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Hydrogen and Fuel Cell Applications in Hamburg: A Policy Perspective

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Abstract

Hydrogen and fuel cell applications are believed to have a significant impact on energy systems in the mid to long term. However, energy systems transform very slowly and many competing options as the use of bio fuels on the one side and electric propulsion and fuel cell applications powered by renewable energy on the other side are feasible and create a difficult environment for decision makers. As many of the current developments within the hydrogen and fuel cell industry are still in an experimental stadium political support and dedication is needed to realize the long awaited market readiness of the promising technology. In this paper projects that have been started in Hamburg, the positive political dedication as well as the reasons why the City of Hamburg is dedicated to clean transport will be presented.

Keywords: Hydrogen, Projects, Hamburg, Political support

1 Introduction

It has been stated [1; 731] that the transition to a Hydrogen Economy could solve many of our present problems associated with the modern use of energy from fossil fuels. For one part the dependence on fossil fuels originating from political unstable regions could significantly be lowered, if hydrogen was introduced as an energy vector and production sources were derived from renewable energy sources as wind or solar [2; 511]. For the other part the development of a new energy system based on hydrogen could potentially alter the decay of environmental systems due to the massive release of CO_2-emissions from burning finite resources [3; 4]. Although all the specifics named above have been internalized into the consideration of political decision makers already the transition to a Hydrogen Economy still takes far longer than expected. Besides technical barriers, the needed expertise, associated costs for the development of the technology and the process of industrial clustering in regions, political dedication seems to be one of the underestimated key factors being necessary for the long awaited establishment of the Hydrogen Economy. In the following the specific political framework of Hamburg regarding actions countering climate change will be investigated before taking a closer look at the German National Innovation Program and the hydrogen and fuel cell projects underway. The climate protection program is a substantial base for the creation of hydrogen and fuel cell projects in Hamburg, hence it is investigated in the following.

2 Climate Protection in Hamburg

In 2007 the City of Hamburg initiated a major program to tackle the problem of climate

Change [4; 5]. Taking the findings of the fourth Intergovernmental Panel on Climate Change Report (IPPC) very serious the City of Hamburg investigated the impact and potential for action in the region. As climate warming and its associated problems is a very complex and diverse, it has been acknowledged that mitigation of CO_2-emissions in Hamburg can only be a first action and motivation for other regions to join in. Hereby the strategy consists of three different pillars.

- Understanding the processes of Climate Change
- Mitigating the outcomes of Climate Change
- Cope with the outcomes of Climate Change

The city has grown significantly within the last 20 years. While in 1990 Hamburg counted 1.65 mill. inhabitant in 2004, this number has grown already to 1.73 mill. At the same time per capita values for CO_2-emissions have fallen by 12,5%, from 12,35 tones in 1990 to 10,8 tones in 2004 [4; 8].

Despite the progress achieved so far scientific evidences, as the Stern Report point out the need for further action. Therefore per capita emissions are intended to be decreased to 9,29 tones, respectively by 24,9 % by 2012 and up to 40% until 2020. Accomplishing this target is very ambitious and can only be met, if all sources of CO_2-emissions are taken into consideration for action. Table 1 gives a detailed description of the CO_2-record of the City and its future plans for the targeted substantial decrease in CO_2-emission overall and measured in changes per capita in 2004. One significant source for lowering CO_2-emissions consists in the introduction of new environmentally friendly and innovative drive train systems for urban transportation and traffic. About 100.000 tons of CO_2-emissions shall be mitigated by this approach, equaling ca. 5% of the overall target for emission avoidance.

Although hydrogen and fuel cell application as well as electric vehicles only play a minor role so far their potential for savings of CO_2-emissions is far greater. In 2004 of the 18.4 mill. tons of CO_2- emissions, 4,7 mill. tons were caused by urban traffic in Hamburg, equaling around 25% of overall emissions [4; 14]. Considering that hydrogen and fuel cell applications can also be used in other areas, e. g. ships or stationary power generation (CHP), part of CO_2-emissions associated to other branches apart from traffic, like industrial services,

Table 1: Mitigation scenarios for CO2-emissions in Hamburg 1990-2012 [4; p.8]

Year	Inhabitants of Hamburg	CO2-emissions in Hamburg**	Total change since 1990	Change in % since 1990	Per capita emissions of CO_2	Change in % since 1990
1990	1.653 mill.	20,4 mill. tons			12,35 tons	
2004	1.731 mill.	18,7 mill. tons	-1,7 mill. tons	-8,3 %	10,8 tons	-12,5 %
2005-2007	not considered yet as statistical data needs to be validated and processed first					
-2008	Climate Change Concept = -2.0 mill. tons					
2012	1,796 mill.*	16,7 mill. tons	-3,7 mill. tons	-18,1 %	9,29 tons	-24,7 %

*Extrapolation based on values by the statistical agency of Hamburg /Schleswig Holstein

**According to concept of polluter record

trading and others could well be lowered substantially by applying innovative fuel cell technology. Keeping in mind that the technology is due to its small production numbers and associated diseconomies of scale today still more expensive and partly immature compared to its technological rivals, as the combustion engine, promotional funding programs are necessary. Therefore the City of Hamburg has undertaken major efforts to promote fuel cell and hydrogen applications through own funds, funds of EU programs, as well as through the newly developed National Innovation Program (NIP) of the German Government. In the following due to its significance for the development of projects a short overview on the NIP will be followed by an introduction to the major project undertaken in Hamburg so far.

3 Hamburg and its efforts in the National Innovation Program

As in Hamburg many regions and governmental bodies as the Federal Ministry of Transport, Building and Urban Affairs of Germany have recognized the need for special funding programs aiming to support developments in new technology branches as hydrogen and fuel cells.

As a result of this a program offering a total of up to 500 mill. € in financial support for the development and demonstration of new hydrogen and fuel cell projects has been initiated. The program runs over a period of ten years up to 2017. Much like the Joint Technology Initiative (JTI) of the European Union the approach taken by the German Government seeks to bring together partners within the industry to start up light house projects and to make use of already existing synergies within the industry.

Hamburg as a very prominent side for the demonstration of hydrogen and fuel cell application has already recognized the potential of the program and its impact on funding opportunities for projects. After all it is the aim of the City of Hamburg to cluster stakeholders of the hydrogen and fuel cells technology branch within the region and to attract associated manufactures, subcontractors and equipment suppliers. Therefore many projects are about to being launched or in preparation. In order to receive financial support for a joint project a process with multiple checks has to be passed.

In the first stage a project draft has to be prepared and presented at the National Organization Wasserstoff (NOW). The objective of NOW is to verify the feasibility of a project draft. NOW is a public-private partnership evaluating projects as an intermediate coordination center on behalf of the German Government. Until March of 2009 NOW has of the actual state of applications, 107 project drafts [5: 4] originating from 131 ideas for projects. The advantages of the chosen approach are as follows:

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Enhanced project coordination between responsible ministries, project institutions, industry, research institutes, federal states and local initiatives

- Transparent evaluation process

- Enhanced synchronization between demonstration programs

So far 48 project drafts have passed the first stage and have been selected for detailed review at the second stage. Among these chosen drafts are also projects intended to be placed in Hamburg. The second stage includes a detailed financial evaluation by the Projektträger Jülich (PTJ). It is an in-depth analysis ensuring the financial feasibility of project drafts. This is very important as projects often run the risk of failing the budget restriction, which in the worst case can lead to the termination of projects. Only after passing this high hurdle projects may receive financial support. Can companies by them selves take part in the program described above? Yes, they absolutely can, but the experiences gathered in Hamburg definitely show that a consolidated approach taken by more than just one company, e.g. an industrial grouping, actively guided and moderated by an independent project management, as hySOLUTIONS, are more likely to be successful when applying for financial programs. The following section will take a closer look at hydrogen and fuel cell projects placed in Hamburg.

Table 2: Overview of projects in place in Hamburg

	Timeframe	Details
Buses	2006-2008	Fleet test with 1st generation of Fuel Cell buses within HyFLEET:CUTE
	2010-2015	Intended procurement of 20 Hybrid-FC buses of 2nd generation
	2015-2020	Continuous introduction of 10 to 15 Hybrid-FC buses per year
	2010-2015	Midibus for the University Hospital of Eppendorf
Fuel Cell cars	2007-2009	3 cars in use
	2009-2013	Up to 20 cars in use
	2013-2015	Up to 50 cars in use
	2015-2020	Up to 1.000 cars in small scale commercialization
Early markets	2006-2009	2 fork lifters and one pallet truck
	2009-2014	10 industrial trucks in application
	2015-2020	15 industrial trucks in application
Ship and Maritime	2006-2010	Zemships project
	2009-2015	e4ships - fuel cell technology for seagoing ships
Aviation	2009-2015	Fuel cell lab – Development of fuel cell components for aviation sector

4 Hydrogen and Fuel Cell projects in Hamburg

The City of Hamburg shares a long tradition in the demonstration of hydrogen and fuel cell projects. Most prominent has been the participation of the largest local provider for puplic transportation HOCHBAHN in the CUTE project in 2003. The project has been the largest demonstration undertaking of its kind, testing 27 fuel cell buses in nine destinations across Europe. CUTE is just one example for the initiation of successful trial projects in Hamburg. Other major projects will be briefly be presented in the following

4.1 HyFLEET:CUTE

Following the successful [6; 39] project of CUTE an extension project for the demonstration of hydrogen and fuel cell buses has started in 2006, the EU co-funded HyFLEET:CUTE project. Some of the cities involved in the CUTE project dropped out of the undertaking of testing hydrogen buses after the end of CUTE. As a result of this development demonstration-fuel cell buses originally operating in Stuttgart and Stockholm were transferred to Hamburg expanding the fleet in Hamburg up to nine vehicles until the summer of 2008. Today six buses are still in operation and will remain so until the summer of 2010. In the meantime the introduction of the newest hybridized fuel-cell vehicle generation of EvoBus is in preparation, supposedly entering service in late 2010.

Again this continuous progress is evidence to the clear commitment by the City of Hamburg to become a strategic cluster region for hydrogen and fuel cell applications. As fuel cell buses are believed to belong to the first economic viable applications within the

technology this has important implications for the development of the technology for other industrial branches as well. As it can be recognized in Table 2 early market applications and fuel cell buses are very important technological demonstrators to attract further investment in the industry. But not only buses and fork lifts could play a crucial role. Maritime applications do offer economic potential as well.

4.2 Project Zemships and e4ships

So far only land based hydrogen and fuel cell applications have been considered. Another promising area though lays according to many experts within the maritime industry. Again Hamburg is a very suitable place for the demonstration of maritime applications.

Project Zemships, which stands for Zero Emission Ships, has therefore been a first approach to introduce the hydrogen and fuel cell technology to water based vehicles. The Fuel Cell Ship "Alsterwasser" is operating in Hamburg since August of 2008 and will continue to do so until April of 2010.It is a project supported by the EU-Life program. Nine partners are involved. Up to 100 passengers are able to travel aboard the PEM-based ship.

In regard to larger ships using fuel cell technology for the generation of onboard power and subsequently replacing the Auxiliary Power Unit of larger seagoing vessels by Molten Carbonated fuel cells the project of e4ships has been launched. It is a demonstration project aiming to show the feasibility of the described changes within the configuration of the power management for seagoing ships and cruise ships until 2015.Hereby synergies between e4ships and other projects in Hamburg are expected to take place.

4.3 Clean City Cars

So far projects presented have targeted the market for buses and also ship applications but the automobile mass market has been neglected. With the Clean City Cars project this is intended to be changed. Until 2015 a partnership between the City of Hamburg, Daimler, Shell, Total and Vattenfall evaluates the feasibility to test up to 1.000 Daimler hybridized fuel cell cars and to install the needed infrastructure, namely up to four hydrogen filling stations. The project will be part of the Clean Energy Partnership (CEP), which is placed in Berlin and Hamburg, and is intended to receive financial support by the NIP. If the project objectives can be met many other hydrogen and fuel cell applications in Hamburg are believed to benefit from the installation of the needed hydrogen infrastructure as well, potentially lowering the costs for hydrogen significantly.

All partners of the Clean City Cars project from the industry only considered Hamburg as a possible site for the intended site test because previous experiences in Hamburg in regard to the processing of hydrogen and fuel cell projects have been very satisfactory.

Many other projects could be named at this point but only a few very prominent examples have been selected on purpose to demonstrate how a political framework and dedication to the development of new technology fields as hydrogen and fuel cell can lead to the establishment of large projects and consequently to close cooperation.

4.4 Fuel Cell Lab

Hamburg being world wide the third largest manufacturing side for the aviation industry has also started a project to develop fuel cell applications for the aviation industry. The Fuel Cell Lab which is placed at the Airbus site will conduct scientific experiments and develop fuel cell solutions for the very sensible aviation industry.

Introducing fuel cell technology into civil aviation can enhance the ecological footprint of the industry significantly and save operating costs for airlines. Besides large synergies concerning the economics of scales are expected to take place between the car, aviation and shipbuilding industry. In this regard Hamburg has a unique position being involved in all the three industries.

5 Conclusion

This paper investigated the political framework set up in Hamburg preparing the ground for large hydrogen and fuel cell projects. Furthermore the National Innovation Program (NIP) of the Federal Ministry of Transport, Building and Urban Affairs of Germany has been taken into close consideration in addition to funds offered by EU programs or funds provided by the City of Hamburg, as these are very important source of financial support for the installation of new projects.

The projects considered in this paper all do have a significant size and prepare the ground for further developments of activities within the hydrogen and fuel cell industry in Hamburg. The Clean City Cars project is evidence of it as some of the partners like Daimler or Vattenfall have been involved in projects in Hamburg before.

6 References

[1] Brockris, J.O'M. *The origin of ideas on a Hydrogen Economy and its solution to the decay of the environment,* International Journal of Hydrogen Energy, 27 (2002),731-740.

[2] Midilli, A. and Dincer, I. *Key strategies of hydrogen energy systems for sustainability,* International Journal of Hydrogen Energy, 32 (2007), 511-524.

[3] UNEP. *The Hydrogen Economy, A non-technical review* (2006).

[4] Bürgerschaft der Freien und Hansestadt Hamburg. *Hamburger Klimaschutzkonzept 2007-2012*.Drucksache 18/6803. 21.08.07.

[5] NOW GmbH. *Das Nationale Innovationsprogramm Wasserstoff und Brennstoffzellentechnologie – Statistik. Stand März 2009.*

[6] U.S. Department of Transport. *A Report on Worldwide Hydrogen Bus Demonstrations, 2002-2007,* Report No. FTA-GA-04-7001-2009.01,http://www.fta.dot.gov/research, accessed on 2009-03-05.