected additional cost a *two component policy support* might be necessary to lead to a successful introduction in this segment: support programs for vehicle purchase subsidies and for infrastructure build-up respectively medium to long-term preferential pricing of hydrogen as vehicular fuel.

A repeatedly stated request by practically all respondents was the need for the *availability of a hydrogen refuelling infrastructure*. Those commercial users which offer vehicle volumes are typically those with more flexible operating schemes not returning to a homebase every day. These fleet operators besides having access to reasonably priced vehicles would need at least a rudimentary refuelling infrastructure quite early in order to be operative. Only if they have the confidence that these requirements will be fulfilled, they also would opt for hydrogen vehicles and thus sales volumes could increase. The most pronounced statement in this direction came from German rental car company Sixt on 7 September 2008 making a plea for state support to build up a network of filling stations as Sixt's average client drives more than 300 km per day and thus pure electric vehicles would fall short in operating range.

*Deployment focus for volume vehicles* (passenger cars, vans) should be on city/regional logistics and mail & courier collection/delivery in larger cities and urban agglomerations. These operator groups typically return daily to their home depot and/or distribution centers.

A further driver for the implementation of clean hydrogen propulsion technologies are the *increasing requirements for conventional pollution abatement measures* reflected in the EURO IV, V and VI emission standards which lead to significant increases in fuel consumption. Already for the switch from EURO III to EURO IV these increases in fuel consumption can lie between 12% and 18% (reported by EMT-Madrid and RVK Cologne respectively) and thus increase the carbon footprint at the same rate. The continuously growing requirements in reducing pollutants will lead to rising invest costs and complexity of technology and sooner or later might force a technology switch anyhow to intrinsically cleaner propulsion concepts.

Currently it is mainly the major cities in Norway, Sweden and Denmark as well as and Germany that are increasingly becoming active in the hydrogen field, the procurement of vehicles and the opening of refuelling stations due to availability of national or regional funding. Those regions will greatly benefit from the existence of refuelling infrastructure and are expected to absorb much quicker a number of vehicles in the early stages. In general the Southern countries of France, Italy and Spain have an overweight of public operators that are the major drivers for hydrogen while during the enquiries for this a virtual absence of interest from the private sector could be observed. Future EU funding should take into account this aspect to avoid unbalanced technology development across European countries.

Hydrogen fuel cell technology was regarded as perpetual technology during the interviews for this study. In the perception of fleet operators technological development moves rather slowly. It needs to be reminded that the introduction of hydrogen would represent a radical shift away from end-of-pipe technologies. Primarily public bus operators consider the intermediate steps of further 'cleaning' of conventional technologies as additional cost that could be avoided with the rapid introduction of buses that run on hydrogen.

In October 2008 the start of the Joint Technology Initiative on Hydrogen Fuel Cells is scheduled and expected to accelerate large-scale demonstrations of hydrogen vehicles that should subsequently trigger pre-series production. Deployment of vehicles that run in one other way on hydrogen (hydrogen ICE or FCV) seems to be not so far off anymore for fleet operators, assuming affordable vehicles and available infrastructure. For the sample in this study, only a fraction of fleet operators in one country or region were part of the research. As each region has its own specific characteristics considering the potential fleet adoption, more research on the opportunities offered by regional fleet operators might be worthwhile to be preformed. As a next step, regional actors should become engaged in business plan activities on the feasible adoption numbers and on how the additional cost of hydrogen could be covered.

## **Annex contents**

Annex A – List of interviewees (including addresses and telecom parameters)

Annex B – Interview Questionnaire – original English version (translated versions to German and Spanish)

Annex C – Reference vehicle data

Annex D - Pro-Hydrogen Statement by a Rental Car Company

## **Annex A – List of interviewees** (including addresses and telecom parameters)

### Overview of Cities/ Regions

- Aragon - Zaragoza
- Arnhem
- Berlin
- Castilla y Leon - Soria
- Hamburg
- Iceland - Reykjavik
- Italy – Piemonte and Lombardia
- London
- Madrid
- North-Rhine Westphalia (NRW) – Bottrop, Herten, Hürth
- Rhône-Alpes Region – Lyon, Sassenage, St. Egrève
- Rotterdam
- Scandinavia – Denmark, Norway and Sweden
- Valencia

## Aragon

Participating organisation: **Ayuntamiento de Zaragoza**  
Field(s) of activity: Vehicle operations  
Representative answering: Víctor Martínez Fernández  
Position of representative: Chief of vehicle operations department  
Address of representative: C/Casa Jiménez, 5, 3rd floor  
[Street/ City/ Zip Code/ Country] 50 004 Zaragoza  
Phone number of representative: +34/609/446 557  
E-mail of representative: ptraccion@ayto-zaragoza.es

Participating organisation: **EXPOZARAGOZA 2008**  
Field(s) of activity: Exposición Mundial 2008  
Representative answering: Pedro Montaner Izcue  
Position of representative: Responsable Proyecto Hidrógeno – Dirección General de Construcción  
Address of representative: Avenida Pablo Ruiz Picasso, 68  
[Street/ City/ Zip Code/ Country] 50018 Zaragoza  
Phone number of representative: +34/976/70 24 83 or +34/619/30 29 70  
E-mail of representative: pmontaner@expo2008.es

Participating organisation: **TUZSA**  
Field(s) of activity: Urban bus operation  
Representative answering: Eduardo Sánchez Hernando (and Marta Alejandre)  
Position of representative: Director Operations  
(Environmental Department)  
Address of representative: Miguel Servet, 199  
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Phone number of representative: +34/976/41 39 00  
E-mail of representative: esanchez@tuzsa.es

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acabello@hidrogenoaragon.org (e-mail)

## Arnhem

Participating organisation: **Arnhem Municipality**  
Field(s) of activity: Municipal Administration on Economic Affairs  
Representative answering: Marc de Kroon  
Position of representative: Advisor of Economic Affairs  
+ Acting President of the Arnhem Hydrogen Network  
Address of representative: .....  
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Mobile: +31/645212055  
Fax: +31/26 362-9323  
E-mail: jacques.smolenaars@hygear.nl

## Berlin

Participating organisation: **Berliner Verkehrs-Betriebe AG (BVG)**  
Field(s) of activity: Municipal public transport operator  
Representative answering: Burkhard Eberwein  
Position of representative: Business Department City Buses – Projects and  
Innovative Technologies  
Address of representative: Potsdamer Str. 188  
[Street/ City/ Zip Code/ Country] 10439 Berlin-Schöneberg  
Phone number of representative: +49/30/256-27516 +49/172/386 24 98 (mobile)  
E-mail of representative: burkhard.eberwein@bvg.de

Participating organisation: **Vattenfall Europe**  
Field(s) of activity: Electric Utility  
Representative answering: Heiko Köpke  
Position of representative: Chief of Warehouse and Waste Management  
Address of representative: Puschkinalle 52  
[Street/ City/ Zip Code/ Country] 12435 Berlin  
Phone number of representative: +49/30/267-4622  
+49/172/3-23 63 20 (mobile)  
E-mail of representative: [heiko.koepke@vattenfall.de](mailto:heiko.koepke@vattenfall.de)

Participating organisation: **Berliner Stadtreinigungsbetriebe**  
Field(s) of activity: Municipal cleaning and garbage collection  
Representative answering: Wolfgang Heinemann  
Position of representative: Technology and Service Department  
Address of representative: Nordring 5  
[Street/ City/ Zip Code/ Country] 12681 Berlin  
Phone number of representative: +49/30/7592-3727  
+49/170/2205694 (mobile)  
E-mail of representative: [Wolfgang.Heinemann@BSR.de](mailto:Wolfgang.Heinemann@BSR.de)

Participating organisation: **Total Deutschland GmbH**  
Field(s) of activity: Vehicle fuel retailer  
Representative answering: Patrick Schnell  
Position of representative: Internal Services  
Address of representative: Schützenstr. 25  
[Street/ City/ Zip Code/ Country] 10117 Berlin  
Phone number of representative: +49/30/20 27 74 10  
+49/162/1333356 (mobile)  
E-mail of representative: [patrick.schnell@total.de](mailto:patrick.schnell@total.de)

## Castilla y Leon - Soria

Participating organisation: **Ayuntamiento de Soria**  
Field(s) of activity: Policy  
Representative answering: Luís Alfonso Rey de las Heras and José Luís Lopez Navarro  
Position of representative: Rey d.l. Heras: Primer Teniente Alcalde  
Address of representative: Plaza Mayor, 8  
[Street/ City/ Zip Code/ Country] 42001 Soria, Spain  
Phone number of representative: +34/975/234 100  
E-mail of representative: .....?.....

## Hamburg

Participating organisation: **hySOLUTIONS /  
Hamburger Hochbahn AG (HHA)**  
Field(s) of activity: public transport  
Representative answering: Carola Thimm  
Position of representative: Project manager  
Address of representative: Steinstraße 25  
[Street/ City/ Zip Code/ Country] 20095 Hamburg  
Germany  
Phone number of representative: +49/40/32884475  
E-mail of representative: carola.thimm@hysolutions-hamburg.de

Participating organisation: **Flughafen Hamburg GmbH**  
Field(s) of activity: Airport operations  
Representative answering: Volker Budde,  
Wolfgang Schümann  
Position of representative: Strategic department environmental protection  
Address of representative: Flughafen Hamburg  
[Street/ City/ Zip Code/ Country] 22331 Hamburg  
Phone number of representative: +49/40/5075-2869  
+49/40/5075-3000; +49/172/4014755 (mobile)  
E-mail of representative: vbudde@ham.airport.de  
wschuemann@ham.airport.de

Participating organisation: **Universitätsklinikum Hamburg Eppendorf (UKE)**  
Field(s) of activity: University hospital  
Representative answering: Manfred Hannig  
Position of representative: Commercial Services – Chief of Department  
(Kaufmännische Dienstleistungen -  
Abteilungsleiter)  
Address of representative: Martinistraße 52  
[Street/ City/ Zip Code/ Country] 20246 Hamburg  
Phone number of representative: +49/40/42803-4343  
E-mail of representative: [hannig@uke.uni-hamburg.de](mailto:hannig@uke.uni-hamburg.de)

Participating organisation: **Vattenfall Europe Hamburg AG**  
Field(s) of activity: Hydrogen production / infrastructure.  
Representative answering: Daniel Hustadt  
Position of representative: .....  
Address of representative: Überseering 12  
[Street/ City/ Zip Code/ Country] 22297 Hamburg, Germany  
Phone number of representative: +49 40 6396 2670  
E-mail of representative: Daniel.Hustadt@vattenfall.de.....

Participating organisation: **Hamburg Wasser**  
Field(s) of activity: Tap water supply and sewage disposal  
Representative answering: Helge Raddatz  
Position of representative: car pool manager  
Address of representative: Pinkertweg 3  
[Street/ City/ Zip Code/ Country] 22113 Hamburg  
Germany  
Phone number of representative: +49/40/3498-55020  
E-mail of representative: helge.raddatz@hhse.de

Participating organisation: **HHLA Frucht- und Kühl-Zentrum GmbH**  
Field(s) of activity: Warehouse operations  
Representative answering: Jan Haase  
Position of representative: Assistant to the management

Address of representative: Sachsenbrücke  
[Street/ City/ Zip Code/ Country] 20257 Hamburg  
Phone number of representative: +49/40/3088-7352  
+49/171/6825237  
E-mail of representative: haase-j@hlla.de

Participating organisation: **TÜV Nord Systems GmbH & Co. KG**  
Field(s) of activity: Third party certifier  
Representative answering: Holger Adams  
Position of representative: Marketing and sales  
Branch manager automotive  
Address of representative: Große Bahnstraße 32  
[Street/ City/ Zip Code/ Country] 22525 Hamburg  
Phone number of representative: +49/40/8557-2744  
+49/160/888-2744  
E-mail of representative: hadams@tuev-nord.de

## Iceland

Participating organisation: **City of Reykjavik**  
Field(s) of activity: Municipal Administration  
Representative answering: Gudmundur Fridriksson  
Position of representative: Department of Environment and Transport  
Address of representative: Skulagotu 19  
[Street/ City/ Zip Code/ Country] 101 Reykjavik, Iceland  
Phone number of representative: +354/4118500  
E-mail of representative: [gvb@rvk.is](mailto:gvb@rvk.is)

Participating organisation: **Iceland Excursions**  
Field(s) of activity: Travel operator  
Representative answering: Runar Gardarsson  
Position of representative: Manager of coach operations  
Address of representative: Hofdatun 12  
[Street/ City/ Zip Code/ Country] 105 Reykjavik, Iceland  
Phone number of representative: +354/5401313  
E-mail of representative: [runar@iea.is](mailto:runar@iea.is)

Participating organisation: **Landsvirkjun**  
Field(s) of activity: Energy company  
Representative answering: Ragnheidur Olafsdottir  
Position of representative: Head of environment  
Address of representative: Haaleitisbraut 68  
[Street/ City/ Zip Code/ Country] 103 Reykjavik, Iceland  
Phone number of representative: +354/515 9078  
E-mail of representative: [ragnheidur@lv.is](mailto:ragnheidur@lv.is)

Participating organisation: **Hertz**  
Field(s) of activity: Car rental  
Representative answering: Hreinn Sigmarsson  
Position of representative: Manager  
Address of representative: Flugvallarvegi  
[Street/ City/ Zip Code/ Country] 101 Reykjavik, Iceland  
Phone number of representative: +354/522 4413  
E-mail of representative: [hreinn@hertz.is](mailto:hreinn@hertz.is)

Participating organisation: **Straeto**  
Field(s) of activity: Public transport  
Representative answering: Reynir Jonsson  
Position of representative: Director  
Address of representative: Ponglabakka 4  
[Street/ City/ Zip Code/ Country] 109 Reykjavik, Iceland  
Phone number of representative: +354/540 2720  
E-mail of representative: [reynir@straeto.is](mailto:reynir@straeto.is)

Participating organisation: **Reykjavik Energy**  
Field(s) of activity: Energy company  
Representative answering: Asdis Kristinsdottir  
Position of representative: Mechanical engineer  
Address of representative: Baejarhals 1  
[Street/ City/ Zip Code/ Country] 110 Reykjavik, Iceland  
Phone number of representative: +354/617 6634  
E-mail of representative: [asdis.kristinsdottir@or.is](mailto:asdis.kristinsdottir@or.is)

## Italy

Participating organisation: **Zincar**  
Field(s) of activity: Car sharing  
Representative answering: Francesco Saverio Baldanzi  
Position of representative:

Address of representative:

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Phone number of representative: +39/02/36575926

E-mail of representative: [Francesco.baldanzi@zincar.it](mailto:Francesco.baldanzi@zincar.it)

Participating organisation: **Milano Car Sharing**

Field(s) of activity: Car sharing

Representative answering: Andrea Leverano

Position of representative:

Address of representative:

[Street/ City/ Zip Code/ Country]

Phone number of representative:

E-mail of representative: [andrea.leverano@carsharingitalia.com](mailto:andrea.leverano@carsharingitalia.com)

Participating organisation: **Regione Piemonte**

Field(s) of activity: Regional Administration

Representative answering: Angelo Benedetti

Position of representative:

Address of representative:

[Street/ City/ Zip Code/ Country]

Phone number of representative: +39/011/4324468

E-mail of representative: [angelo.benedetti@regione.piemonte.it](mailto:angelo.benedetti@regione.piemonte.it)

Participating organisation: **CarCityClub**

Field(s) of activity: Car sharing

Representative answering: Umberto Vitrotti

Position of representative:

Address of representative:

[Street/ City/ Zip Code/ Country]

Phone number of representative: +39/011/8137804

E-mail of representative: [umberto.vitrotti@carcityclub.it](mailto:umberto.vitrotti@carcityclub.it)

## London

Participating organisation: **E.ON**  
Field(s) of activity: Business Services  
Representative answering: David Graham  
Position of representative: Fleet Manager  
Address of representative: Westwood Way  
[Street/ City/ Zip Code/ Country] Westwood Business Park, Coventry  
Phone number of representative: +44/02/476182384  
E-mail of representative: [David.C.Graham@eon-uk.com](mailto:David.C.Graham@eon-uk.com)

Participating organisation: **EDF Energy**  
Field(s) of activity: Transport and services  
Representative answering: Chris Pascall  
Position of representative: Head of Transport  
Address of representative: 255 Broadway  
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Participating organisation: **Tesco**  
Field(s) of activity: Fleet management  
Representative answering: Neal Burton  
Position of representative: Fleet operational manager  
Address of representative: Dryburgh Industrial Estate  
[Street/ City/ Zip Code/ Country] Dundee  
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Participating organisation: **Thames Water**  
Field(s) of activity: Corporate and social responsibility  
Representative answering: Julian Dennis  
Position of representative: Director of Compliance & Sustainability  
Address of representative: Clearwater Court  
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Participating organisation: **London Borough of Camden**  
Field(s) of activity: Transport and streets  
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Position of representative: Air Quality Policy Officer  
Address of representative: Camden Town Hall  
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Participating organisation: **BT Fleet**  
Field(s) of activity: Fleet management  
Representative answering: Paul Morton  
Position of representative: 11 Trinity Park  
Address of representative: Bickenhill Lane  
[Street/ City/ Zip Code/ Country] Birmingham  
Phone number of representative: +44/0/1217807033  
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## **Madrid**

Participating organisation: **Madrid Municipal Transport Company S.A. (Madrid EMT)**  
Field(s) of activity: Entity that provides regular passenger surface transport service in the municipality of Madrid.  
Representative answering: Mr. Eugenio Bañobre  
Position of representative: Head of the Environmental Department of EMT S.A  
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[Street/ City/ Zip Code/ Country] Spain  
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E-mail of representative: [eugenio.banobre@emtmadrid.es](mailto:eugenio.banobre@emtmadrid.es)

## North-Rhine Westphalia (NRW)

### Hürth (HyCologne)

Participating organisation: **Regionalverkehr Köln GmbH (RVK)**  
Field(s) of activity: Public Transport Operator  
Representative answering: Carsten Bußjaeger  
Position of representative: Authorized Signatory  
Address of representative: Theodor-Heuss-Ring 38-40  
[Street/ City/ Zip Code/ Country] 50668 Köln, Germany  
Phone number of representative: +49/221/1637-500  
E-mail of representative: carsten.bussjaeger@rvk.de

Participating organisation: **Bayer AG**  
Field(s) of activity: Pharmacy/ Chemistry.  
Representative answering: Lutz Hansen.....  
Position of representative: Purchasing Fleet Management Services  
Address of representative: 51368 Leverkusen  
[Street/ City/ Zip Code/ Country] .....  
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Participating organisation: **Infraserv-Knapsack**  
Field(s) of activity: Infrastructure Operator in Hürth  
Representative answering: Wolfgang Urmetzer  
Position of representative: Bereich Infrastruktur – Strategische Projekte  
Address of representative: Chemiepark Knapsack, Industriestraße  
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## **Herten & Bottrop (H2R2)**

Participating organisation: Hertener Stadtwerke GmbH  
Field(s) of activity: Municipal Services (Gas, electricity, district heating, Swimming pool, etc.)  
Representative answering: Gisbert Büttner  
Position of representative: Geschäftsführer  
Address of representative: Herner Straße 21  
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[www.hertener-stadtwerke.de](http://www.hertener-stadtwerke.de)

Participating organisation: **Umweltamt Bottrop**  
Field(s) of activity: Environmental Planning and Prevention  
Representative answering: Wolfgang Bäck  
Position of representative: Chief of Department  
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## Rhône-Alpes Region

- Participating organisation: **Région Rhône-Alpes**
- Field(s) of activity: .....
- Representative answering: Jérôme Biasotto
- Position of representative: Policy Officer
- Address of representative: 78, rout de Paris, BP 19  
[Street/ City/ Zip Code/ Country] 69751 Charbonnières-les-Bains Cédex
- Phone number of representative: +33/472/594951
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- 
- Participating organisation: **Rhônealpenergie-Environnement - Energy and Environment Agency**
- Field(s) of activity: Energy Policiy and Advice
- Representative answering: Reinhard Six
- Position of representative: Project Manager
- Address of representative: 10, rue des Archers  
[Street/ City/ Zip Code/ Country] 69002 Lyon
- Phone number of representative: +33/472/563344
- E-mail of representative: reinhard.six@raee.org  
www.raee.org
- 
- Participating organisation: **Mairie St. Egrève**
- Field(s) of activity: Municipal Administration
- Representative answering: Catherine Kamowski
- Position of representative: Mayor of Saint Egrève
- Address of representative: 36, avenue du Général de Gaulle, BP 120  
[Street/ City/ Zip Code/ Country] 38521 Saint-Egrève cédex
- Phone number of representative: +33/476/565341
- E-mail of representative: cabinetdumaire@mairie-st-egreve.fr  
Catherine.kamowski@mairie-st-egreve.fr
- 
- Participating organisation: **Mairie Sassenage**
- Field(s) of activity: Municipal Administration
- Representative answering: M. Coigne
- Position of representative: Mayor of Sassenage

Address of representative: Hôtel de Ville, Place de la liberation  
[Street/ City/ Zip Code/ Country] 38360 Sassenage  
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<b>Rotterdam</b>
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Participating organisation: **TNT Post**  
Field(s) of activity: Corporate Sustainability & Business Excellence  
Representative answering: Theun Lourens  
Position of representative: Consultant Environmental Affairs  
Address of representative: Prinses Beatrixlaan 23  
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Participating organisation: **Rabobank**  
Field(s) of activity: ICT and facilities  
Representative answering: Frank Schmitz  
Position of representative: Advisor facility products and services  
Address of representative: Blaak 333  
[Street/ City/ Zip Code/ Country] 3011 GB Rotterdam  
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Participating organisation: **Roteb Lease**  
Field(s) of activity: Sales and administration manager  
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Position of representative: Manager  
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Participating organisation: **DCMR Milieudienst Rijnmond**  
Field(s) of activity: Facilities service centre  
Representative answering: Adri van Hattem  
Position of representative: manager  
Address of representative: 's-Gravelandseweg 565  
[Street/ City/ Zip Code/ Country] 3100 AV Schiedam  
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E-mail of representative: [Francesco.baldanzi@zincar.it](mailto:Francesco.baldanzi@zincar.it)

Participating organisation: **RET**  
Field(s) of activity: Bus company  
Representative answering: Vincent Gabriëls  
Position of representative: Senior Strategic Programme Administrator  
Address of representative: Vasteland 80  
[Street/ City/ Zip Code/ Country] 3000 AC Rotterdam  
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E-mail of representative: [vgabriels@ret.nl](mailto:vgabriels@ret.nl)

Participating organisation: **KPN**  
Field(s) of activity: Fleet management  
Representative answering: Cees van der Want and Fred Reinhard  
Position of representative: Category Purchaser Procurement Office  
Senior Advisor Fleet Management  
Address of representative: Maanplein 55  
[Street/ City/ Zip Code/ Country] 2516 CK, The Hague  
Phone number of representative: +31/70/4463243  
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E-mail of representative: [cees.vanderwant@kpn.com](mailto:cees.vanderwant@kpn.com)  
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Participating organisation: **Eneco**  
Field(s) of activity: Business to Business Marketing  
Representative answering: Paul Broos  
Position of representative: Consultant Climate Footprint  
Address of representative: Rivium Quadrant 75  
[Street/ City/ Zip Code/ Country] 2909 LC Capelle aan den IJssel  
Phone number of representative: +31/6/15068839  
E-mail of representative: [p.broos@eneco.nl](mailto:p.broos@eneco.nl)

Participating organisation: **Port of Rotterdam**  
Field(s) of activity: Fleet management  
Representative answering: Steef Korfker  
Position of representative: Fleet manager  
Address of representative: Eemshavenweg 14  
[Street/ City/ Zip Code/ Country] 3002 AP Rotterdam  
Phone number of representative: +31/10/2521010  
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## Scandinavia

Participating organisation: **City of Malmo, Environment Department**  
Field(s) of activity: Municipal Administration  
Representative answering: Katarina Pelin  
Position of representative: Director  
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Phone number of representative: +46/40/342014  
E-mail of representative: [Katrina.pelin@malmo.se](mailto:Katrina.pelin@malmo.se)

Participating organisation: **Sunfleet Carsharing**  
Field(s) of activity: Car sharing  
Representative answering: Susanne Mahlstroem  
Position of representative: Head of Operations  
Address of representative: Box 11022, Centralstationen, spar 1  
[Street/ City/ Zip Code/ Country] 40421 Goteborg, Sweden  
Phone number of representative: +46/31/7034510  
E-mail of representative: [Susanne.malmstroem@sunfleet.com](mailto:Susanne.malmstroem@sunfleet.com)

Participating organisation: **Gatubolaget**  
Field(s) of activity: Municipal vehicle fleet  
Representative answering: Kristian Magnusson  
Position of representative: Technical manager  
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Phone number of representative: +46/31/3684905  
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Participating organisation: **Box**  
Field(s) of activity: Delivery services  
Representative answering: Bjorn Sandstrom  
Position of representative: Area Manager  
Address of representative: Box 651  
[Street/ City/ Zip Code/ Country] 55119 Jonkoping, Sweden  
Phone number of representative: +46/36/395959  
E-mail of representative: [bjorn.sandstrom@box.eu](mailto:bjorn.sandstrom@box.eu)

Participating organisation: **TDC**  
Field(s) of activity: Telecommunication  
Representative answering: Anders Mehlsen  
Position of representative: Environmental director  
Address of representative: Slotsgade 7  
[Street/ City/ Zip Code/ Country] 9000 Aalborg, Denmark  
Phone number of representative: +45/66/656422  
E-mail of representative: [aa@tdc.dk](mailto:aa@tdc.dk)

Participating organisation: **Grontmij Carl Bro**  
Field(s) of activity: Engineering services  
Representative answering: Sigurd Vagn Bunk Lauritsen  
Position of representative: Chief Advisor, Climate Change & Energy  
Address of representative: Granskoven 8  
[Street/ City/ Zip Code/ Country] 2600 Glostrup, Denmark  
Phone number of representative: +45/43/486060  
E-mail of representative: [aa@tdc.dk](mailto:aa@tdc.dk)

Participating organisation: **Movia**  
Field(s) of activity: Public Transport  
Representative answering: Jesper Kaas Petersen  
Position of representative: Contract department  
Address of representative: Gammel Koge Landevej 3  
[Street/ City/ Zip Code/ Country] 2500 Valby, Denmark  
Phone number of representative: +45/36/131635  
E-mail of representative: [jp@movia.dk](mailto:jp@movia.dk)

Participating organisation: **Posten**  
Field(s) of activity: Mail delivery  
Representative answering: Odd-Olaf Schei  
Position of representative: Project manager Environment  
Address of representative: Biskop Gunnerus Gt. 14  
[Street/ City/ Zip Code/ Country] 0001 Oslo, Norway  
Phone number of representative: +47 911 22 747  
E-mail of representative: [odd.schei@posten.no](mailto:odd.schei@posten.no)

Participating organisation: **City of Oslo**  
Field(s) of activity: Municipal Administration  
Representative answering: Espen Skistadt  
Position of representative: Senior Purchaser  
Address of representative: Stromsveien 102  
[Street/ City/ Zip Code/ Country] 0606 Oslo, Norway  
Phone number of representative: +47/02/180  
E-mail of representative: [espen.skistadt@uke.oslo.kommune.no](mailto:espen.skistadt@uke.oslo.kommune.no)

Participating organisation: **Telenor**  
Field(s) of activity: Telecommunication  
Representative answering: Frode Jarle Sorum  
Position of representative: Manager vehicle fleet administration  
Address of representative: Snaroyveien 30  
[Street/ City/ Zip Code/ Country] 1331 Fornebu, Norway  
Phone number of representative: +47/67/890000  
E-mail of representative: [frode-jarel.sorum@telenor.com](mailto:frode-jarel.sorum@telenor.com)

Participating organisation: **Ruter A/S**  
Field(s) of activity: Public Transport  
Representative answering: Anne Merete Andersen  
Position of representative: Environmental Advisor  
Address of representative: Dronningens gate 40  
[Street/ City/ Zip Code/ Country] 0104 Oslo, Norway  
Phone number of representative: +47/464 09 312  
E-mail of representative: [anne.merete.andersen@ruter.no](mailto:anne.merete.andersen@ruter.no)

## Valencia

Participating organisation: **Empresa Municipal de Transportes (EMTValencia)**  
Field(s) of activity: Public bus operation  
Representative answering: Ariane Calero  
Position of representative: n.a.  
Address of representative: Avenida Enric Valor,  
[Street/ City/ Zip Code/ Country] 1346100 BURJASSOT (Valencia), Spain  
Phone number of representative: +34/96/3784412  
E-mail of representative: urbanbat@emtvalencia.es

Participating organisation: **Bombers Consorci Valencia**  
Field(s) of activity: Firebrigades in the Province of Valencia  
(10,000 km<sup>2</sup>)  
Representative answering: Javier Navarrete Ruiz  
Position of representative: Chief of Logistical Support Section  
Address of representative: Cami de Moncada, No. 24  
[Street/ City/ Zip Code/ Country] 46009 Valencia, Spain  
Phone number of representative: +34/96/346 98 00  
[mobile: +34/629/25 89 92]  
E-mail of representative: jnavarrete@bombers.dva.gva.es

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**Annex B – Interview Questionnaire –**  
original English version (+ translated versions to German and Spanish)

Questionnaire  
VEHICLE REQUIREMENTS AND  
DAILY OPERATION CHARACTERISTICS



<b>Participating organisation:</b>	.....
<b>Field(s) of activity:</b>	.....
<b>Type of vehicle(s) in operation:</b>	..... .....

<b>Representative answering:</b>	.....
<b>Position of representative:</b>	.....
<b>Address of representative:</b> <b>[Street/ City/ Zip Code/ Country]</b>	..... .....
<b>Phone number of representative:</b>	.....
<b>E-mail of representative:</b>	.....

**Questionnaire**  
**VEHICLE REQUIREMENTS AND DAILY OPERATION**  
**CHARACTERISTICS**



This questionnaire is part of the EU funded (FP6) HyLights project ([www.HyLights.eu](http://www.HyLights.eu)). This project aims at assisting stakeholders in the preparation of the next important phase in the transition to hydrogen as a fuel and long-term renewable energy carrier in the transport sector. This next phase will comprise large scale demonstration projects (Lighthouse projects) at various locations throughout the EU, leading to an acceleration of the commercialisation of hydrogen and fuel cells in the field of transport in Europe.

For this purpose the Ludwig-Bölkow-Systemtechnik (LBST) and Energy Research Centre of the Netherlands (ECN) are assessing which kind of markets might be ideal for the early deployment of hydrogen vehicles. This is done by analysis of the markets requirements for their vehicles and by analysing the way those vehicles are used in daily practice. The results of this survey will be provided to the Joint Technology Initiative on Fuel cells (FC) and Hydrogen (H2).

To assess potential markets for the deployment of hydrogen technologies, interviews will be conducted throughout Europe with a diverse kind of stakeholders. The questions below are used to structure those interviews.

This questionnaire is sent to you as preparation of an interview. You are kindly requested to check the questions before the interview will take place.

For more information about this questionnaire, the interview or the HyLights project in general, you can contact Ludwig-Bölkow-Systemtechnik (Reinhold Wurster +49 89 608110-33, [questionnaire@hylights.eu](mailto:questionnaire@hylights.eu)). Information about the project is also available at [www.hylights.eu](http://www.hylights.eu). Information about activities in the field of hydrogen for transport in Europe can be obtained from [www.h2moves.eu](http://www.h2moves.eu).

**Questions**

<b>Question 1:</b>	Are you familiar with hydrogen and fuel cell technology?					
<b>Question 2:</b>	Are you involved in any projects on hydrogen and fuel cells and what are the reasons? If not – why?					
	<input type="radio"/> Yes: <input type="radio"/> No: (Reasons)					
<b>Question 3:</b>	What would be the main driver(s) for you to start using hydrogen technologies (technical, societal, legal/ approval, image, finance, acceptance, etc.)?					
<b>Question 4:</b>	What do you expect from hydrogen technologies for transport in future? (e.g. with regard to the energy market / transport sector / reduction of emissions / reduction of fuel consumption / energy security of supply and fuel diversification / support of renewable energy use in the transport sector / etc.)					
	<i>Criteria</i>	<b>+</b>	<b>o</b>	<b>-</b>	<i>No idea</i>	<i>Comments</i>
	energy market					
	transport sector					
	reduction of emissions					
	reduction fuel consumption					
	fuel diversification					
	support renewable energy in the transport					
	Employment growth					
<b>Question 5:</b>	Which policy goals does hydrogen contribute to?					
	a) Your company's					
	b) The regional government's or municipality					

c) The national government's or European	
<b>Question 6:</b>	How does hydrogen and fuel cell technology relate to other solutions, like biofuels, catalysts, ICE-hybrids or other alternative fuels, on the short term and far future?
<b>Question 7:</b>	In what case would you be interested in the usage of hydrogen technologies (e.g. participating in demonstrations, as an early market)? a) What are your expectations of such a project (e.g. learning, contacts, PR, technology insight)? b) What are your preconditions? c) Where do you see the near-term market for H2/FC and why (advantages of H2/FC against conventional technology)?
<b>Question 8:</b>	Which barriers and opportunities (technological, social, legal, policy and financial) do you see for the deployment of hydrogen technology?
<b>Question 9:</b>	In case you intend to participate in a future large scale demonstration project for hydrogen in transport, would policy or financial support be available? Which incentives are available (or necessary) to support hydrogen? (e.g. EU legislation, national programs, regional programs, or local initiatives – hydrogen production, refuelling stations & infrastructure, hydrogen vehicles)
<b>Question 10:</b>	Who is responsible for the introduction of sustainable technology development? (EU, national governments, regional governments, municipalities, industry, operators/ consumers, other) a) In your organisation/ company (e.g. responsible for the introduction of alternative technologies)? b) If it is not your organisation/company responsibility, is this a reason not to participate in the demonstration of hydrogen and fuel cell technology?
<b>Question 11:</b>	If you expect that hydrogen will be an important fuel in future, what should happen before large scale deployment can take place? (e.g. recommendations on commercialisation for industry and policy) Is further development (technical/society/market), demonstration or education necessary?
<b>Question 12:</b>	What is your vision of limited city centre access? What role could hydrogen play in limited city centre access? (e.g. Are city access limits in place or in planning? Do co-operations with other cities or regions or companies, organisations, projects exist regarding the introduction of restrictions?)
<b>Question 13:</b>	Any other comments, issues, feedback to the previous questions?
<b>Question 14:</b>	Does your company use the following kind of vehicles and how many of them? Passenger car <input type="radio"/> No <input type="radio"/> Yes (1-10) <input type="radio"/> Yes (11-50) <input type="radio"/> Yes (>50) Van <input type="radio"/> No <input type="radio"/> Yes (1-10) <input type="radio"/> Yes (11-50) <input type="radio"/> Yes (>50) Bus <input type="radio"/> No <input type="radio"/> Yes (1-10) <input type="radio"/> Yes (11-50) <input type="radio"/> Yes (>50)
<b>Question 15:</b>	Do you think that your company is / will become interested to start using hydrogen vehicles as a first early market? <input type="radio"/> Yes: passenger cars. <input type="radio"/> Yes: vans. <input type="radio"/> Yes: buses. <input type="radio"/> Yes: scooters (or similar). <input type="radio"/> Yes: small street sweepers (or similar).

	<ul style="list-style-type: none"> <li>o Yes: other 3 or 4 wheelers (e.g. gardening, police or municipality vehicles).</li> <li>o No: Why not?</li> </ul>
<b>Question 16:</b>	Does your company have its own fuelling stations for fuelling the company owned vehicle fleet?

<b>Question 17:</b>	What is the most important (largest) fleet of your company? Which minimal performance requirements do you set for those vehicles (please fill in the indicators below).
---------------------	---

	Performance indicator	Unit	Description	Minimal performance requirement for the vehicles in your most important fleet (see question 17)
A	Maximum Speed	km/h	Top speed of the car	
B	Driving range	km/tank	Number of kilometres per tank	
C	Vehicle costs	Euro or Euro/ month	Approximate cost of the car	
D	Fuel Consumption	km / litre and km/€	Fuel consumption in km/litre and km/€	Diesel: ..... Petrol: .....
E	Number of passengers	#	Maximal number of passengers	
F	Load	kg & m <sup>3</sup>	Possible load in kilograms and in volume	kg:..... m <sup>3</sup> :.....
G	Annual maintenance costs	Euro/year	Average costs for maintenance of the car	
H	Refuelling rate Fuel cartridge exchange	Litres / Minute Minute	Average refuelling time Average exchange time	Diesel: ..... Petrol: .....
I	Buses: Acceleration (0-60)			
j	Cars and vans: Acceleration (0-100km/h)	s	Approximate acceleration time from 0 to 100 km/h	
K	Availability	%	Number of days a car is down compared to the number of days it is used	
L	Refuelling frequency	Number/day	How often are the vehicles refuelled?	
M	Refuelling locations	Number of locations	At how many refuelling locations will be refuelled?	
N	Average driving range	Km/day	How many kilometres are on average driven per day?	
O	Maximum driving range	Km/day	How many kilometres are maximally driven	

	<b>Performance indicator</b>	<b>Unit</b>	<b>Description</b>	<b>Minimal performance requirement for the vehicles in your most important fleet (see question 17)</b>
			per day?	
P	Average driving distance	Km from office/site	How many kilometres from the office/site will the vehicles drive?	



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## Fragebogenübersicht

### WP4: Defizitanalyse Phase II - Interview Aktivität -

Ingo Bunzeck, Harm Jeeninga [ECN]  
Ulrich Bünger, Reinhold Wurster [LBST]



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## Inhalt des Fragebogens

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**Frage 1:** Sind Sie mit Wasserstoff oder Brennstoffzellen vertraut ?

**Frage 2:** Nehmen sie an Wasserstoff- oder Brennstoffzellenprojekten teil und was sind die Gründe ? Wenn nicht – warum ?

**Frage 3:** Welches wäre für Sie der größte Antrieb, Wasserstofftechnologien einzusetzen (technische, gesellschaftliche, rechtliche/ genehmigungstechnische, Ansehen/Image, Finanzen, Akzeptanz, etc.)

**Frage 4:** Was erwarten Sie von Wasserstofftechnologien künftig im Transportsektor ?

**Frage 5:** Zu welchen politischen Zielsetzungen leistet Wasserstoff einen Beitrag ? Zu den Ihrer Firma ? Zu den der regionalen Regierung oder der Stadtverwaltung? Zur Politik der nationalen oder europäischen Regierungen ?

**Frage 6:** Wie stehen Wasserstoff- und Brennstoffzellentechnologie im Vergleich zu anderen Lösungen, wie Biokraftstoffe, dem Katalysator, verbrennungsmotorischen Hybriden oder anderen alternativen Kraftstoffen – kurzfristig und sehr langfristig ?

**Frage 7:** In welchem Fall wären Sie an am Einsatz von Wasserstofftechnologien interessiert ? (z.B. Teilnahme an Demonstrationen, als früher Markt). Welches sind Ihre Erwartungen an solch ein Projekt (z.B. lernen, Kontakte, PR, technologischer Zugewinn)? Was sind Ihre Anforderungen? Sehen Sie einen naheliegenden Markt für H2/BZ und warum (Vorteile von H2/BZ gegenüber konventioneller Technologie)

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## Inhalt des Fragebogens (2)

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- Frage 8:** Welche Hindernisse und Chancen (technische, gesellschaftliche, gesetzliche, politische und finanzielle) sehen Sie für die Einführung der Wasserstofftechnik?
- Frage 9:** Für den Fall, dass Sie künftig beabsichtigen an einem großen Demonstrationsprojekt mit Wasserstoff im Transportsektor teilzunehmen, würde politische und finanzielle Unterstützung verfügbar sein? Welche Anreize sind verfügbar (oder notwendig), Wasserstoff zu unterstützen? (z.B. EU-Gesetzgebung, nationale Programme, regionale Programme, oder lokale Initiativen – Wasserstoffherzeugung, Tankstellen und Infrastruktur, Wasserstofffahrzeuge)
- Frage 10:** Wer ist für die Einführung nachhaltiger Technologieentwicklungen verantwortlich? (EU, nationale Regierungen, regionale Regierungen, Stadtverwaltungen, Industrie, Betreiber/ Verbraucher, andere)
- a) in Ihrer Organisation?
- b) Wenn nicht im Verantwortungsbereich Ihrer Organisation liegt, wäre dies ein Grund nicht an einem H<sub>2</sub>/BZ-Demovorhaben teilzunehmen?
- Frage 11:** Wenn Sie erwarten, dass Wasserstoff ein wichtiger Kraftstoff der Zukunft sein wird, was sollte geschehen bevor großmaßstäbliche Einführung stattfinden kann? (z.B. Empfehlungen zur Kommerzialisierung für Industrie und Politik) Ist weitere Entwicklung (technisch/gesellschaftlich/marktbezogen), Demonstration oder Erziehung/ Ausbildung notwendig?

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## Inhalt des Fragebogens (3)

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- Frage 12:** Was ist Ihre visionäre Sicht zu begrenztem Innenstadtzugang? Welche Rolle könnte Wasserstoff in diesem Zusammenhang spielen? (z.B. sind Begrenzungen des Innenstadtzugangs bereits verfügt oder in Planung? Existieren diesbezüglich Kooperation mit anderen Städten, Regionen, Firmen, Organisationen oder Projekten hinsichtlich der Einführung von Begrenzungen/ Restriktionen?)
- Frage 13:** Irgendwelche Kommentare, Schwierigkeiten, Informationsrückfluss i.V.m. den vorherigen Fragen?
- Frage 14:** Nutzt Ihre Firma eine der folgenden Fahrzeugarten und wieviele davon
- |             |                            |                                 |                                  |                                |
|-------------|----------------------------|---------------------------------|----------------------------------|--------------------------------|
| PKW         | <input type="radio"/> Nein | <input type="radio"/> Ja (1-10) | <input type="radio"/> Ja (11-50) | <input type="radio"/> Ja (>50) |
| Lieferwagen | <input type="radio"/> Nein | <input type="radio"/> Ja (1-10) | <input type="radio"/> Ja (11-50) | <input type="radio"/> Ja (>50) |
| Bus         | <input type="radio"/> Nein | <input type="radio"/> Ja (1-10) | <input type="radio"/> Ja (11-50) | <input type="radio"/> Ja (>50) |
- Frage 15:** Glauben Sie, dass Ihre Firma interessiert ist/ oder sein wird, Wasserstofffahrzeuge in einem ersten Markt zu nutzen?
- Ja: PKWs.
  - Ja: Lieferwagen
  - Ja: Busse
  - Ja: Motorroller (oder ähnliches)
  - Ja: kleine Straßenreinigungsfahrzeuge (oder ähnliches)
  - Ja: andere 3- oder 4-rädrige (z.B. Gärtnerei, Polizei, städt. Fahrzeuge)
  - Nein: Warum nicht?

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## Inhalt des Fragebogens (4)

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**Frage 16:** Verfügt Ihre Firma über eigene Tankstellen, um die eigene Firmenfahrzeugflotte zu betanken ?

**Frage 17:** Welches ist die wichtigste (größte) Flotte in Ihrer Firma? Welches sind Ihre minimalen vorgegebenen Leistungsanforderungen für diese Fahrzeuge (bitte die Indikatoren unten eintragen):

	Leistungsindikatoren	Einheit	Beschreibung
A	Höchstgeschwindigkeit	km/h	Max. Geschwindigkeit des FZ
B	Reichweite	km/Tank	Kilometer pro Tank
C	Fahrzeugkosten	Euro oder Euro/ Monat	Ungefähre Kosten des Fahrzeugs
D	Kraftstoffverbrauch	l/km und €/km	Kraftstoffverbrauch in l/km und €/km
E	Zahl der Passagiere	#	Max. Zahl der Passagiere
F	Zuladung	kg & m <sup>3</sup>	Mögliche Zuladung in kg und in Volumen
G	Jährl. wartungskosten	€/Jahr	Durchschnittliche Wartungskosten des Fahrzeugs
H	Betankungsgeschwindigkeit Wechselkartusche	l/ Minute Minuten	Durschn. Betankungszeit Durschn. Wechselzeit

## Inhalt des Fragebogens (5)

HYLIGHTS

	Leistungsindikatoren	Einheit	Beschreibung
I	Busbeschleunigung (0-60)	s	Durschn. Beschleunigung von 0 auf 60 km/h
J	PKWs und Lieferwagen: Beschleunigung (0-100km/h)	s	Durschn. Beschleunigung von 0 auf 100 km/h
K	Verfügbarkeit	%	Zahl der Ausfalltage verglichen mit der Zahl der Einsatztage
L	Betankungshäufigkeit	Zahl/Tag	Wie oft werden die Fahrzeuge betankt ?
M	Betankungsorte	Zahl der Orte	An wievielen Orten wird betankt?
N	Durschn. Fahrstrecke	Km/Tag	Wie viele km werden durchschnittlich an einem Tag gefahren ?
O	Max. Fahrstrecke	Km/Tag	Wie viele km werden maximal an einem Tag gefahren ?
P	Durschn. Fahrentfernung	km vom Büro/ Standort	Wie viel km fährt das Fahrzeug vom Büro/ Standort

## Inhalt des Fragebogens (6)

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	Leistungsindikatoren	Einheit	Beschreibung
Q	Wie viel Fahrer fahren das Fahrzeug?	Zahl der Fahrer (etwa)	Ist das Fahrzeug einem Fahrer zugeordnet oder ist es in allgemeiner Benutzung?
R	Flexibler Einsatz	Beschreibung	Ist das Fahrzeug (z.B. Bus) für die gleiche Bedienung/ Entfernung/ Strecke täglich im Einsatz, oder sollte es flexible verfügbar sein ?
S	Anforderungen für den Innenraumeinsatz		Luftschadstoffe Geräusch Begrenzung von Wasserverschüttungen
T	Dimension der Kartusche u/o BZ	mm x mm x mm kg	Abmessung der Packung Gewicht der Packung [aus Kartusche und BZ]

## Inhalt des Fragebogens (7)

HYLIGHTS

**Frage 18:** Welche minimalen Leistungsanforderungen stellen Sie für Ihre eigene Betankungsinfrastruktur (bitte die Indikatoren unten eintragen).

	Leistungsindikatoren	Einheit	Beschreibung
A	Jährliche Wartungskosten	Euro/Jahr	Durchschn. Kosten für die Wartung der Betankungseinrichtung
B	Betankungsgeschwindigkeit	l/ Minute	Durchschn. Betankungsgeschwindigkeit je Fahrzeug
C	Kraftstoffkosten	Euro / l	Bitte angeben, ob Steuern enthalten sind
D	Kraftstoffab-/umsatz	L flüssiger Kraftstoff/ Jahr Kg-H2/Jahr	
E	Verfügbarkeit	%	Ausfalltage zu Betriebstagen der Tankstelle
F	Aufeinanderfolgende Betankungsvorgänge	#	Zahl der max. möglichen aufeinander folgenden Betankungsvorgänge

## Inhalt des Fragebogens (8)

	Performance indicator	Unit	Description
G	Kriterien/ Begrenzungen für die bauliche Einbettung der Tankstelle	-	z.B. integriert oder nicht integriert in eine bestehende Tankstelle, gelegen in einem Industrie- oder Wohngebiet; besondere bauliche Anforderungen, Begrenzung der Aufstellungsfläche, Begrenzung bei den Öffnungszeiten, Begrenzungen für die Zugänglichkeit für Wasserstofflieferlastwagen, die Möglichkeit selbstbedienten Betankens, Verfügbarkeit einer Fahrzeugwartungseinrichtung, nicht-Kraftstoff-bezogener Verkauf (Shop)

**Frage 19:** An wie vielen Tankstellen tanken Sie und welches ist ihre ungefähre Entfernung vom Fahrzeugstützpunkt ?

**Frage 20:** Wie oft tanken Sie an Tankstellen, die nicht auf Ihrem Gelände oder in der Nähe (innerhalb von 5 km) liegen ?

## Ansprechpartner

Für weitere Informationen zur Interviewaktivität, zum Fragebogen, oder allgemein zum HyLights-Projekt, kontaktieren sie bitte

Ludwig-Bölkow-Systemtechnik GmbH  
Daimlerstrasse 15, 85521 Ottobrunn, Germany  
Reinhold Wurster  
Tel.: +49 89 608110-33  
E-mail: [questionnaire@hylights.eu](mailto:questionnaire@hylights.eu)

Informationen zum Projekt sind verfügbar unter: [www.hylights.eu](http://www.hylights.eu).

Information zu Aktivitäten im Bereich Wasserstoff für das Transportwesen in Europa können erhalten werden von [www.h2moves.eu](http://www.h2moves.eu).

# Zuordnung zu den Regionen

Nr.	Land	Stadt/Region	Anwendungstyp	Verantwortlicher
1	GER	Hamburg	Autos, Busse, andere	LBST
2	GER	Berlin	Autos, Busse	LBST
3	GER/NL	NRW/Arnhem	Autos, Busse	LBST
4	ES	Valencia/ Aragon/ Soria/ Madrid	Autos, Busse, andere	LBST
5	FR	Rhône-Alpes (Grenoble, Lyon)	Autos, andere	LBST
6	NL	Amsterdam/Rotterdam	Autos, Busse, andere	ECN
7	IT	Piemont/ Lombardei	Autos, Busse, andere	ECN
8	NO,SE,DK	Skandinavien	Autos, Busse	ECN
9	IS	Reikjavik	Autos, Busse, andere	ECN
10	UK	London	Autos, Busse, andere	ECN

Zahl der Interviews (ca.): Anzahl Standorte : 10,  
Anzahl Interviews / Standort: 5-6, Gesamt: 50-60

# Anwendungen/Nutzermatrix



Anwendungsarten/ Potenzielle Nutzer	Autos	Lieferfahrzeug	Busse	Andere Fahrzeuge
<b>Öffentlich</b>				
Flotten	X	X	X	
Interne Lieferdienste	X	X		
Stadtreinigung		X		
Öffentlicher Transport			X	X
Feuerwehr	X			X
Polizei	X	X		X
Postauslieferung	X	X		X
...				
<b>Privat</b>				
Flotten	X	X	X	
Postauslieferung	X	X		
Öffentlicher Transport			X	X
Taxibetreiber	X			
...				


## Mit wem sprechen?

Es ist wichtig, unterschiedliche Informationsquellen zu beurteilen über einen Kontakt über den alle erforderlichen Daten aus unterschiedlichen Richtungen gesammelt werden

**Strategie/ Firmenentwicklung**  
- Übergeordnete Strategie, Politik

**Einkaufsabteilung**  
- Kaufentscheidung

**Flottenbetreiber/ Einsatzplaner**  
- Tägliche betriebliche Charakteristika  
- Technische Eigenschaften




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## Cuestionario

### WP4: Analisis de Deficite – Fase II - Actividad de Entrevista -

Ingo Bunzeck, Harm Jeeninga [ECN]  
Ulrich Büniger, Reinhold Wurster [LBST]



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## Contenido del cuestionario

**HYLIGHTS**

- Pregunta 1:** Esta Ustd. familiarizado con hidrógeno y pilas de combustible ?
- Pregunta 2:** Esta Ustd. Involucrado en algun proyecto de hidrógeno y pilas de combustible y cuales son las razones ? Si no – porqué ?
- Pregunta 3:** Cual podría ser para Ustd. La causa más importante para empezar a utilizar tecnologías de hidrógeno ? (tecnología, sociedad, asuntos legales o de aprobación de la tecnología, imagen/PR, financieras, aceptabilidad, etc.)
- Pregunta 4:** Que espera Ustd. de las tecnologías de hidrógeno en el transporte futuro ?
- Pregunta 5:** A que metas políticas contribuye hidrógeno ? Para las de su compañía ? Para las del gobierno regional o municipal ? Para las del gobierno nacional o europeo ?
- Pregunta 6:** Como estan posicionadas las tecnologías de hidrógeno y pilas de combustible en comparación a otras soluciones, como biocombustibles, convertidor catalítico, motor de combustión interna hibridizado, u otro combustible alternativo – a corto plazo y a largo plazo ?
- Pregunta 7:** En que caso estaría Ustd. interesado en el uso de tecnologías de hidrógeno ? (p.e. participación en demostraciones, como mercados iniciales). Cuales son sus expectativas de un proyecto semejante ? (p.e. Aprendizaje, contactos, publicidad, ganancia tecnológica)? Cuales son sus prerequisites ? Ven la posibilidad de un mercado cercano para hidrógeno y pilas de combustible y cuales son las ventajas en comparación con tecnologías convencionales ?

## Contenido del cuestionario (2)

HYLIGHTS

- Pregunta 8:** Que barreras y oportunidades (tecnológicas, sociales, legales, políticas y financieras) ve Ustd para la introducción de la tecnología del hidrógeno ?
- Pregunta 9:** En el caso de que pretenda de participar en futuras demostraciones de proyectos de hidrógeno a gran escala en el sector de transporte, que soporte político y financiero estara disponible ? Que incentivos estan disponibles (o necesarios) para soportar el hidrógeno ? (p.e. legislación de la UE, programas nacionales, programas regionales, iniciativas locales, – producción del hidrógeno, estaciones de servicio e infraestructura, vehículos de hidrógeno)
- Pregunta 10:** Quien esta responsable para el desarrollo sostenible de tecnología ? (UE, gobiernos nacionales, gobiernos regionales, gobiernos municipales, industria, operadores/ clientes, otros)  
a) en su organización ?  
b) Si no esta en el ámbito de responsabilidad de su organización, sería una razón para no participar en un proyecto de demostración de hidrógeno/ pilas de combustible?
- Pregunta 11:** Si espera que hidrógeno estara un combustible importante del futuro, que debería realizarse antes que una introducción a gran escala estara posible ? (p.e. Recomendaciones para comercialización para industria y política). Sería necesario más desarrollo (tecnológico/social/comercialización), demostración o educación/formación?

## Contenido del cuestionario (3)

HYLIGHTS

- Pregunta 12:** Cual es su vista visionaria con respecto a un acceso limitado a centros urbanos? Que papel desempeña el hidrógeno ? (p.e. ya existen limitaciones al acceso al centro urbanos o están en planificación ? Con respecto a la introducción de estas limitaciones/ restricciones ya existen cooperaciones con otras ciudades, regiones, compañías o proyectos)
- Pregunta 13:** Algunos comentarios, problemas, reflexiones relacionadas a las preguntas anteriores ?
- Pregunta 14:** Usa su compañía algunos de los siguientes tipos de vehículos y cuantos de ellos:
- |            |                          |                                 |                                  |                                |
|------------|--------------------------|---------------------------------|----------------------------------|--------------------------------|
| Coche      | <input type="radio"/> No | <input type="radio"/> Si (1-10) | <input type="radio"/> Si (11-50) | <input type="radio"/> Si (>50) |
| Camionetas | <input type="radio"/> No | <input type="radio"/> Si (1-10) | <input type="radio"/> Si (11-50) | <input type="radio"/> Si (>50) |
| Autobús    | <input type="radio"/> No | <input type="radio"/> Si (1-10) | <input type="radio"/> Si (11-50) | <input type="radio"/> Si (>50) |
- Pregunta 15:** Piensa Ustd. que su compañía esta/ estaría interesada aplicar vehículos de hidrógeno en un mercado inicial ?
- Si: coches
  - Si: camionetas/ furgonetas
  - Si: autobuses
  - Si: escúteres (o semejantes)
  - Si: pequeñas vehículos de limpieza callejera (o semejantes)
  - Si: otros von 3 o 4 ruedas (z.B. Jardinería, policía, veh. municipales)
  - No: porqué no?

## Contenido del cuestionario (4)

HYLIGHTS

**Pregunta 16:** Dispone su compañía de estaciones de servicio propias para suministrar su propia flotilla de vehículos ?

**Pregunta 17:** Cual es su más importante (grande) flotilla en su organización ? Cuales son sus preriquisitos de prestación/ potencia minimos para estos vehículos (por favor llenar los espacios abajo):

	Indice de eficacia/ rendimiento	Unidad	Descripción
A	Velocidad máxima	km/h	Velocidad maxima del vehículo
B	Alcance	km/Tank	Kilómetros por tanque
C	Costos del vehículo	Euro o Euro/ mês	Costos aproximados del vehículo
D	Consumo de combustible	l/km y €/km	Consumo de combustible en l/km y €/km
E	Numero de pasajeros	#	Numero máximo de pasajeros
F	Carga	kg & m <sup>3</sup>	Carga permitida máxima en kg y en volumen
G	Costes anuales de mantenimiento	€/año	Costes promedio anuales de mantenimiento del vehículo
H	Velocidad de llenado/ Intercambio del cartucho	l/ minuto minutos	Tiempo promedio de llenado Tiempo promedio de intercambio

## Contenido del cuestionario (5)

HYLIGHTS

	Indice de eficacia/ rendimiento	Unidad	Descripción
I	Acceleración de autobús (0-60 km/h)	s	Acceleración promedio de 0 a 60 km/h
J	Acceleración de coche o camioneta (0-100km/h)	s	Acceleración promedio de 0 a 100 km/h
K	Disponibilidad	%	Cantidad de días afuera del servicio comparado con los días en servicio
L	Frecuencia de llenado	Nº/día	Cuántas veces se llena los vehículos ?
M	Lugar de suministro	Cantidad de lugares	En cuántos lugares se llena?
N	Recorrido promedio	Km/día	Cuántos km se viaja por día promedio?
O	Recorrido máximo	Km/día	Cuántos km se viaja por día en máximo ?
P	Distancia promedio	km de la oficina/ del sitio	Cuántos km des distancia viaja el vehiculo de la oficina/ del sitio promedio ?

## Contenido del cuestionario (6)

HYLIGHTS

	Indice de eficacia/ rendimiento	Unidad	Descripción
Q	Cuantos choferes conducen el vehículo ?	N° de conductors (approx.)	Esta asignado el vehículo a un solo conductor o esta para uso comun?
R	Utilización flexible	Descripción	Esta el vehículo (p.e. autobús) en uso por el mismo servicio/ la misma distancia/ el mismo trayecto diario, o debe que utilizarse flexiblemente?
S	Prerequisitos para el use en espacio interior		contaminantes sonido/ ruido limites en derrame de agua
T	Dimensión modular del cartucho y/o de pila de combustible	mm x mm x mm kg	Dimensión del empaque Peso del empaque [del cartucho y de la PdC]

## Contenido del cuestionario (7)

HYLIGHTS

**Pregunta 18:** Cual es la rendimiento minimo que Ustd. require para su infraestructura de suministro de combustible (por favor llenar los espacios abajo).

	Indice de eficacia/ rendimiento	Unidad	Descripción
A	Costes anuales de mantenimiento	Euro/año	Costes promedios para el mantenimeinto de le estación de llenado
B	Velocidad de llenado	litros / minuto	Tiempo promedio de llenado por vehículo
C	Costes del combustible	Euro / litre	Expone si estan incluidos los impuestos
D	Volumen de venta de combustible	litros de combustible líquido/ año Kg-H2/ año	
E	Disponibilidad	%	Cantidad de días la estación esta afuera del servicio comparado con los días en servicio
F	Cantidad de llenados consecutivos	#	Numero máximo de llenados consecutivos

## Contenido del cuestionario (8)

	Indice de eficacia/ rendimiento	Unidad	Descripción
G	Criterios/ limitaciones para ubicar una estación de servicio	-	p.e. no-/ integrado en una estación de servicio existente convencional, ubicado en una area industrial o residencial, requisitos especiales de construcción, limitaciones de area edificada, limitaciones con respecto a las horas permisibles de servicio, limitaciones con respecto al acceso de camiones de suministro de hidrógeno, posibilidad de auto-servicio, disponibilidad de un taller de servicio y venta de otros productos (shop)

**Pregunta 19:** En cuantas estaciones llena su vehículo y que es la distancia aproximada de la base de su vehículo ?

**Pregunta 20:** Con que frecuencia abastece su vehículo en estaciones que no estan en el terreno de su compañía o en las cercanías (dentro de 5 km de la base) ?

## Contacto

Para más informaciones con respecto a la encuesta, al cuestionario o en general al proyecto HyLights por favor dirijase a:

Ludwig-Bölkow-Systemtechnik GmbH  
Daimlerstrasse 15, 85521 Ottobrunn, Alemania  
Reinhold Wurster  
Tel.: +49 89 608110-33  
E-mail: [questionnaire@hylights.eu](mailto:questionnaire@hylights.eu)

Informaciones sobre el proyecto estan disponibles en: [www.hylights.eu](http://www.hylights.eu).

Información sobre actividades en el sector de hidrógeno en el sector de transporte en Europa puede obtener en [www.h2moves.eu](http://www.h2moves.eu).

# Asignación a regiones

No.	País	Ciudad/ Región	Tipo de aplicación	Responsable
1	GER	Hamburgo	coches, autobuses, otros	LBST
2	GER	Berlin	coches, autobuses	LBST
3	GER/NL	NRW/Arnhem	coches, autobuses	LBST
4	ES	Valencia/ Aragon/ Soria/ Madrid	coches, autobuses, otros	LBST
5	FR	Rhône-Alpes (Grenoble, Lyon)	coches, otros	LBST
6	NL	Amsterdam/Rotterdam	coches, autobuses, otros	ECN
7	IT	Piemonte/ Lombardia	coches, autobuses, otros	ECN
8	NO,SE,DK	Escandinavia	coches, autobuses	ECN
9	IS	Reikjavik	coches, autobuses, otros	ECN
10	UK	Londres	coches, autobuses, otros	ECN

Cantidad de entrevistas (aprox.): numero de lugares : 10,  
 Cantidad de entrevistas / lugar: 5-6, Gesamt: 50-60

# Matriz de aplicación/ usuario



tipos de uso/ usuarios potenciales	Coches	Camionetas	Autobuses	Otros vehículos
<b>Público</b>				
Flotilla	X	X	X	
Servicios internos	X	X		
Limpieza municipal		X		
Transporte público			X	X
Bomberos	X			X
Policia	X	X		X
Entrega de correo	X	X		X
...				
<b>Particular</b>				
Flotilla	X	X	X	
Entrega de correo	X	X		
Transporte público			X	X
Operador de taxis	X			
...				

**Con quien hablar?**

Es importante calificar diferentes fuentes de información obtenidas por medio de un contacto el cual las colecciona de varias direcciones

**Estrategia/ Desarrollo corporativo**  
 - Estrategia general, política

**Departamento de compras**  
 - decisión de compra

**Operador de flotilla/ Coordinador**  
 - Característica operacional diaria  
 - Característica técnica

# **HyLights Gaps Analysis**

## **Annex C**

### **Reference vehicle data**

## Key Performance Indicators (KPIs) - Input for the HyLights Gaps Analysis

### Passenger Cars - Segment B

Nr.	KPI name	Unit	Reference Vehicle I	Reference Vehicle II	Reference Vehicle III
	Vehicle type	-	<u>Peugeot 206 1.4 90 Tendance</u>	<u>Volkswagen Polo 1.4 Trendline</u>	<u>Ford Fiesta 1.4</u>
1	Maximum speed	km/h	178	172	166
2	Driving range	km/tank	769	692	703
3	Vehicle costs	€	11.806	10.546	9.915
4	Number of passengers	#	5	5	5
5	Payload	kg	425	557	425
6	Load (min)	l	245	270	268
7	Load (max)	l	1130	1030	945
8	Fuel consumption	l/100km*	6,5	6,5	6,4
9	Refuelling rate	kg H <sub>2</sub> / min			
10	Accelleration (0-100km/h)	s	12,2	12,9	13,2
11	Availability	%			
12	First presentation of vehicle	year	-	-	-

\* gasoline equivalent in case of H2 vehicles  
(1kg H2 => 3,73l gasoline)

## Key Performance Indicators (KPIs) - Input for the HyLights Gaps Analysis

### Passenger Cars - Segment C

Nr.	KPI name	Unit	Reference Vehicle I	Reference Vehicle II	Reference Vehicle III
	Vehicle type	-	Volkswagen Golf 1.6 FSI Trendline	Opel Astra 1.8	Ford Focus 1.6 Ti-VCT Trend
1	Maximum speed	km/h	192	198	190
2	Driving range	km/tank	859	675	859
3	Vehicle costs	€	14.978	14.714	14.873
4	Number of passengers	#	5	5	5
5	Payload	kg	411	482	420
6	Load (min)	l	347	350	350
7	Load (max)	l	1305	1300	1205
8	Fuel consumption	l/100km*	6,4	7,7	6,4
9	Refuelling rate	kg H <sub>2</sub> / min			
10	Acceleration (0-100km/h)	s	10,8	10,8	10,8
11	Availability	%			
12	First presentation of vehicle	year	-	-	2004

\* gasoline equivalent in case of H2 vehicles  
(1kg H<sub>2</sub> => 3,73l gasoline)

## Key Performance Indicators (KPIs) - Input for the HyLights Gaps Analysis

### Vans

Nr.	KPI name	Unit	Reference Vehicle I	Reference Vehicle II	Reference Vehicle III	Reference Vehicle IV
	Vehicle type	-	<u>Volkswagen Transporter 2,5l TDI</u>	<u>DaimlerChrysler Vito 120 CDI</u>	<u>Ford Transit 2.2l Duratorq TDCi</u>	<u>DaimlerChrysler Sprinter 311 CDI</u>
1	Maximum speed	km/h	188	198	-	145
2	Driving range	km/tank	952	815	1052	721
3	Vehicle costs	€	26.150	29.041	19.075	<u>29.190</u>
4	Number of passengers	#	2-3	2-3	2-3	3
5	Payload	kg	625-825	980	1143	1555
6	Load (min)	l	5800	4650	6300	7500
7	Load (max)	l	5800	4650	6300	7500
8	Fuel consumption	l/100km*	<u>8,4</u>	<u>9,2</u>	<u>7,6</u>	<u>10,4</u>
9	Refuelling rate	kg H <sub>2</sub> / min				
10	Acceleration (0-100km/h)	s	12,2	8,8	-	<u>24,8</u>
11	Availability	%				
12	First presentation of vehicle	year	-	-	-	-

\* Diesel equivalent in case of H2 vehicles  
(1kg H2 => 3,40l Diesel)

## Key Performance Indicators (KPIs) - Input for the HyLights Gaps Analysis

### Buses

Nr.	KPI name	Unit	Reference Vehicle
	Vehicle type		Daimler Citaro Diesel
1	Maximum speed	km/h	80
2	Driving range	km/tank	440
3	Vehicle costs	€	240000
4	Number of passengers	#	102
5	Payload	kg	empty:11.9 t/ loaded 19t
6	Load	m <sup>3</sup>	
7	Fuel consumption	l/100km*	45 <sup>***</sup>
8	Refuelling rate	kg H <sub>2</sub> / min	typically 90l/min
9	Acceleration (0-60km/h)	s	
10	Ambient temperature limits	°C	
11	Availability	%	>95%
12	First presentation of vehicle	year	

\* Diesel equivalent in case of H2 vehicles  
(1kg H2 => 3,40l Diesel)

\*\* real world data derived from CUTE project

\*\*\* 45-46l/100km is Euro IV data from EMT-Madrid and RVK Cologne

**HyLights Gaps Analysis**  
**Annex D**  
**Pro-Hydrogen Statement by a Rental Car Company**

<http://www.reuters.com/article/idUSL629330120080907>

Sixt CEO wants hydrogen fuel station subsidies

Sun Sep 7, 2008 6:07am EDT

FRANKFURT, Sept 7 (Reuters) - The chief executive of German car rental firm Sixt AG (SIXG.DE: Quote, Profile, Research, Stock Buzz) supported hydrogen-fuelled cars in a newspaper interview on Sunday and made a plea for state support to build up a network of filling stations.

"Politicians must finally bring themselves to throw their weight behind a certain technology (alluding to hydrogen cars) ... we need more financial support," he told the Sunday paper Frankfurter Allgemeine Sonntagszeitung.

Sixt said he believed the technology had more environmental merits than natural gas-fuelled cars, for which the network of filling stations was also too small, and superior to electric cars, whose range he said was too small for business travellers.

Hydrogen fuel technology is years from being launched at large scale in Europe, but the U.S. state of California is building a filling-station network and hopes to inspire other mass car markets such as India and China with its initiative.

Sixt, one of Germany's leading car rental firms, still saw two-thirds of its customers opting for big limousines as their employers paid fuel costs, he said.

"Change can only come with subsidies. You can also do it with tax relief," Sixt said.

Profits at his firm would suffer in this year's economic downturn, he said, which would be the trigger for a greater focus on overseas markets including Australia.

Sixt has said its pretax profits this year will fall to between 115 and 125 million euros (\$178.8 million) from 137 million in 2007. (Reporting by Vera Eckert; Editing by Quentin Bryar)

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07.09.2008   Sixt glaubt nicht an Elektroautos

BERLIN, 7. September (Reuters). Der Chef von Deutschlands größtem Autovermieter Sixt, Erich Sixt, fordert Subventionen für den Aufbau eines deutschen Wasserstoff-Tankstellen-Netzes. Sixt sagte der Frankfurter Allgemeinen Sonntagszeitung ...

F.A.Z. vom 08.09.2008