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Analysis of the legal framework for a hydrogen infrastructure in the United Kingdom.

A report on an internship project at BMW Group, Traffic and Environment

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Abstract

This study concerns the legal framework for a hydrogen infrastructure on road traffic in the UK. The laws of first order are called Acts, the executing ones of second order are called Regulations. The discussed Regulations are not in force for the whole United Kingdom but primarily for England in the majority of cases. The scope results from the title or the first paragraph or section of the particular analysed Regulations. Mainly these are based on EU-Directives which are implemented to national Regulations. As far as possible the UK abode by the Directives.

The work builds upon the study “En route to a hydrogen infrastructure for road traffic - A study into the legal framework created by legislation in the European Union and in Germany”¹. The five sections along the total hydrogen process chain were systematically screened in regard of all relevant Regulations. New developments since 2005 are listed in Chapter 1.

The production of hydrogen in the UK is possible by the legal side. Like in Germany a permission of the authorities for handling dangerous substances is required. An environmental impact assessment is mandatory for facilities as of a specific plant size and a storage quantity given by the European Union. Consent by the authorities for hydrogen on a plant is necessary for 2 tons or above. The quantity thresholds and obligations of the SEVESO-II-Directive were transferred essentially - as in Germany by the 12.BImSchV.

The Directive for the avoidance and reduction of environmental pollutions was implemented, too. The difference to Germany consists of the fact that the unclear definition „industrial plant“ was replaced by „materials for commercial purposes“, which offers more reliability for the dimensioning of production plants. Further Directives have been implemented essentially. Safety regulations are on European standard and correspond to the logical understanding for protection against hazards. A VAT-Exemption for hydrogen as fuel is not given.

The ADR/RID Directives were transferred also to Great Britain and extended partially. The structure changed regarding the chapter numbers. Tunnel Regulations adapted to the European Union are introduced 2007, which prescribe security concepts for tunnels in the European road system starting from a length of 500m. Hydrogen vehicles and the transport of hydrogen are forbidden in the Euro-Tunnel. The taxes for transport vehicles in Great Britain are above the European average. Tolls all over the country do not exist. „Fees“ are raised over the duty for diesel, which is a disadvantage compared to Europe.

Building permits for new constructions and changes of gas stations turn out to be difficult, since the planning and building Regulations are very complicated. Some mean, in order to really understand this, permission should be requested (to see what happens). Regulations for dangerous substances such as hydrogen are the same in the building and planning regulations for gas stations as for industrial plants. The quantity threshold must be considered as well. Health and safety at work is implemented like in the European framework.

Different possibilities are discussed for hydrogen filling stations. Mobile trailers or decentralised hydrogen producing filling stations are to be considered. The fact that for small „gas stations“ fewer regulations and permissions are to be considered is obvious. There is a funding of 30% for hydrogen filling stations and a separate 100% first year allowances until March 2008. According to British understanding hydrogen is to be defined as a „road fuel gas“, whereby a taxation as fuel becomes possible and the motor vehicle tax depends on the CO₂-emission of the vehicle. Otherwise a taxation would be to be made according to the engine size, which would constitute 30% of the purchase price of a vehicle with an engine of 2 litres or above. Likewise a self-obligation of Great Britain to promote fuel from renewable energies was introduced with quantity specifications.

The EC type approval for vehicles was adopted as it stands. Because of the manufacturers of small series of vehicles, spread in Great Britain, also permission by a Minister's Approval Certificate is possible for such small series. Product-liability and -security were revised and adapted to the European Directives. Health and safety at work naturally concern also the production of the vehicles, as well as the safety regulations for handling hydrogen by vehicle manufacturers.

The possibility of the first year allowances concerns also hydrogen vehicles. The taxation depends on the CO₂-emission. Privileges are available for low-pollution vehicles. A changed vehicle class comes into force 2008 with 10% reduction. Hydrogen vehicles and electric vehicles are excluded from the London Congestion Charge. Electric vehicles have special park permission on proven surfaces in London; they are free or reduced of charge. Possibly also hydrogen vehicles receive such an exception.

In the last chapter regulations are listed, which have only relevance for hydrogen at first sight. Political goals like the Energy White Paper 2003 are explained else. The CUTE project in London which was successfully accomplished and resumed as Hyfleet:CUTE project is described at last.

Kurzfassung

Diese Arbeit beschäftigt sich mit den rechtlichen Rahmenbedingungen zur Einführung einer Wasserstoffinfrastruktur im Straßenverkehr in Großbritannien. Die Gesetze der ersten Ordnung sind „Acts“, die ausführenden Gesetze zweiter Ordnung die „Regulations“. Die behandelten „Regulations“ betreffen nicht das gesamte Vereinigte Königreich, sondern in erster Linie England. Manche Gesetze sind auch für Wales, manche für ganz Großbritannien gültig. Dies ergibt sich aus dem Titel oder dem ersten Paragraphen des jeweiligen Gesetzes. Die behandelten Vorschriften basieren hauptsächlich auf EU-Richtlinien, welche in nationales Recht umgesetzt wurden. Dabei wurde sich weitestgehend an die EU-Richtlinien gehalten.

Der in der Studie „Auf dem Weg zu einer Wasserstoffinfrastruktur im Straßenverkehr“² vorgegebene Aufbau wurde weitestgehend übernommen, um so einen direkten Vergleich herzustellen. Neuere Entwicklungen in der „Wasserstoff-Welt“ seit Abschluss dieser Studie im Jahr 2005 sind im Kapitel 1 aufgeführt.

Der Produktion von Wasserstoff in England stehen keine Vorschriften im Wege. Wie auch in Deutschland bedarf es einer Genehmigung der Behörden für den Umgang mit gefährlichen Stoffen. Ab einer durch die EU vorgegebenen Anlagengröße und Menge in der Lagerung muss eine Umweltverträglichkeitsprüfung vorgenommen werden. Einer Genehmigungsbedürftigkeit für Wasserstoff auf einem Gelände bedarf es schon ab 2 Tonnen. Die Mengenschwellen und Pflichten der SEVESO-II-Richtlinie wurden - wie in Deutschland durch die 12.BImSchV - in wesentlichen Elementen und Mengenschwellen übernommen.

Ebenfalls umgesetzt wurde die Richtlinie zur Vermeidung und Verminderung von Umweltverschmutzungen. Der Unterschied zu Deutschland besteht darin, dass die unklare Definition „industrielle Anlage“ nicht vorkommt, sondern durch „Stoffe zu kommerziellen Zwecken“ ersetzt wurde, was mehr Sicherheit bei der Auslegung von produzierenden Anlagen bietet. Weitere Richtlinien wurden im Wesentlichen übernommen. Sicherheitsvorschriften sind auf europäischem Standard und entsprechen dem logischen Verständnis für Gefahrenschutz. Eine Befreiung der Mehrwertsteuer für Wasserstoff als Treibstoff ist nicht gegeben.

Die ADR/RID Richtlinien sind auch in Großbritannien übernommen und zum Teil erweitert worden. Der Aufbau hat sich in Bezug auf die Kapitelnummern geändert. Ein an die EU angeglichenes Tunnelgesetz wird 2007 eingeführt, welches Sicherheitskonzepte für Tunnel ab 500m Länge im europäischen Straßennetz vorschreibt. Im Eurotunnel sind Wasserstofffahrzeuge und der Transport von Wasserstoff verboten. Die Abgaben für Transportfahrzeuge liegen in Großbritannien über dem europäischen Durchschnitt. Flächendeckende Mautgebühren sind nicht vorhanden. „Gebühren“ werden über die Dieselsteuer erhoben, was gegenüber Europa nachteilig ist.

Baugenehmigungen bei Neuerrichtungen und Änderungen von Tankstellen gestalten sich als schwierig, da das Planungsrecht bzw. Baurecht nicht einfach strukturiert ist. Es heißt, um dieses wirklich zu verstehen, sollte man eine Genehmigung beantragen (und sehen was passiert). Regelungen für gefährliche Stoffe wie Wasserstoff sind im Baurecht für Tankstellen wie für industrielle Anlagen gleich. Auch die Mengenschwelle muss beachtet werden. Arbeits- und Gesundheitsschutz ist im europäischen Rahmen implementiert.

Für Wasserstofftankstellen sind verschiedene Möglichkeiten erörtert. Dabei sind mobile Anhänger oder dezentrale Wasserstoff selbst produzierende Tankstellen in Erwägung zu ziehen. Dass für kleine „Tankstellen“ weniger Vorschriften und Genehmigungen zu beachten sind, liegt auf der Hand. Für Wasserstofftankstellen gibt es bis März 2008 Zuschüsse von 30% und eine (Sonder-) Abschreibung für das erste Jahr. Wasserstoff ist nach britischer Ansicht unter „road fuel gas“ zu definieren, wodurch eine Besteuerung als Treibstoff möglich wird und die Kraftfahrzeugsteuer sich nach der CO₂ Emission des Fahrzeuges richtet. Andernfalls wäre eine Besteuerung nach der Motorgröße vorzunehmen, was ab 2 Litern Motorvolumen 30% des Kaufpreises ausmachen würde. Eine Eigenverpflichtung des EU-Mitgliedstaates Großbritannien, Kraftstoff aus erneuerbaren Energien zu fördern, wurde mit Mengenangaben ebenfalls eingeführt.

Die EG-Typengenehmigung für Fahrzeuge wurde übernommen. Wegen in Großbritannien verbreiteten Kleinserien von Fahrzeugherstellern sind auch Genehmigungen durch das Ministerium für solche Kleinserien möglich. Produkthaftung und -sicherheit wurden überarbeitet und dem

² Schwab, Roland: En route to a hydrogen infrastructure for road traffic – A study into the legal framework created by legislation in the European Union and in Germany, Institute for Mobility Research (ifmo) Berlin, 2006

europäischen Recht angeglichen. Arbeits- und Gesundheitsvorschriften betreffen selbstverständlich auch die Produktion der Fahrzeuge, sowie die Sicherheitsvorschriften für den Umgang mit Wasserstoff bei den Fahrzeugherstellern.

Die Möglichkeit der Erstjahres-Abschreibung betrifft auch Wasserstofffahrzeuge. Die Besteuerung richtet sich nach der CO₂ Emission. Vergünstigungen sind für schadstoffarme Fahrzeuge erhältlich. Eine geänderte Klasse tritt 2008 in Kraft mit 10% Ermäßigung. Wasserstofffahrzeuge und Elektrofahrzeuge sind von der London-Maut (Congestion Charge) ausgenommen. Elektrofahrzeuge haben eine besondere Parkerlaubnis auf ausgewiesenen Flächen in London; sie sind gebührenfrei oder -ermäßigt. Möglicherweise erhalten auch Wasserstofffahrzeuge eine solche Ausnahme.

Im letzten Kapitel werden noch Vorschriften aufgelistet, die nur auf den ersten Blick eine Relevanz für Wasserstoff haben. Politische Ziele wie das Energy White Paper 2003 werden ebenfalls erklärt. Dann wird noch das in London erfolgreich durchgeführte CUTE Projekt, das als Hyfleet:CUTE Projekt weitergeführt wurde, beschrieben.

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List of abbreviations

ACOP	Approved Code Of Practice
ATEX 137	ATEX=Atmosphère Explosibles; Workplace Directive on minimum requirements for improving the health and safety protection of workers potentially at risk from explosive atmospheres.
ATEX 95	ATEX=Atmosphère Explosibles; Equipment Directive Council Directive 94/9/EC on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres
CCL	Climate Change Levy
CCL 2005	Climate Change Levy (Fuel Use and Recycling Processes) Regulations 2005
ccm	cubic centimetres
CGH2	Compressed Gaseous Hydrogen
CHIP	Chemicals (Hazard Information and Packaging for Supply) Regulations 2002
CNG	Compressed Natural Gas
COMAH	Control of Major Accident Hazards
COSHH	Control of Substances Hazardous to Health Regulations 2002
CUTE	Clean Urban Transport for Europe
CVP	Cleaner Vehicles Programme
DCLG	The Department for Communities and Local Government
DfT	Department for Transport
Directive	Council Directive of the European Parliament and of the Council
DSEAR 2002	The Dangerous Substances and Explosive Atmospheres Regulations 2002
DTI	Department of Trade and Industry
DTLR	Department for Transport, Local Government and the Regions
DVLA	Driver and Vehicle Licensing Agency
EIA 1999	The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999
EMC	electromagnetic compatibility
EPA	Environmental Protection Act
EPS	The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996
EST	Energy Saving Trust
F+	extremely flammable
GDPO	general development procedure order
GPDO	Town and Country Planning (General Permitted Development) Order 1995
GRPE	Working Party of the UNECE on Pollution and Energy
HELA	effective liason between HSE and local authorities (LA)
HGV	Heavy Goods Vehicles
HMRC	HM (Her Majesty's) Revenue & Customs
HODA	Hydrocarbon Oil Duties Act 1979
HSA	Hazardous Substances Authority
HSC	Health and Safety Commission
HSE	Health and Safety Executive
ICI	Imperial Chemical Industries
ITEPA	Income Tax (Earnings and Pensions) Act 2003
LACs	Local Authority Circulars
LDF	Local Development Framework

LHP	London Hydrogen Partnership
LNG	Liquified Natural Gas
LPG	Liquified Petroleum Gas
PED	Pressurised Equipment Directive
PETEL	Petroleum Enforcement Liaison circulars
PPC	Pollution Prevention and Control (England and Wales) Regulations 2000
PPG	Planning policy guidance notes
PPS	Planning Policy Statements
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
ROC	Renewable Obligation Certificates Issued
RTFO	Renewable Transport Fuel Obligation
s. / ss.	section(s) / sub-section
Schwab Study	Dr. Roland Schwab, En route to a hydrogen infrastructure - A study into the legal framework created by legislation in the European Union and in Germany, 2006
SCR	selective catalytic reduction
SEA	strategic environmental assessment
SEVESO II	96/82/EC - on the control of major-accident hazards involving dangerous substances
SI	Statutory Instrument (year/number)
VED	Vehicle excise duty
VERA	Vehicle Excise and Registration Act 1994

1. General information and current activities

1.1 Introduction

This study supports the projects with the aim of establishing hydrogen within the fuel market in the United Kingdom (UK). It is hoped that this study will aide legislators and authorities to see hydrogen as an excellent opportunity and that this study will be handled with due care. The Regulations relating to hydrogen should remain strictly based on its physical properties. Therefore a comparison with LPG and CNG were avoided as far as possible. The interpretation of hydrogen related Regulations should not be over cautious, but seen with efforts to ensure maximum safety. The safety problems are mostly related to its specific properties (see Appendix 1), as e.g. the danger of explosion.

This study builds upon a study conducted by Dr. Roland Schwab at the Institute of Mobility Research (ifmo). Dr. Schwab is the author of the study “En route to a hydrogen infrastructure for road traffic - A study into the legal framework created by legislation in the European Union and in Germany.” The elaborations of the „Schwab study“ concerning the European Legislation have been reflected in the content of this study. The five sections along the total hydrogen process chain were systematically screened in regard of all relevant Regulations.

As a Member of the EU the UK implements the Council Directives of the European Parliament and of the Council in the Acts and Regulations. Like in Germany the UK law is strictly guided by EU law. Many Annexes of the Directives are transferred unmodified in the Schedules of the respective Regulations. The study was made for England and where possible for London. The Regulations named are these which relate to England. If the Regulation is for solely England, Wales, Scotland, North Ireland or for the whole of the UK it is stated within the name of the Regulation or in s.1. Wales is mostly concurrent with England whereas Scotland has its own Regulations, especially its own planning law. As far as possible the German legislation was looked in comparison.

The case law has no effect in this matter. There was no case raised concerning a hydrogen infrastructure until now as far as it is possible to overview the civil cases of the common law (case law). In future the EU and national legislation will act especially for hydrogen as a fuel road traffic.

When the local authority refused consent or granted it subject to conditions, then the applicant may appeal under the provisions of a Section³ of the relevant Regulation.

1.2 Worldwide

1.2.1 International Partnership of Hydrogen Economy (IPHE)

The IPHE⁴ was established in 2003 as an international institution to accelerate the transition to a hydrogen economy. 16 countries and the EU are members of the IPHE. By creating the IPHE, the Partners have committed to accelerate the development of hydrogen and fuel cell technologies to improve their energy security, environmental security and economic security. IPHE endorses 10 projects to advance hydrogen transition. The efforts on hydrogen and fuel cell research, development and demonstration projects have the potential to significantly advance the move towards a hydrogen economy. These projects cover a broad range of topics, including fuel cells development, hydrogen safety, the use of natural gas as catalyst, and hydrogen production using solar energy.

Among them is HySafe⁵. HySafe focuses on safety issues relevant to improve and to co-ordinate the knowledge and understanding of hydrogen safety and supports the safe and efficient introduction and commercialisation of hydrogen as an energy carrier of the future, including the related hydrogen applications. To this end the project will prepare the foundation of the European Hydrogen Safety Centre.

³ For simplification sections and paragraphs are named section in this study.

⁴ <http://www.iphe.net>

⁵ <http://www.hysafe.org>

1.2.2 ISO Standards

ISO Standards are from a NGO, an international standard-setting body composed of representatives from national standard setting bodies. They provide world-wide industrial and commercial standards. The relevant ISO standards for hydrogen are listed below.

Table 1: List of ISO/TC 197 Standards

International standards published or under development		
Liquid Hydrogen	ISO 13984	Vehicle Fueling System Interface
	ISO/CD 13985	Land Vehicle Fuel Tanks
	ISO/WD 13986	Tank Containers for Multimodal Transportation of Liquid Hydrogen
Hydrogen Fuel	ISO 14687 (2001)	Product Specification
Gaseous Hydrogen	ISO/WD 15866	Blends and Hydrogen Fuel – Service Stations
	ISO/AWI 17268	Land Vehicle Fueling Connectors
	ISO/WD 15594	Airport Hydrogen Fueling Facility
Gaseous Hydrogen and Hydrogen Blends	ISO/WD 15869	Land Vehicle Fuel Tanks
	ISO 11439	High-Pressure Tanks
	ISO/WD 15916	Basic Requirements for the Safety of Hydrogen Systems Safety
Safety	ISO 6469	Electric road vehicles – Safety specifications

1.3 U.S. activities

The U.S. Government is highly involved in the hydrogen and fuel cells research. The U.S. Department of Energy runs an Infrastructure Technologies Program for hydrogen and fuel cells⁶. This Program is well developed and covers all main parts for the hydrogen infrastructure in the USA. Another important website⁷ for the fuel cells and hydrogen infrastructure helps to assist the worldwide community working to develop and interpret fuel cell codes and standards. President Bush, State of the Union Address, January 28, 2003, created a Hydrogen Fuel Initiative. This initiative is outlined at Hydrogen.gov⁸ which is the Federal government's central source of information on R&D activities related to hydrogen and fuel cells. The transition to a hydrogen-based energy system, shown in Figure 1, will require strong public-private partnerships.

⁶ <http://www1.eere.energy.gov/hydrogenandfuelcells/>

⁷ <http://www.fuelcellstandards.com/>

⁸ <http://www.hydrogen.gov>

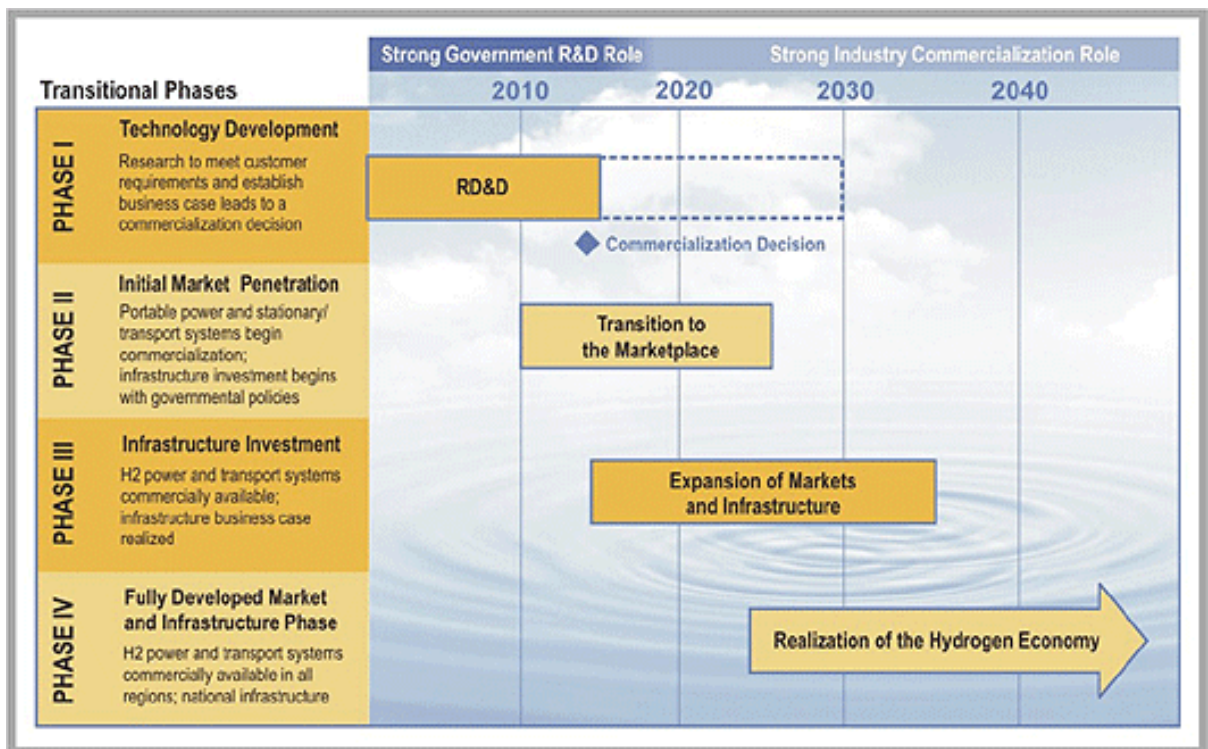


Figure 1: Realizing the hydrogen economy by the Hydrogen Fuel Initiative, 2003

1.4 European Commission activities

1.4.1 Proposal for Directive on the approval of hydrogen vehicles

On 13 July 2006 the European Commission services with the sole view of consulting stakeholders have produced a preliminary draft proposal for a Regulation of the European Parliament and of the Council relating to the type-approval of hydrogen powered motor vehicles⁹. The objective of the draft is to lay down harmonised testing requirements for the type-approval of hydrogen powered vehicles.

The proposal for the Directive on the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles was adopted by the Commission 2004. The first stage of the recasting, which consisted of the codification of the technical annexes, was achieved by the adoption of Directive 2001/116/EC. The second stage consists of the recasting of the enacting part of the Directive. The UK discussed about the implementation of this Directive in the initial regulatory impact assessment¹⁰. Two broad options are possible. Option A is to adapt the proposal as drafted. Option B is to change the limits for small series and to permit the British Single Vehicle Approval scheme.

The Commission takes the view that the new Directive it is proposing will provide all partners – be they manufacturers, Member States, candidate countries, approval authorities or technical services – with better legibility of the administrative provisions and regulations in force, in order to make Community type-approval operational for the various categories of vehicles and their components. Moreover, by broadening the scope to include commercial vehicles, the Directive will contribute measurably to the completion of the internal market in a sector in which the three major economic powers produce 40 million vehicles per year – over 40 % of which are from Western Europe alone – and which is showing no signs of slowing down.

Replacing national approval procedures by a Community system based on harmonised technical requirements will, without any doubt, speed up and simplify all the administrative formalities that precede vehicle registration. The Commission also believes that harmonisation of the requirements applicable to vehicles built in small series, initially in the case of passenger cars, will allow smaller manufacturers to gain access to the single market, while achieving a level of safety that matches or

⁹ <http://ec.europa.eu/enterprise/automotive/pagesbackground/hydrogen/consultation/call.htm>

¹⁰ http://www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_505053.pdf

even exceeds previous levels. Lastly, the Commission feels that the introduction of a 'split-level' approach to the regulatory work will help facilitate the adoption of future legislation in the automotive sector. The closing date for comments was September 15, 2006.

1.4.2 The way to a European Chemicals Agency

The EU published on March 2006 a Proposal for a Regulation of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency and amending Directive 1999/45/EC and for amending Directive 67/548/EEC in order to adapt it to EC-Regulation concerning the registration, evaluation, authorisation and restriction of chemicals. The purpose of this Regulation is to ensure a high level of protection of health and the environment as well as the free circulation of substances on the internal market while enhancing competitiveness and innovation. It is expected that the REACH comes into force in the middle of 2007. REACH Implementation Projects (RIPs) will support the Directive and have an important role. RIP 3 "Technical Guidance for Industry" and RIP 4 "Technical Guidance for Authorities" are the main parts¹¹.

Fortunately, in Annex III, No. 9 basic elemental substances for which hazards and risks are already well known are exempted from the obligation to register, even if the tonnage per annum of production or import is exceeded. Hydrogen is named in this number and exempted from Title II, V and VI. The other titles which remain for hydrogen are common duties from other Regulations.

1.4.3 European Hydrogen & Fuel Cell Technology Platform (HFP)

The HFP has worked out an Implementation Plan to foster the hydrogen and fuel cell implementation in Europe¹². This plan describes 4 Innovation and Development Actions (IDA):

IDA 1: Hydrogen Vehicle and Infrastructure

IDA 2: Sustainable for Hydrogen Supply

IDA 3: Fuel Cells for CPH and Power Generation

IDA 4: Cells for Early Market

In these IDAs necessary actions were evaluated. E.g. in IDA 1 "Hydrogen Vehicle and Infrastructure" the following evaluation (Figure 2) was done. One of the most important topics is the hydrogen infrastructure topics.

¹¹ <http://ecb.jrc.it/REACH/>

¹² <http://www.hfpeurope.org/>

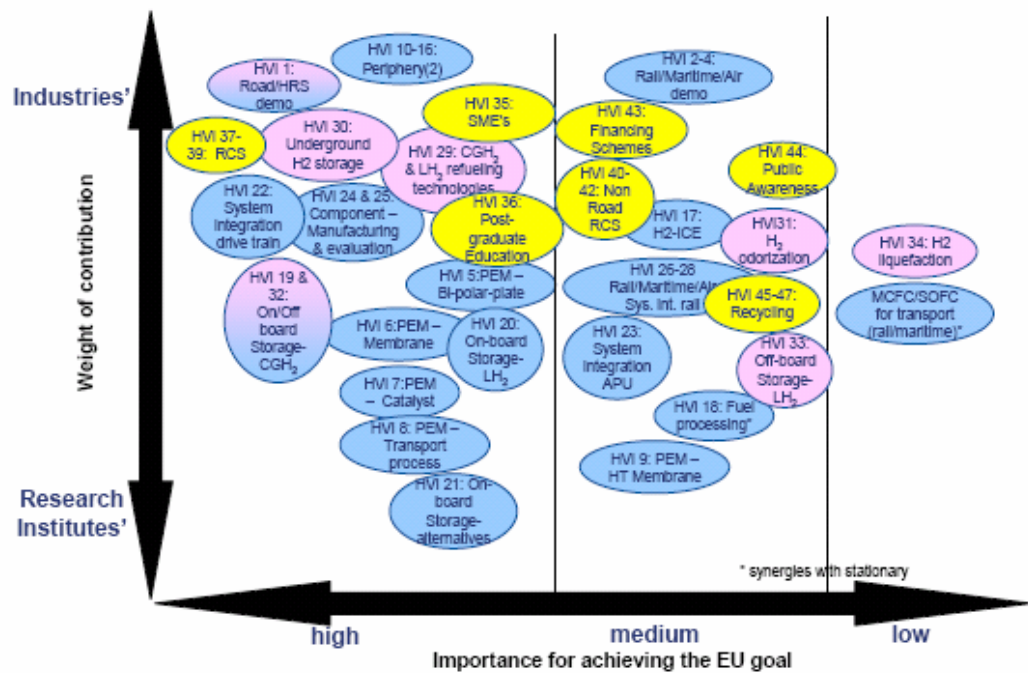


Figure 2: Action portfolio of IDA 1 in its analytical framework

1.4.4 Hydrogen in the City

The European Hydrogen Association (EHA)¹³ created a new working group named “Hydrogen in the City”. It shall supply local authorities with information about available applications of hydrogen, conditions for their installation as well as Regulations and Standards. In close co-operation with industrial members as well as national members of the EHA the working group shall work on the increasing inquiries from municipalities about examples of feasible urban hydrogen projects.

1.5 Germany

1.5.1 New Energy Tax Law

The Directives 2003/96/EC¹⁴ and 2003/30/EC¹⁵ are implemented in the Energy Tax Law 2006¹⁶ replacing the Mineral Oil Tax Law. The EU makes a standard excise duty for energy products. Hydrogen as a fuel is dutiable for the first time completely. Germany rates hydrogen when used as a fuel in internal combustion engines and in fuel cells. The difference made in the old Law is now repealed. Hydrogen in fuel cells for producing only heat is not rated. Because there is no tax advantage for hydrogen over other fuels, it is taxed with €31.80 for 1 MWh (§2 (1) No. 7 EnergieStG). The taxation of hydrogen is derived from the taxation for natural gas, because the properties and utilisation correlate much. A tax-free demonstration project is possible. Responsible for such a project is the main customs duty offices.

1.5.2 Environmental Liability Directive

Germany will implement the Directive 2004/35/EC in a law called Environmental Damage Law – Umweltschadengesetz (USchadG) and adapts the Federal Immissions Control Law – Bundesimmissionsschutzgesetz (BImSchG). The first resolution for the Environmental Damage Law to avoid and sanify damages to the environment by the liability of the polluter was on September 20 2006. The bill is transmitted now to the Bundesrat to the statement. This Law needs additions of specialised laws in force. Exemptions possible from the Directive for federal authorised plants are not

¹³ <http://www.h2euro.org/>

¹⁴ restructuring the Community framework for the taxation of energy products and electricity 2003/96/EC

¹⁵ The biofuel or other renewable fuels for transport Directive 2003/30/EC

¹⁶ Energiesteuerengesetz - EnergStG of 15 July 2006

established. This was let to the Federal States. Plants and the carriage of dangerous goods are part of the obligation to avoid damage through information and a danger warning. The polluter has to redevelop the damage if made culpably.

1.5.3 National Development Plan “Hydrogen and Fuel Cell Innovation Programme”

The Federal Government of Germany supports the hydrogen and fuel cells development by means of the well-targeted assistance provided within the scope of the National Hydrogen and Fuel Cell Innovation Programme¹⁷. This programme promotes this technology in the course of the next ten years by targeted assistance and funding to the emerging industry in the mobile, stationary and portable sectors, thereby speeding up the market development of this technology, which is important for Germany as a competitive site for economic activity. Targeted support and specific activities for small and medium-sized enterprises will be set up in order to create networks and make use of the research inputs provided by institutions in Germany and Europe.

1.5.4 New master course “Hydrogen technology”

In order to establish a hydrogen economy still much research and development is needed. Thereby the linkage of most different branches of technology and an industry-spreading specialised knowledge are required from engineers which could only be acquired so far through several single studies. Starting 2007 the Dresden International University¹⁸ (DIU) offers a master course of studies “Hydrogen technology”. The in-service study takes two years. It is divided into nine modules, which cover the whole area from the scientific bases over different applications up to the national and international activities. 29 lecturers care for the participants.

1.5.5 Hydrogen filling stations website

Germany's strategy and technology consultant Ludwig-Bolkow-Systemtechnik launched a new website on hydrogen filling stations¹⁹ and hydrogen cars²⁰. The websites offers an overview, photos and detailed data on more than 100 operable filling stations worldwide. It also provides an overview on more than 100 planned filling stations. New filling stations will be added each month. This database is set to be the most complete database on hydrogen filling stations worldwide.

1.6 Japan activities

Activities toward commercialisation of fuel cells and hydrogen technology in Japan are funded by the Ministry of Economy, Trade and Industry and support the market for the next 15 years. Japan considers that the 3E (Environment, Economy, Energy) could be achieved only by commercialization. They start R&D projects for creation of initial market and for full commercialization. After 2008 large-scale demonstration projects are supported by the Government. Another activity is the review of regulations and the establishment of Codes and Standards in Japan. In order to realize a hydrogen energy society, a new laboratory in the period 2006-2012 aims to establish basic technologies to use hydrogen more safely and conveniently. The lab for hydrogen material R&D aims at a unique research base for hydrogen material in the world. The development of advanced technologies and materials is phase II, the full commercialisation of hydrogen and fuel cells. The JHFC Centrair hydrogen station is part of the Japan Hydrogen & Fuel Cell Demonstration Project²¹ (JHFC) and will serve as a fuelling facility for fuel cell buses that operate in and around the Centrair Airport.

¹⁷ <http://www.bmvbs.de/en/artikel-,1872.960602/National-Hydrogen-and-Fuel-Cel.htm>

¹⁸ <http://www.di-uni.de/?id=864>

¹⁹ <http://www.h2stations.org/>

²⁰ <http://www.h2cars.de/>

²¹ <http://www.meti.go.jp/english/information/downloadfiles/PressRelease/060718JHFCcentrair.pdf>

2. Legal framework in the UK

It is well known that in the UK the legal system general differs from the continental systems. Most Regulations implement the EC-Directives. There is currently very little hydrogen infrastructure in place to support the refuelling of vehicles and no infrastructure in the UK²².

The UK's 2003 Energy White Paper of the Department for Transport²³ identified two fuels with the potential to achieve very large reductions in road transport CO₂: renewable hydrogen and biomass-based fuels. It committed the Government to undertaking an assessment of the overall and long-term energy implications of the very large-scale use of these fuels in road transport, with a time-horizon of 2050.

2.1. Industrial Production

2.1.1 Environmental law

The EU created a new Environmental Liability Directive 2004/35/EC to the prevention and remedying of environmental damage. The Directive has to be implemented in the national legislation of the EC Member States until May 2007. Environmental damage is defined as damage

- to biodiversity which is protected at Community and national levels;
- to water covered by the Water Framework Directive; and
- to land which creates a threat to human health.

Like the German Environmental Liability Act from 1990 the UK has existing Regulations²⁴ which deal with the main theme. Through the physical properties of hydrogen, this Directive will hardly have a relation to hydrogen industries and filling stations.

2.1.1.1 Environmental Impact Assessment (EIA)

Described in chapter 2.1.1.1 of the „Schwab study“²⁵ an Environmental Impact Assessment is to be done when the project falls into Appendix II of the 85/337/EEC, amended by the Directive 97/11/EC. The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999²⁶ implemented these Directives. All developments in Schedule 1 require EIA. A mandatory EIA through Schedule 1 No. 21, installations for storage of 200.000 tonnes of hydrogen, are not relevant at the moment. No. 6 of Schedule 1 does not fit for Hydrogen production, because one does not need several units juxtaposed and functionally linked. Development mentioned in Schedule 2 is only affected if it would be likely to have significant effects on the environment by virtue of factors such as its nature, size and location. The sensitive areas are defined in Schedule 3 (“screening”) which the local authority need for the procedures for determining whether development is EIA development.

Schedule 2 No. 3 (d) refers to the underground storage of combustible gases if the area of any new building, deposit or structure exceeds 500 square metres or is to be sited within 100 metres of any controlled waters. The underground storage is to implicate with the water conservation. There are Codes of Practice for underground liquid hydrocarbon storage tanks and pipelines in order to minimise the risks to the water environment, including groundwater. The physical properties of hydrogen are not hazardous to controlled waters. Schedule 2 s.3(d) and these Codes of Practice are not relevant for hydrogen.

²² <http://www.est.org.uk/fleet/Vehicles/Alternativefuels/Fuelcells/>

²³ DTI, Our Energy Future: Creating a Low Carbon Economy, 2003

²⁴ E.g. EPA 1990

²⁵ Roland Schwab, En route to a hydrogen infrastructure - A study into the legal framework created by legislation in the European Union and in Germany

²⁶ SI 1999/293

Schedule 2 No. 6 (a),(c) concern the production and storage of chemicals. These regulations are related to hydrogen, if the area of new floorspace exceeds 1,000 square metres, the area of any new building or structure exceeds 0.05 hectare, or the storage exceeds 200 tonnes.

The applicant can seek an opinion from the local planning authority ("scoping") on the information to be included in an environmental statement. Advice on the content of an environmental statement must be given to a developer who requests it before submitting an application.

2.1.1.2 Pollution Prevention and Control (PPC)

The "Integrated Pollution Prevention and Control Directive" 96/61/EC 27 discussed in chapter 2.1.1.2 in the „Schwab study“ is implemented in The Pollution Prevention and Control (England and Wales) Regulations 2000 (PPC)²⁸. The comments there (chapter 2.1.1.2) can be transferred to the UK, because the Schedule 1 of the PPC 2000 has the same content and numbers like the Appendix to the Directive 96/61/EC.

The only interesting difference is that the preliminary note in Number 4 does not use the term industrial scale, but uses the definition producing in a chemical plant by chemical processing for commercial purposes substances. In this way the size of a plant is irrelevant.

For another way of producing hydrogen the only requirement for gasification and refining activities, s. 1.2 Part 1 Schedule 1, is to use more than 1,000 tonnes of involved gas in any period of 12 months. Named is reforming natural gas and producing gas from oil or other carbonaceous material or from mixtures thereof.

In addition the same operation controlling Regulations are valid for mobile plants. Mobile plants are plants which are designed to move or to be moved whether on roads or otherwise and which are used to carry out one or more activities from the Schedule, where hydrogen is named. With this applications and permissions to operate deals the Environmental Agency, see s. 8.

Interesting is that the unloading of petrol into stationary storage tanks at a filling station needs a permission if in a 12 month period 500m³ or more are delivered²⁹ which is commercially not much.

2.1.1.3 Electricity produced from Renewable Energy Sources

Article 5 of the Directive 2001/77/EC is established in the Electricity (Guarantees of Origin of Electricity Produced from Renewable Energy Sources) Regulations 2003³⁰ on the promotion of electricity produced from renewable energy sources in the internal electricity market. Guarantees of origin shall be issued by the Authority in accordance with the provisions of these Regulations. The specified amounts of electricity generated by using renewable sources supplied to customers in Great Britain are regulated in the Renewables Obligation Order 2006³¹.

Hydrogen for use in an electricity generating station is part of the regulations for eligible renewable sources³². The electricity supplier has to produce evidence of the renewable source to the Electric Market Authority, which issues certificates, referred to as ROCs. Electricity generated from eligible renewable sources in a generating station fuelled wholly or partly by hydrogen is input electricity not only a renewable source. The kind of the production of hydrogen is regardless. That hydrogen shall be used to produce electricity by a licensed supplier makes just sense in additional electricity supply during a peak load³³. To produce hydrogen from renewable sources this amount must not be too less. From 6.7% during the obligation period 2006/2007 the total supply raises till 2010 over 10%. 2015 Schedule 1 ends with 15.4%. Electricity exported to the grid from transportable renewable fuel production plants should be CCL exempt and qualify for ROCs, as it is produced from renewable sources.

²⁷ Directive 96/61/EC, amended by the Directive 2003/35/EC (the "Emissions Trading Directive")

²⁸ PPC - Pollution Prevention and Control (England and Wales) Regulations 2000,(SI 200/1973) amended by the Pollution Prevention and Control (Public Participation)(England and Wales) Regulations 2005, (SI 2005/1448)

²⁹ Part B(d), Section 1.2, Part 1, Schedule 1 of the PPC

³⁰ SI 2003/2562

³¹ SI 2006/1004

³² Regulation 9(7)(d) of the Renewables Obligation Order 2006, SI 1004/2006




³³ E.g. On-shore wind power is defined in Schedule 1 of the Electricity (Non-Fossil Fuel Sources) (England and Wales) Order 1998, SI 1998/2353

2.1.2 Health and safety

The base Directive 67/548/EEC is implemented in the UK legislation in different Regulations from waste and emissions to protection and safety. A closer look for hydrogen has to be done.

The relevant R and S phrases, worked out in the „Schwab study“, p. 32/33, are implemented in The Chemicals (Hazard Information and Packaging for Supply) Regulations 2002³⁴ (CHIP). CHIP explains the regulation and control of classification, packaging and labelling of dangerous substances and preparations, and for measures relating to consumer protection. As the Directive these Regulations are not to be used for the carriage of dangerous goods. The difference between dangerous substances and dangerous preparations can be disregarded, because the definition of substance fits to hydrogen as a chemical element and not a mixture of two or more substances defined as preparations. Hydrogen needs a safety data sheet which is required when it is supplied.

Table 2: List of identifiers for petrol, diesel and hydrogen under EU law, p. 33 in the „Schwab study“

Name of substance	Petrol	Diesel	Hydrogen
Danger symbols			
Special dangers (R phrases)	R 12: Extremely flammable R 38: Irritates the skin R 45: Can cause cancer R 48/20/21/22: Harmful, danger of serious health damage in the event of lengthy exposure by inhalation, contact with the skin and ingestion R 65: Harmful, may cause lung damage if ingested R 67: Vapours may cause drowsiness and loss of feeling R51/53: Toxic for aquatic organisms, may have a long term harmful effect in water	R 40: Suspected of having a carcinogenic effect R 65: Harmful, may cause lung damage if ingested R 66: Repeated contact may result in brittle and cracked skin R51/53: Toxic for aquatic organisms, may have a long term harmful effect in water	R 12 : Extremely flammable
Safety advice (S phrases)	S 2: Keep out of the hands of children S16: Keep away from ignition sources – no smoking S 23: Do not inhale gas, smoke, vapour and aerosols S 24: Avoid contact with the skin S 29: Do not pour into the public sewer S 36/37: Wear suitable safety gloves and safety clothing during work S 45: Consult a doctor immediately if you feel unwell S 53: Avoid exposure – obtain special instructions before use / consult the safety data sheet S 62: Do not induce vomiting after ingestion. Seek immediately medical advice and show the packaging or this label.	S 2: Keep out of the hands of children S 36/37: Wear suitable safety gloves and safety clothing during work S 61: Avoid release into the environment. Obtain special instructions / consult the safety data sheet. S 62: Do not induce vomiting after ingestion. Seek immediately medical advice and show the packaging or this label.	S 2: Keep out of the hands of children S 9: Store containers in a well-ventilated place S16: Keep away from ignition sources – no smoking S 33: Take action to prevent electrostatic charging

³⁴ SI 2002/1689; CHIP revoke and re-enact with amendments the Chemicals (Hazard Information and Packaging for Supply) Regulations 1994

2.1.2.1 Hydrogen as hazardous substance

The Planning (Hazardous Substances) Act 1990³⁵ operates by requiring any person wishing to store hydrogen at or above prescribed levels to obtain prior consent from the HSE. The conditions attached to any consent granted will be strongly influenced by the opinion of the HSE, which must be sought alongside other statutory consultees. There is in effect a strong presumption in favour of the HSE's view. Non-compliance with a consent, or acting without consent, is an offence.

The Planning (Hazardous substances) Regulations 1992³⁶ named at first in Schedule 1 Part B a controlled quantity on, over or under land at or above only of 2 tonnes for hydrogen as a requirement for hazardous substances consent. The quantity specified in column 2 of Schedule 1 is the controlled quantity of the corresponding hazardous substance in column 1 of that Schedule for the purposes of the Act. There are lots of rules for the application to the hazardous substances authority. They set out the procedure to be followed for an application for hazardous substances consent and in s.10 the bodies which shall be consulted before determining an application, mainly the HSE.

The Planning (Control of Major-Accident Hazards) Regulations 1999³⁷ amended the Schedule 1 of the Regulations above. Column 2 as controlled quantity stayed. The Planning (Control of Major-Accident Hazards) Regulation 1999 describes in the new Column 3 of Schedule 1 the 5 tonnes as Quantity (Q*). Q* means Quantity for purposes of note 4 to the notes to Parts A and B. There is the explanation about the addition of quantities on a plant³⁸. The complicated formula is:

$$q1/Q + q2/Q + q3/Q + q4/Q + q5/Q + \dots > 1.$$

If Q* is available then qx (hazardous substance present) is to be divided by this quantity Q*. Natural gas is also a Q*. For these substances, the divisor to be used is the controlled quantity of Column 3 for the generic category of substance in which it would normally fall. This formula is more specifically explained in chapter 2.3.2.2.

Table 3: Consolidated Schedules of the Regulations above

Column 1	Column 2	Column 3
Hazardous substances	Controlled quantity (Q) in tonnes	Quantity for purposes of note 4 to the notes to Parts A and B (Q*)
Schedule 1 of The Planning (Hazardous substances) Regulations 1992		
11. Hydrogen	2	5
Schedule 1 of The Control of Major Accident Hazards (Amendment) Regulations 2005		
Dangerous substances	Quantity in tonnes	
Hydrogen	5	50

In England, Scotland and Wales the control of major accident hazards are implemented by the Control of Major Accident Hazards Regulations 1999 (COMAH)³⁹, and in Northern Ireland through the Control of Major Accident Hazards Regulations (Northern Ireland) 2000. Amended by The Control of Major Accident Hazards (Amendment) Regulations 2005⁴⁰ to adapt the UK Quantity to the EU Quantity named in Directive 2003/105/EC, amending Directive 96/82/EC, Annex 1, shall apply only to an establishment (the whole controlled area) where such a dangerous substance is present in a quantity equal to or exceeding the quantity listed in column 3, if the operator of the establishment sends a safety report to the satisfaction of the authority and prepares an on-site emergency plan. The authority shall prepare an off-site emergency plan. Also there shall be Provision of information to the

³⁵ basis is the The Planning (Hazardous substances) Act 1990, s. 40 for The Planning (Hazardous substances) Regulations 1992; amended by The Planning (Control of Major-Accident Hazards) Regulations

³⁶ SI 1992/656

³⁷ SI 1999/981

³⁸ See chapter 2.3.2.2

³⁹ SI 1999/743, involving Directive 96/82/EC (Seveso II)

⁴⁰ These Regulations amend the Control of Major Accident Hazards Regulations 1999 ("COMAH"),

⁵¹ 1999/743; so as to give effect to Directive 2003/105/EC of the European Parliament and of the Council, amending Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances (to which COMAH gives effect in Great Britain), and to give belated effect to the latter Directive in one respect.

public in this area. Then it is possible to keep the listed quantity of 50 tonnes or more regarding the just explained s. 7 to 14 since the 2005 amendment. For a quantity of 5 tonnes of hydrogen or above, but not exceeding 50 tonnes, the operator shall prepare and keep major accident prevention policy document and shall send to the competent authority a notification containing detailed information about the site and the substance periodically or in case of changes. The competent authority for the purposes of the Regulations is the Health and Safety Executive and the Environment Agency acting jointly.

2.1.2.2 The consent procedure of the local authority

Where the presence of a hazardous substance is directly associated with a proposed development, local planning authorities are able to exercise a degree of control over the siting and use of hazardous substances through the development control system. This consent procedure allows for control to be exercised over the presence of hazardous substances whether or not associated development requiring planning permission is involved. It is geared to regulating the storage and use of hazardous substances. It will enable breaches of control which may present serious risks to be dealt with quickly and effectively.

The controls are planning controls. They do not replace or duplicate the requirements of the Health and Safety at Work etc Act 1974, or the relevant statutory provisions defined in Part I of that Act. Even after all reasonably practicable measures have been taken to ensure compliance with the requirements of the 1974 Act, there will remain the residual risk of an accident which cannot entirely be eliminated. The controls will ensure that this residual risk to people in the vicinity or to the environment is taken into account before a hazardous substance is allowed to be present in a controlled quantity. The extent of this risk will depend upon where and how a hazardous substance is to be present; and the nature of existing and prospective uses of the application site and its surroundings⁴¹.

The local hazardous substances authority is responsible for deciding whether the risk is tolerable for the community and hence whether a particular proposal to store or use a hazardous substance should be allowed. This authority will normally be the same Council or other authority which would act as local planning authority in dealing with any related development proposal. The HSE will advise the hazardous substances authority (HAS) on the nature and severity of the residual risk to persons in the vicinity arising from the presence of a hazardous substance. The Environment Agency will advise on the risk to the environment. In 2004 the local authority permitted a hydrogen powered fuel cell in London, see Figure 3.

Where planning permission is also required for development associated with storage or use of hazardous substances, separate applications and approvals are necessary. Applicants and local authorities may wish to ensure that related applications for the HSC and for planning permission are submitted and dealt with together. Responsibility for determining hazardous substances consent applications, for checking claims for deemed consent, and for administering and enforcing the procedure, rests with hazardous substances authorities (HSA). Usually this will be the same council or other body that would act as the local planning authority in dealing with any associated application for planning permission.

⁴¹ DCLG - Hazardous substances consent: a guide for industry, 09/00; advice for consent chapter 2.3.2.3



Figure 3: The 2004 Trafalgar Square Christmas tree lights were powered by a hydrogen fuel cell and the use in public was permitted by the authorities

2.1.2.3 Pressure equipment

The Pressure Equipment Regulations 1999⁴² implement the Directive 97/23/EC to harmonise national regulations relating to health and safety of pressure equipment and assemblies. They apply to the design and construction aspects of pressure. The Regulations are laid out in the same way as the Pressure Equipment Directive 97/23/EC. Equipment covered by the ADR, the RID and the IMDG is extended from these regulations, Schedule 1 on The Pressure Equipment Regulations 1999.

Hydrogen as an extremely flammable substance is a fluid of Group 1 defined in s. 2 of the Pressure Equipment Regulations 1999 and related to this Regulation with an allowable pressure greater than 0.5 bar, defined in section 3. Part III sets out the general requirements relating to the placing on the market or putting into service of pressure equipment and assemblies by a "responsible person". Pressure equipment or assemblies must satisfy the relevant essential requirements and be safe. The Conformity Assessment Tables (Annex II to the Pressure Equipment Directive) are also taken from the Directive as the Schedule 3 Conformity Assessment Procedures (Annex III to the Pressure Equipment Directive) in Schedule 4.

The pressure equipment and assemblies not covered in the Directive 97/23/EC are also not covered by the Pressure Equipment Regulations 1999. This Directive is directly implemented in this Regulation like the German 14th regulation for the equipment and product safety law.

The well established, Pressure Systems and Transportable Gas Containers Regulations 1989 were replaced by The Pressure Systems Safety Regulations 2000⁴³ which apply mainly to the in-service aspects of pressure systems such as operation and periodic examination⁴⁴. They also deal with design and construction aspects of systems which are outside the scope of The Pressure Equipment Regulations 1999. These Regulations cover all aspects of pressure systems from initial design and construction (including in-service repair and modification) through to installation, operation, maintenance, examination in accordance with a written scheme and record keeping and modify and extend provision for sending, keeping and passing on in electronic form reports of examinations. They are essentially a revision of the Pressure Systems and Transportable Gas Containers Regulations

⁴² SI 1999/2001

⁴³ SI 2000/128

⁴⁴ British Compressed Gases Association, Pressure System Legislation – a Summary, 2001

1989, modified to remove transportable gas containers (generally referred to as gas cylinders) from scope and to accommodate the introduction of The Pressure Equipment Regulations 1999. It should be noted that as from 1996, all the transportable gas container aspects of the 1989 Regulations were removed and placed within, The Carriage of Dangerous Goods (Classification, Packaging and Labelling) and Use of Transportable Pressure Receptacles Regulations 1996 which again was revoked and replaced in Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2004⁴⁵.

A Health and Safety Commission Approved Code of Practice (ACOP) is available to support the requirements of the Regulations and is entitled, Safety of Pressure Systems. It should be borne in mind that whilst the requirements contained within a HSC Approved Code of Practice are not law, the Code does have special legal status. The Code states, "if you are prosecuted for breach of Health and Safety law, and it is proved that you did not follow the relevant provisions of the Code, you will need to show that you have complied with the law in some other way or a court will find you at fault". Hence it is essential to be aware of the ACOP interpretation of the Regulations. The British Compressed Gases Association (BCGA) Code of Practice CP 15 establishes a procedure for the re-rating of gas cylinders manufactured to a charging pressure consistent with the test pressure as specified in Amendment AMD 5145⁴⁶.

2.1.2.4 Fire and explosions in potentially explosive atmospheres

Hydrogen and petrol are extremely flammable (F+). The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR 2002) implement the Directive 99/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from fire, explosion or other events arising from the hazardous properties of a dangerous substance, which is called explosive atmospheres (ATEX 137), and Directive 98/24/EC for the same related to chemical agents at work. The Appendixes of the 99/92/EC Directive are substantially reproduced in the Schedules of the DSEAR 2002.

Installations have to comply with the DSEAR 2002, controlled by the employers and other dutyholders. There, the protection of people against the risks from fire and explosion is regulated. Risk is defined as meaning "the likelihood of a person's safety being affected by harmful physical effects being caused to him from fire, explosion or other events arising from the hazardous properties of [-hydrogen-] in connection with work and also the extent of that harm". Employers are required by these Regulations to eliminate or reduce risk so far as is reasonably practicable. Where the risks can't be eliminated so far as is reasonably practicable must be assessed in the appropriate manner, what means a careful identification and examination of the presence of hydrogen in the workplace. In short it means what can happen and what can we do against that.

It is to carry out, (DSEAR 2002, s.5,6):

- the likelihood of hazardous explosive atmosphere occurring
- all potential ignition sources
- foreseeable factors like accidental damage and vandalism
- control of any-non-routine operations
- maintenance and repair activities
- manual-handling issues
- human factors and training requirements

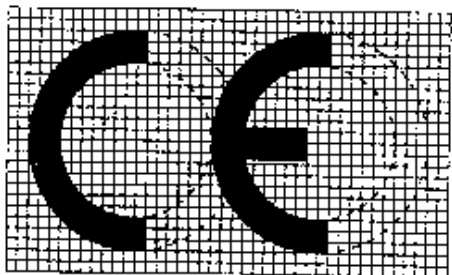
In rooms, under a roof or other top closed installations (i.e. in a wheelhouse) explosive atmospheres could form. Explosive atmospheres by hydrogen are not likely to occur in normal operation but, if it does occur, will persist for a short period only. This is the definition of Zone 2 and Category 3 equipment for hazardous area zones in the Schedule 2 and 3 for Regulation 7 of the DSEAR 2002. Zone 2 duties have therefore to be fulfilled.

A third Directive 94/9/EC concerning equipment and protective systems intended for use in potentially explosive atmospheres (ATEX 95) has been implemented in the UK by The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996

⁴⁵ SI 2004/568

⁴⁶ Safe re-rating of existing BS 5045:Part 1:1982 containers to Amendment AMD 5145:1986 Part 1: Containers for hydrogen trailer service, Revision 1:1996

(EPS). EPS⁴⁷ require that the responsible person, who places equipment and protective systems, devices and components on the market or puts these into service, has ensured that the essential health and safety requirements for the equipment have been satisfied. This includes carrying out the relevant conformity assessment procedure and application of the CE mark. Excluded from these Regulations are transport vehicles⁴⁸. Excluded from the scope and listed in Schedule 5 of EPS are the road transport vehicles. EPS apply to equipment intended for use in potentially explosive atmospheres (relevant definitions are contained in regulation 3), other than those by regulation 4 or 5.



The CE marking shall be accompanied by the identification number of the notified body involved at the production control phase. The CE marking shall be affixed in a visible, easily legible and indelible fashion to each item of pressure equipment

The Directive 89/654/EEC on the introduction of measures to encourage improvements in the safety and health of workers at work is implemented in Regulatory Reform (Fire Safety) Order 2005⁴⁹ once. This Order reforms the law relating to fire safety in non-domestic premises. It replaces fire certification under the Fire Precautions Act 1971 with a general duty to ensure, so far as is reasonably practicable, the safety of employees, a general duty, in relation to non-employees to take such fire precautions as may reasonably be required in the circumstances to ensure that premises are safe and a duty to carry out a risk assessment. The Order imposes a number of specific duties in relation to the fire precautions to be taken and comes into force on October 2006.

For the work equipment, defined in the Directive 89/655/EEC, The Provision and Use of Work Equipment Regulations 1998⁵⁰ is responsible in the UK. In addition to minor and drafting changes these Regulations contain new provision giving effect as respects Great Britain to the provisions of the Directive identified below and inserted in it by the amending Council Directive 95/63/EC. Beside placing duties on employers, they also place those duties (not required by the Directive) on others to the extend of their control, namely persons

- who have control of work equipment,
- who use it,
- who supervise or manage its use or the way it is used.

The Regulations (giving effect to the replaced last paragraph of point 2.1 of Annex I to the Directive) require that control systems of work equipment are chosen making due allowance for the failures, faults and constraints to be expected in the planned circumstances of use.

Hydrogen is one of the substances related to The Control of Substances Hazardous to Health Regulations 2002⁵¹ (COSHH 2002), because it is classified as dangerous to health under the CHIP⁵². The CHIP calls any substance dangerous, which is named in the "approved supply list"⁵³.

The conclusion lined out by the „Schwab study“ at the end of 2.1.2.5 is as follows.

“The introduction of hydrogen as a fuel would not result in any new types of danger in terms of explosion protection. The large scale production of hydrogen is already in force today and the regulations for the prevention of explosive atmospheres during the production of hydrogen have been in use for some considerable time. Explosion protection regulations also apply to the production of conventional fuels. Only the type of precautions is different due to the different material properties of the fuel types. If we consider that both gaseous and liquid

⁴⁷ SI 1996/192

⁴⁸ Schedule 5 and Regulation 4 of the EPS Regulation; Vehicles intended for use in a potentially explosive atmosphere shall not be excluded. Because no vehicles just operate at a filling station, vehicles are excluded.

⁴⁹ SI 2005/1541, amended by SI 2006/484 modifying the commencement date

⁵⁰ SI 1998/2306

⁵¹ The Control of Substances Hazardous to Health Regulations 2002; SI 2002/2677; COSHH 2002 re-enact, with modifications, the COSHH 1999

⁵² The Chemicals (Hazard Information and Packaging for Supply) Regulations 2002; SI 2002/1689

⁵³ "the approved supply list" means the document entitled "Information Approved for the Classification and Labelling of Dangerous Substances and Dangerous Preparations (Seventh Edition)" approved by the Health and Safety Commission on 16th April 2002

hydrogen is always stored and transported in sealed systems, we come to the conclusion that in comparison to petrol fewer areas may be expected where explosive atmospheres may occur.”

After another study⁵⁴ there are 62 risk analyses methodologies for industrial plants and transport of dangerous goods. The principles groups are based of qualities and quantities. The technique of Hazard and Operability Studies, or in more common terms HAZOPS, has been used and developed over approximately four decades for identifying potential hazards and operability problems caused by deviations from the design intent of both new and existing process plants. HAZOPS were initially invented by ICI in the UK, but the technique only started to be more widely used within the chemical process industry after the Flixborough disaster in 1974. Essentially the HAZOPS procedure involves taking a full description of a process and systematically questioning every part of it to establish how deviations from the design intent can arise. Once identified, an assessment is made as to whether such deviations and their consequences can have a negative effect upon the safe and efficient operation of the plant. If considered necessary, action is then taken to remedy the situation. This is just one of the methods.

2.1.3 Taxation

Article 2(3) of the Directive 2003/96/EC ensures that the member states taxation of energy products in respect of motor fuel substitutes, and additives and extenders (other than biodiesel) complies with the Community framework for taxation of energy products.

The VAT Act 1994, Schedule 4, Paragraph 3 defines any supply of heat, power, refrigeration or ventilation as a supply of goods. Supplies of fuel and power are subject to the standard rate of VAT unless there is a provision for the reduced rate for qualifying use. Qualifying use is defined as “domestic use” and “charity non-business use” and is not relevant for industrial production of hydrogen. The minimal quantities as definition of domestic use will be exceeded.

Supplies of gases for use as road fuel are always standard-rated. VAT is due on the total value for any road fuel gas or hydrocarbon oil on which excise duty is chargeable.

2.2. Transport

2.2.1 Road transport

2.2.1.1 ADR/RID in the Carriage Regulations

The UK legislation on the carriage of dangerous goods has gradually converged with European legislation. The ADR (2003), RID (2003) and miscellaneous Directives are implemented in The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2004⁵⁵ (The Carriage Regulations). The Carriage Regulations cover the ADR and RID topics. The relevant Directives for road transport are: Directives 94/55/EC, 1999/36/EC, 2000/61/EC and 2003/28/EC. Directives 96/49/EC, 2000/62/EC and 2003/29/EC concern rail transport. Thirdly these Regulations implement Directive 1999/36/EC concerning transportable pressure equipment.

Part 2 imposes the requirements contained within RID and ADR and Part 3 sets out the competent authorities for carrying out functions within RID and ADR. Part 4 imposes the requirements of the Transportable Pressure Equipment Directive. Part 5 imposes requirements which are additional to or alternatives to the requirements of RID and ADR. They concern requirements for the carriage of explosives by road and rail, the marshalling and formation of trains, the keeping of documentation and placarding requirements for carriage within Great Britain.

⁵⁴ <http://people.pwf.cam.ac.uk/pp286/Risk62%20METHOD.pdf>

⁵⁵ The Directive on transportable pressure equipment, 1999/36/EC, is implemented in The Carriage Regulation; amended by the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment (Amendment) Regulations 2005

The 2005 and 2007 edition of the ADR and RID does not bring in any changes especially to hydrogen related carriage⁵⁶. Section 10A was inserted⁵⁷ in The Carriage Regulations with general security measures to any person who is involved in the carriage of dangerous goods by road or rail.

Table 4: DfT: Working with ADR (footnote 4)

Topic	The Carriage Regulations	ADR
Dangerous Goods List and special provisions	17	3.2
Class	15	3.2, 2.2
Classification Code	15	3.2, 2.2
Tank Code	19(3)	3.2, 4.3
Mark, label and placard packages and vehicles	20(1)-(4), 55	5.1-5.5
Carriage of liquefied gas	7(8) – (11)	Derogations
Use and Construction of new tanks and pressure receptacles	5, Schedule 1-2	Derogations

A consultation draft for The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2007⁵⁸ relate to ADR and RID principally. There they say, where a term is defined in ADR or in RID and is not defined for the purposes of these Regulations, it bears the meaning as defined in ADR in relation to carriage by road and in RID in relation to carriage by rail. Most definitions refer to ADR and RID.

2.2.1.2 Road Tunnel Safety

The Road Tunnel Safety Regulations 2007⁵⁹ will implement in relation to the whole of the UK the European Parliament and Council Directive 2004/54/EC on minimum safety requirements for tunnels in the trans-European road network. The Regulations apply to all UK road tunnels that are over 500 metres in length and form part of the trans-European road network. In Schedule 1, No. 3.7., the duties for the transport of dangerous goods are explained. The tunnel manager and safety officer have to perform a risk analysis, place appropriate signs and consider specific operating measures. It is likely that these Regulations come into force as drafted.

2.2.1.3 Channel Tunnel Safety

The Carriage of dangerous goods will be accepted if it is prior declared with all information and permission is given. The ADR/RID is the main condition for the carriage, but the Eurotunnel policy is more stringent. A transport person has to enquire the freight department. Hydrogen with the UN 1049 and 1966 as carriage good is strongly prohibited. Under the No. 5 of the Terms and Conditions of the Eurotunnel LPG and dual powered vehicles cannot be accepted for transport by Eurotunnel. This is written in bold. Hydrogen vehicles are not named but prohibited as well. It doesn't make any change in which kind of tank and mass the hydrogen is carried along.

⁵⁶ The DfT supporting guide ("Working with ADR – an introduction to the carriage of dangerous goods by road" - IND(G)393) will not be reissued; its contents will become part of any guidance published in connection with the proposed 2007 Regulations.

⁵⁷ Carriage of Dangerous Goods and Use of Transportable Pressure Equipment (Amendment) Regulations 2005

⁵⁸ http://www.dft.gov.uk/stellent/groups/dft_freight/documents/page/dft_freight_612386.pdf

⁵⁹ Consultation draft, Published: 14 July 2006; Closing date: 7 October 2006.

2.2.1.4 Health and safety

The Health and Safety at Work etc Act 1974 (Application to Environmentally Hazardous Substances) Regulations 2002⁶⁰ extend the reference to dangerous substances in section 1(1)(c) of The Health and Safety at Work etc Act 1974 to include environmentally hazardous substances. The Act sets out general duties which employers have towards employees and members of the public, and employees have to themselves and to each other. These duties are qualified in the Act by the principle of “so far as is reasonably practicable”, s. 2(1). The risk assessment is more explicit for the duties and managing health and safety in The Management of Health and Safety at Work Regulation 1999.

2.2.1.5 VED for road transport, probably HGVs

The Directive 99/62/EC on the charging of heavy goods vehicles (HGV) is one point as part of the transport costs. Hydrogen has a lower energy density than diesel and petrol relative to the volume, what means a HGV has to drive more often⁶¹. In the UK this toll is the Vehicle Excise Duty (VED) and the rates are for cars separated in CO₂-emission figures and for HGVs in weight and axes. The following rates take effect from 23 March 2006. Heavy goods vehicles are liable for £165 and £1,850 per annum, based on a formula reflecting tractive unit axle number, trailer axle number and overall weight. Light goods vehicles are liable for £165 per annum. Reductions are available for all these types of vehicle if they meet specific pollution standards. In 2002 UK operators face levels of freight taxes that are over twice the European average. The Government has announced plans to replace VED for HGVs with a Lorry Road-User Charge based on distance-travelled⁶². This was expected to be introduced until now but no further action followed.

Table 5: Form V149 of DVLNI, Rates of Vehicle Excise Duty, May 2006

Key to HGV, VED bands Part VIII				
Lorry VED Band	Standard TC01		◆ Reduced pollution TC45	
	12 month rate £	6 month rate £	12 month rate £	6 month rate £
A	165.00	90.75	160.00	88.00
B	200.00	110.00	160.00	88.00
C	450.00	247.50	210.00	115.50
D	650.00	357.50	280.00	154.00
E	1,200.00	660.00	700.00	385.00
F	1,500.00	825.00	1,000.00	550.00
G	1,850.00	1,017.50	1,350.00	742.50

The road transport is established through semi-trailers with compressed light weight pressure vessels and cryogenic liquid semi-trailers with vacuum isolation. Both semi-trailers are running on revenue weight of 40 tonnes. That means they are in Band G, regardless the axes on the trailer and the tractive unit. Just a three axled tractive unit with a three or more axled semi-trailer is in Band E⁶³. For a revenue weight not over 38 tonnes the VED would be in Band F and E.

Table 6: Form V149 of DVLNI, Lorry VED Band allocation, May 2006

Revenue Weight (and tractive unit)	1 or more axled semi-trailer	2 or more axled semi-trailer	3 or more axled semi-trailer
Not over 38 tonnes	F (2 and 3 axled)	F (2 axled) / E (3 axled)	E (2 axled) / D (3 axled)
Not over 44 tonnes	G (2 and 3 axled)	G (2 and 3 axled)	G (2 axled) / E (3 axled)

⁶⁰ SI 2002/282

⁶¹ „Schwab study“ chapter 2.2.1.4

⁶² Finance Act 2002, Ch. 23, s. 137, ss. (1) where say they: “A tax, to be known as lorry road-user charge, shall be charged in respect of use of roads by lorries.”

⁶³ http://www.dvlni.gov.uk/vehicles/vehicle_forms/v149.pdf

Drivers can tax their vehicles in one of the reduced pollution taxation classes when they produce a valid reduced pollution certificate (RPC). To obtain the RPC TC45 the local Vehicle and Operators Services Agency (VOSA) testing station has to be contacted. A DVLA local office takes the application on vehicle tax application form (V85) for lorries⁶⁴.

The new M6 Toll is a 27 mile, three lane motorway. It will offer shorter journey times through the West Midlands. The standard toll for HGV's is £11, putting the road out of the price range of many firms. Even some of the biggest haulage companies have said at that price they won't be using the road. And that means that HGV's are likely to remain on the existing M6. The Lorry Road User Charge abandoned by the Government in 2005, because it became too complicated and too costly, would have taxed all lorries based on the distance they travelled, with a compensatory reduction in fuel duty for UK vehicles. The calling for a revised scheme comes with the notion of learning from the mistakes of the past. However, the logic of a distance tax on lorries, accompanied by a reduction in the enormous amounts of fuel duty, which they pay, remains sound. The planned introduction in 2008 is far away yet.

2.2.2 Waterways

International Carriage of Dangerous Goods by Inland Waterways (ADN) is the equivalent for shipping. The ADN adopted on 25 May 2000 was amended like ADR/RID 2003 and 2005. The UK handles with The Dangerous Substances in Harbour Areas Regulations 1987⁶⁵, amended by The Carriage Regulations. These Regulations shall apply in every harbour and harbour area in Great Britain and to any premises or activities in any part of a harbour area in the territorial waters adjacent to Great Britain to which or in relation to which sections 1 to 59 and 80 to 82 of the Health and Safety at Work etc. Act 1974 apply. Excepted are substances which are not the carriage good, s.5(2). General duties are imposed upon companies and personnel working in and around harbours and on harbour authorities themselves. ADN aims to ensure a high level of safety in the international carriage of dangerous goods by inland waterways, contribute effectively to the protection of the environment by preventing any pollution resulting from accidents or incidents during such carriage and facilitate transport operations and promote international trade of chemicals.

Most estuarial waterways are open to sea going vessels and are therefore governed by The International Maritime Dangerous Goods (IMDG) Code. This is lined out in the „Schwab study“ chapter 2.2.3.1

The transport by sea for UK registers ships and other ships loading and unloading in UK ports is affected by The Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997⁶⁶. Hydrogen is not dangerous or pollutant to water but the safety duties of ADN are to respect.

2.2.3 Pipelines

The Petroleum Act 1998 concerns the construction, use and authorisation from submarine pipelines in controlled waters⁶⁷. Hydrogen is one of the substances which are defined under the meaning of gas in section 28. The chance for submarine pipelines used for hydrogen is small in the moment, because offshore production of hydrogen in the territorial sea adjacent to the UK is not projected, but first considerations are made.

But hydrogen is a gas in the Gas Act 1986 as well. This Act deals with the application for licenses of pipelines and storage facilities. The principal objective is to protect the interests of consumers in relation to gas conveyed through pipes, wherever appropriate by promoting effective competition between persons engaged in, or in commercial activities connected with, the shipping, transportation or supply of gas so conveyed. All kind of gas supplier, interconnectors and transporter have to attend Health and Safety Regulations as well as construction and conditions of use. The Pipe-lines Act 1963 regulates and facilitates the construction, and secures the safe operation, of pipe-lines and makes provision for matters arising thereout. An application for the grant of a pipe-line construction authorisation must be made to the Minister in writing. The UK, like the EU Directive, excludes pipelines from the Pressure Equipment Regulation 1999, Schedule1 No 1.

⁶⁴http://www.direct.gov.uk/Motoring/OwningAVehicle/TaxationClasses/TaxationClassesArticle/fs/en?CONTENT_ID=4022043&chk=8ISZfu

⁶⁵ SI 1987/37, amended by SI 2004/568

⁶⁶ SI 1997/2367

⁶⁷ S. 14 (2) of the Petroleum Act 1998

A hazardous substances consent is not required for the presence of hazardous substances in pipelines, except for substances present in that part of a pipeline which is on, over or under the establishment to or from which it is connected, or in a pipeline used to convey a hazardous substance from one part of the establishment to another. Substances so present are regarded as part of the overall inventory of substances at an establishment.

The Secretary of State may by order grant exemption from the prohibition of unlicensed activities. There is no difference between a primary application and an extension or restriction of a licence. An EIA of the Directive 85/337/EEC, amended by the Directive 97/11/EC, is intended in The Pipe-line Works (Environmental Impact Assessment) Regulations 2000⁶⁸ which refers to the Pipe-lines Act 1962. The relevant applications are those in respect of pipe-lines of more than 40 kilometres in length and more than 800 millimetres in diameter which carry oil, gas or chemicals (for which an environmental statement is mandatory) or any other pipe-line requiring authorisation which carries either oil or gas. In respect of those cases where an environmental statement is not mandatory, for the Secretary of State, where he is satisfied that the pipe-line works in question will not have a significant effect on the environment, to direct that an application need not be accompanied by an environmental statement, s. 4. The applicant is required to submit particulars of the pipe-line works in question for consideration by the Secretary of State, who must consult the relevant planning authorities before giving a direction.

Provision is made for copies of directions by the Secretary of State as to the need for an environmental statement to be made available to the public. Where an application is accompanied by an environmental statement, the Secretary of State must be satisfied before granting an authorisation that the requirements of the Regulations as to publicity and consultation have been substantially complied with and must consider any representations by environmental bodies interested in the works by reason of their environmental responsibilities and any representations by the public, s.3. Provision is also made for decisions by the Secretary of State in respect of authorisations to be made public. The Regulations also lay down requirements for publicity for and public consultation on the environmental statement and the application for authorisation. Also provision is made requiring the Secretary of State, when so requested, to give a preliminary opinion to an applicant as to the information to be included in an environmental statement which the applicant is to submit.

2.3 Hydrogen Filling Stations

There are different possibilities of filling the vehicles at stations:

- **Bundled filling solution** – where packaged high pressure cylinders are delivered to a site, with appropriate pressure configuration to directly refuel hydrogen vehicles. Solutions exist which could be relevant in footprints under 5 m². Filling solutions could be **available on a scale as low as one vehicle refuel per week**.
- **Small “mobile” refueller** – a number of companies have developed flexible refuellers which can be deployed on a customer’s own facility and moved if required. These fuellers include built in compressors, ready to be connected up to a source of hydrogen (often delivered hydrogen in a tube trailer or manifolded cylinder pack). These relatively low cost solutions are **relevant for small fleet trials and demonstration projects**.
- **Small electrolysis plant** – many Electrolyser manufacturers have developed small electrolysis filling systems appropriate for filling on a small scale. These currently represent a high cost option but are particularly relevant for very small scale hydrogen supply where delivered hydrogen is not available. Electrolyser solutions exist **as low as 1 Nm³/hour, which corresponds to refueling a single hydrogen passenger car less than once every day**.
- **Small reformer plant** – on-site reformation of natural gas or biogases can be a lower cost option for the production of hydrogen than the delivery of hydrogen in tube trailers. Solutions now exist for hydrogen production rates **as low as 10 Nm³/hour, which corresponds to approximately 5 cars refueled every day**. The larger the throughput of the reformer, the lower the cost of delivered hydrogen.

⁶⁸Si 2000/1928

- **Large scale filling station** (multiple options for hydrogen generation/delivery) – on a large scale, a range of filling station solutions have been devised. Many of these are under investigation as a part of the CUTE project. Solutions range from on-site generation to delivery by liquid hydrogen tanker (as used at Hornchurch). **These stations are aimed at refueling over 50 vehicles per day**⁶⁹.

It depends on the development of car fleets which kind of station or stations will be leading. Small trailers can be easily registered. Large scale filling stations need different permissions. The authorities have to grant the production and storage of hydrogen, the public filling station, the construction of the buildings and the shop. The change of use, restructure or extension of an existing filling station will need a new permission and all aspects will be regarded again.

2.3.1 Assessment of environmental effects or EIA

The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 regarding Directive 85/337/EEC can be relevant for hydrogen installations of electrolysis⁷⁰. Then, the authority has to take the environmental information into consideration first, s. 4(2). Development mentioned in Schedule 2 is only affected if it would be likely to have significant effects on the environment by virtue of factors such as its nature, size and location. Industrial plants for carrying hydrogen of ss.3(b) are described in chapter 2.1.1.1 of this study. Schedule 2 refers to the underground storage of combustible gases, to the treatment of intermediate products and production of chemicals, other than development falling within Schedule 1.

There is barely a difference to the German Regulations⁷¹. The Directive 2001/42/EC (SEA Directive) is implemented in The Environmental Assessment of Plans and Programmes Regulations 2004⁷². The SEA Directive, to which these Regulations give effect, addresses the issue of environmental impact at an earlier stage for any plan or programme which sets the framework for future development consent of projects listed in Annex I or II to Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment, s. 5 of these Regulations 2004. There are exceptions for plans and programmes that determine the use of a small area at local level, and for minor modifications, if the responsible authority for preparing the plan or programme has determined under s. 9(1) that the plan or programme is unlikely to have significant environmental effects. The Secretary of State may direct at any time that a plan, programme or modification is likely to have significant environmental effects, s.10(3). The terms “minor modifications” and “small areas at local level” are not defined, and are likely to prompt debate. Although it might be argued that a local plan determines the use of small areas at local level such an interpretation would be unlikely to find favour with the European Court of Justice, given the central role of local plans in the current system of land use control in the UK⁷³. Large scale hydrogen filling stations could fall into these Regulations. This depends on the amount of fuel storage, the size of the station and the sight of the authority and the Secretary of State.

Hydrogen producing stations and mobile plants need consent from the local authority. The Pollution Prevention and Control (England and Wales) Regulations 2000 (PPC) defines “producing” as producing in a chemical plant by chemical processing for commercial purposes substances⁷⁴ for s.4.2 of Schedule 1. Public participation requirements apply to all applications for permits to operate new Part A installations and to variations authorising substantial changes in the operation of a Part A installation or variations resulting from a review by the regulator of a Part A installation under regulation 15(2)(a). The exemption for an experimental plant used for research, development and testing in order to improve the incineration process and which treats less than 50 tonnes of waste per year is specified more concrete than in the Directive 96/61/EC.

The on-site production of hydrogen at the filling station is interesting from renewable energy sources. Chapter 2.1.1.3 of this study refers to filling stations, too.

⁶⁹ LHP transport projects – Near term deployment plan for the LHP, Ch. 5.1

⁷⁰ SI 1999/293; Schedule 1 of the Regulations refers to a chemical installation with two or more chemical processes.

⁷¹ Roland Schwab, l.c. chapter 3.1.2.1

⁷² SI 2004/1633

⁷³ Jonathan Robinson and David Elvin Q.C. in The Environmental Assessment of Plans and Programmes, p. 1028 (1037), [2004] J.P.L., AUGUST _ SWEET & MAXWELL AND CONTRIBUTORS

⁷⁴ from Directive 96/61/EC; see chapter 2.1.1.2 of this study

2.3.2 Health and safety

2.3.2.1 Health and Safety at Work

The health and safety at work at filling station is a major point to observe. The employees as well as the customers are concerned from the risks of petrol, diesel, LPG and hydrogen. Petrol and diesel in the neighbourhood are every day life and people are used to their dangers. This could be achieved for hydrogen as well, when they are used to the properties of hydrogen.

The Provision and Use of Work Equipment Regulations 1998 is placing duties on employers and others having control of work equipment, of persons at work who use or supervise or manage its use or of the way it is used, to the extent of their control. For further details chapter 2.1.2.4 of this study applies.

The other Regulations named in chapter 2.1.2 are relevant for filling stations, too. There is barely a difference for people in industrial plants and filling stations for COMAH, CHIP and DSEAR. The ATEX 95 in EPS and ATEX 137 in DSEAR 2002 have the same meaning for the producers and help to take risks from employees and customers by safer equipment. For health and safety concerns of employees of the stations The Regulatory Reform (Fire Safety) Order 2005 and The Fire Precautions (Workplace) Regulations 1997, amended 1999, implement the Directive 89/654/EEC concerning the minimum safety requirements for the workplace.

Most commentators accept that petrol filling stations require some controls over and above those available in DSEAR, mainly to reflect the fact that petrol filling stations are very public places. These additional controls would include:

- Advance notification of certain information to the petroleum enforcement authority;
- Special regulatory requirements relating to those persons who work on and use petrol filling stations.

This could be hold for hydrogen as well, because it is not as common as traditional fuels. Because of Technical Regulations for Compressed Gases (Technische Regeln Druckgase TRG 400 ff) the German Technical Inspection Agency (TÜV) demands at a German hydrogen filling station big signs for customers with guidance for refilling and safety. In this way the filling procedure is easy to be internalised by the customers and the risk of failures minimized. In a similar way this will be standard in the whole EU.

The HSE publishes LACs to support with advice the Local Authorities Enforcement Officers. Special circulars for filling stations (PETEL) give advice to the Officers and applicants for safety guidance. Some points are flammable gas detectors with two alarm levels, portable fire extinguishers, garaging and garage design guidance, overnight parking, smoking prohibitions and ducting. Some PETEL refer to LPG and if the guidance does not affect the physical properties of LPG it is a useful safety advice for hydrogen as well⁷⁵.

To ensure that the objectives of preventing major accidents and limiting their consequences taken into account in land-use planning policies and that these objectives are pursued through controls are the main requirement of The Planning (COMAH) Regulation 1999⁷⁶. The requirement to ensure that planning authorities set up appropriate consultation procedures to facilitate implementation of these and other policies are also taken from Article 12 of the Directive 96/82/EC.

It is to carry out a COSHH assessment regarding exposure to fuel. The Petroleum Licensing Authority⁷⁷ is responsible for ensuring safety at sites where petrol is delivered, stored and dispensed. Although even LPG is not subject to The Petroleum (Consolidation) Act 1928 the Petroleum Licensing Authority may take its presence into account in determining the conditions on any licence that may be issued under the Act⁷⁸. Care should be exercised to ensure that any conditions imposed do not conflict with guidance given on the safe storage and handling of alternative fuel types. If the not subjected LPG is a safety aspect responsible to the Licensing Authority's Petroleum Officers, hydrogen at filling stations could be responsible to the Petroleum Officers as well. This is the case if any part of the hydrogen (or LPG) installation may effect the petroleum installation.

The Fire Authorities may become involved with these installations in connection with the fire certification duties under The Fire Precautions Act 1971. If a licence issued under The Petroleum

⁷⁵ http://www.hse.gov.uk/LAU/Lacs/m_s.htm#65

⁷⁶ SI 1999/743, see footnote 13

⁷⁷ Enforcing authorities under the Health and Safety at Work etc. Act 1974 made by Petroleum (Consolidation) Act 1928.

⁷⁸ <http://www.hse.gov.uk/LAU/LACS/52-12.htm>

(Consolidation) Act 1928 is in force s. 31 of this Act shall not have effect in relation to any term, condition or restriction imposed in connection with the issue, renewal, transfer or variation of such licence. The fire authority in the case of premises subject to the requirements for fire certification has the duty to inspect the filling station before allowing the application.

Mobile refuellers (not trailers) not used on the road, e.g. purely for internal transport on-site, are not subject to the Road Vehicles (Construction and Use) Regulations 1986 but are subject to the Health and Safety at Work Act 1974.

2.3.2.2 Hazardous substances consent

The quantity threshold of more than 50 tonnes of hydrogen at a filling station is barely conceivable; Schedule 1 on The Planning (Hazardous Substances) Regulations 1992.

Q* is the Quantity for the purposes of note 4 to the notes to Parts A and B. There is the explanation about the addition of quantities on a plant. The complicated form is:

$$q1/Q + q2/Q + q3/Q + q4/Q + q5/Q + \dots > 1.$$

If Q* is available then qx (hazardous substance present) is to be divided by this quantity Q*. Natural gas and LPG is also Q*. For these substances, the divisor to be used is the controlled quantity for the generic category of substance in which it would normally fall⁷⁹. This is interesting for a full service filling station. If the sum of the quantities is more than 1 then the controlled quantity of each of the substances which are added together shall be deemed to be present for the purposes of sections 4(2), 14(2)(c), 23(2)(a) and of section 11(5) of the 1990 Act and others. Note 4 to Part A and B has to be read to understand, maybe. If these add to a sum of 1 or greater, then a consent is required for each of the substances which have been included in the addition. Substances with unrelated hazards are not added together, so toxic substances are not added to flammable ones.

An exemption is provided under which small quantities of a hazardous substance may be disregarded when calculating the quantity of hazardous substances present at a site. Amounts not exceeding 2% of the relevant controlled quantity of a substance may be disregarded if their location at the site is such that they cannot act as an initiator of a major accident elsewhere on the site. The responsibility for determining whether such small quantities of hazardous substances are in a location which cannot act as an initiator of a major accident elsewhere on a site is, in the first instance, one for the site operator. In doing so, he will wish to take into account his responsibilities under the Management of Health and Safety at Work Regulations 1992 which require risk assessments to be made of the danger arising from the presence of these substances at the site and for these to be submitted to HSE. Site visits by HSE inspectors will seek to ensure the exemption is not being abused.

For the purposes of hazardous substances consent this exemption does not apply to pressurised LPG. LPG is a substance numbered 6, 14, 35 and 39 in column 1 of Part A of Schedule 1 and therefore excluded from the exemption in s.4(6) on The Planning (Hazardous Substances) Regulations 1992. The storage of pressurised LPG, even in such small amounts as 2% of their controlled quantities, is considered by HSE to have the potential to create a significant off-site risk. Hydrogen is number 11 and therefore not excluded from the exemption. Interesting is the on-site storage at filling station. Compressed hydrogen is not named but if the HSE thinks there will be an off-site risk with the 2% amount they could handle it like pressured LPG.

The physical property of rushing and burning into the air without a heat emitting flame could reduce the concerns for off-site risks. Just an explosive atmosphere if the hydrogen is caught against rushing into the air can have the same concerns like for LPG. Liquefied hydrogen shouldn't have a different approach.

2.3.2.3 Health and Safety Executive

HSE's role in the land use planning system is to provide local authorities with advice on the nature and severity of the risks presented by major hazards to people in the surrounding area so that those risks can be given due weight, when balanced against other relevant planning considerations, in making planning decisions. This role is recognised by the requirement at Article 10 of The Town and Country Planning (General Development Procedure) Order 1995 (GDPO) for HSE to be consulted on:

⁷⁹See chapter 2.1.2.1

- proposed development involving the siting of new establishments where hazardous substances may be present; or
- modifications to existing establishments which could have significant repercussions on major accident hazards; or
- proposed development that is in the vicinity of existing hazardous installations and pipelines where the siting is such as to increase the risk or consequences of a major accident; or
- development within an area that has been notified to the local planning authority by the HSE because of the presence of hazardous substances and which involves residential accommodation, or more than 250 square metres of retail floor space, or more than 500 square metres of office floor space, or more than 750 square metres of floor space to be used for an industrial purpose or which otherwise is likely to result in a material increase in the number of people working within or visiting the notified area.

There is also a requirement for HSE to be consulted on every application for a hazardous substances consent. HSE may advise either on a case-by-case basis or, for certain more straightforward proposals, through the issue of generic guidance. HSE's role is an advisory one⁸⁰. It has no power to direct refusal of planning permission or of hazardous substances consent. Where HSE advises that there are health and safety grounds for refusing, or imposing conditions on an application, it will, on request, explain to the local planning or hazardous substances authority the reasons for the advice. Where that advice is material to any subsequent appeal, it is prepared to provide expert evidence at any local inquiry.

GDPO 1995 requires local planning authorities to consult with HSE in respect of certain proposals to develop land within an area notified to them by HSE because of the presence within the vicinity of (also) flammable substances. The types of development within this consultation zone on which HSE is to be consulted include

- all residential development;
- retail, office and industrial development above floor areas specified in paragraph (d) of the table in Article 10;
- and any development likely to result in a material increase in the number of persons working within or visiting the notified area.

The local planning authorities have to consult with HSE and the Environment Agency and, in appropriate cases, with the Nature Conservancy Council for England on development

- involving the siting of new establishments;
- consisting of modifications to existing establishments which could have significant repercussions on major accident hazards;
- including transport links, locations frequented by the public and residential areas in the vicinity of existing establishments, where the siting or development is such as to increase the risk or consequences of a major accident.

It is possible that some proposed developments falling within the scope of this stanza may also fall within the scope of the stanza above, Article 10(d). In considering proposed development and in consulting on those proposals, it is for planning authorities to assure themselves that the requirements of both subparagraphs have been satisfied.

The Secretary of State exercises the power to call in applications very selectively. Applications are only called in if they raise planning issues of more than local importance, including safety issues of exceptional concern or other major planning issues. Call in of hazardous substances consent applications will be similarly selective. In accordance with this policy, HSE will normally consider its role to be discharged when it is satisfied that the local authority is acting in full understanding of the advice received and the consequences that could follow. It will consider recommending call in action only in cases of exceptional concern or where important policy or safety issues are at stake.

2.3.2.4 London County Council Act

For a London petroleum filling station s. 69 of The London County Council (General Powers) Act 1933 is still in force with three not repealed sections and regulates that the control of these stations is attached to consent of the local authority. In ss.(2) they say:

⁸⁰ DCLG - Circular 04/00: Planning controls for hazardous substances, see also chapter 2.1.2.2

"The local authority may attach to any consent under this section such terms conditions and restrictions as they may determine in relation to the layout of and the approach to and egress from any proposed petroleum-filling station and any other matters relevant to the prevention of obstruction to traffic and a consent to which terms conditions or restrictions have been so attached is in this section referred to as a "conditional consent."

2.3.2.5 Employers

Generally employers are required under the Health and Safety at Work etc Act 1974 to secure the health, safety and welfare of people at work and to protect those not at work from risks to their health and safety arising from work activities. This obtains to all people at work. For the purposes only of enabling regulations The Health and Safety at Work etc. Act 1974 (Application to Environmentally Hazardous Substances) Regulations 2002, amended 2005, are in force to extend the reference to dangerous substances in section 1(1)(c) of the Health and Safety at Work etc Act 1974 to include environmentally hazardous substances.

The Management of Health and Safety at Work Regulation 1999⁸¹ require all employers and self-employed people to assess the risks to workers and others so that they can decide what measures need to be taken to fulfil their statutory duty.

The Provision and Use of Work Equipment Regulations 1998⁸² will apply to fuel cells in most work situations and impose duties to ensure that the equipment provided is suitable and appropriate.



Figure 4: Hydrogen filling station in Berlin, Germany(left) and in Hornchurch, London (middle and right)

2.3.3 Planning of filling stations

2.3.3.1 Planning procedure

The planning procedure within the UK is a complex process, which can only be understood when making an application.

The Primary legislations are:

- The Town and Country Planning Act 1990; with The Planning (Hazardous Substances) Act 1990
- The Planning and Compensation Act 1991
- (The Greater London Authority Act 1999)
- The Planning and Compulsory Purchase Act 2004

A planning procedure is not required for permitted developments⁸³, certain changes of use within the same Use Class or from one Use Class to another⁸⁴. Filling stations are not listed in the Use Classes. They are "sui generis", what means class of their own kind. This class always need a planning application to be submitted. In normal circumstances, proposals for petrol filling stations, and roadside services are unlikely to be acceptable in Green Belts, Areas of Outstanding Natural Beauty and

⁸¹ SI 1999/3242

⁸² SI 1998/2306

⁸³ The Town and Country Planning (General Permitted Developments) Order 1995; SI 1995/418, amended several times, Drafts 2006 to this Order and Circulars do not change anything for hydrogen

⁸⁴ The Town and Country Planning (Use Classes) Order 1987, Amended 2005 (SI 2005/84)

Countryside Policy Areas. This was a problem with the Hornchurch station (see Figure 4) as well, because this was planned in the Green Belt of London.

The Planning and Compulsory Act 2004 introduced some major changes to the planning system. A key aim of the Planning and Compulsory Purchase Act 2004 is to provide a speedier and more efficient planning system. The power for a local authority to make a Local Development Order (LDOs) is intended to facilitate that aim. A LDO would, in effect, grant permission for the type of development specified in the LDO and by so doing, negate the need for a planning application to be made by the developer. A LDO can only be made to implement policy contained in a local planning document. These permitted development rights are set out in The Town and Country Planning (General Permitted Development) Order 1995 (GPDO). These Secondary Legislations, Regulations and Orders, set out detailed procedures and requirements.

Hydrogen filling stations, storage and production are not included. A planning application would not be able to progress with greater speed and certainty as well as the developer would not be required to save the planning application fee or commit the resources associated with the preparation of an application.

The amended Planning (Hazardous Substances) Act 1990 provides that the presence of a hazardous substance on, over or under land at or above the controlled quantity requires hazardous substances consent, see chapter 2.3.2.2.

The requirement for hazardous substances consent does not override the need for planning permission to be obtained where development of land is also involved⁸⁵. This may arise, for instance, where it is proposed to erect buildings for the storage or processing of hazardous substances. Where both planning permission and hazardous substances consent are required, two separate applications will be necessary and the respective statutory requirements must be followed. It may not be possible, or practicable, to act upon one authorisation without having obtained the other. Developers and local authorities will, so far as is possible, wish to ensure that related applications for hazardous substances consent and for planning permission are dealt with together. This will help ensure speedier resolution of the applications and will avoid unnecessary duplication in providing information.

The hazardous substances authority will usually be the same council or other body that would act as the local planning authority in dealing with any associated application for planning permission. This will help ensure consistency in the handling of any linked applications. The hazardous substances authority will usually be the council of the district or London borough in which the land is situated.

A main part in the planning procedure is the public. Everybody who is somewhere involved can raise safety concerns about hydrogen, mainly safety concerns. For example: In a public hearing for a hydrogen plant an inhabitant was concerned about a second Tschernobyl in his neighbourhood. This example underlines the necessity that the public has to be enlightened about the properties and risks of hydrogen.

In the planning system a commercially interesting point for the operating company is the duration of the planning process. This is a fraught situation because the applicant does not know if and when the application is approved. It depends on the complaints of the public, appeals after denying and concerns of the authorities. A petrol filling station in Roundway was approved after astonishingly after just nine weeks, while another station in Hindhead, first refused was approved only after 26 weeks. Because of a change in the application a Station in London Great Central needed even 40 weeks for the approval.

2.3.3.2 Planning permission for buildings

Building Regulations 2000⁸⁶ are made under the Building Act 1984. They revoke and replace with amendments the Building Regulations 1991 and consolidate all subsequent amendments to those Regulations. They impose requirements on people carrying out certain building operations like the erection of shop buildings and other service facilities. These Regulations for the most part carry forward the provisions of the 1991 Regulations, as successively amended, with minor alterations to clarify the sense or to reflect changes in other legislation. Applicable requirements are set out in Schedule 1 for building work. Schedule 2 exempts from control the erection of, and work in connection with certain buildings and extensions.

⁸⁵ DCLG - Circular 04/00: Planning controls for hazardous substances, see also chapter 2.1.2.2

⁸⁶ SI 2000/2531

2.3.3.3 PPG and PPS

PPG and PPS⁸⁷ establish Government planning policies that apply across England and with respect to a wide range of issues. They explain the relationship between planning policies and other policies which have an important bearing on issues of development and land use. Local authorities must take their contents into account in preparing their development plans. The guidance may also be relevant to decisions on individual planning applications and appeals. To supplement and update PPG and subsequent PPS, the Government from time to time issues planning circulars. PPG will be replaced by PPS as the Planning and Compulsory Purchase Act 2004 is implemented. Planning applicants should have a look into the PPG and PPS before.

2.3.3.3 Trunk road network and Roadside Service Facilities

The Policy IC 15 of the Planning Service⁸⁸ relies on roadside service facilities on the trunk roads network in the open countryside. A clear indication of need is important for the permission of new stations. In normal circumstances it is considered reasonable to expect a driver to travel at least 12 miles along the main traffic route network before reaching a petrol filling station or service centre (on either side of single carriageway roads). Proposals for new facilities within 12 miles of existing services will therefore not normally be acceptable. Proposals which would lead to traffic hazards will not be permitted. Stations should have an access arrangements and be designed for one-way working and should be accessible without dangerous right-turning movements across traffic flows. Also an adequate screening by landscaping will normally be required. In normal circumstances, proposals for petrol filling stations, and roadside services are unlikely to be acceptable in Green Belts, Areas of Outstanding Natural Beauty and Countryside Policy Areas. The Hornchurch station in the Green Belt of London is delivered by road transportation, Figure 5.

The extension with a hydrogen filling dispenser may be considered on an existing filling station. Proposals will carefully be considered to ensure that they can be satisfactorily integrated into the local landscape.

⁸⁷ <http://www.planningportal.gov.uk/england/professionals/en/1020432881271.html>

⁸⁸ http://www.planningni.gov.uk/AreaPlans_Policy/Strategies/PlanStratforRuralNI/Part3_Policies/IC/IC15.htm

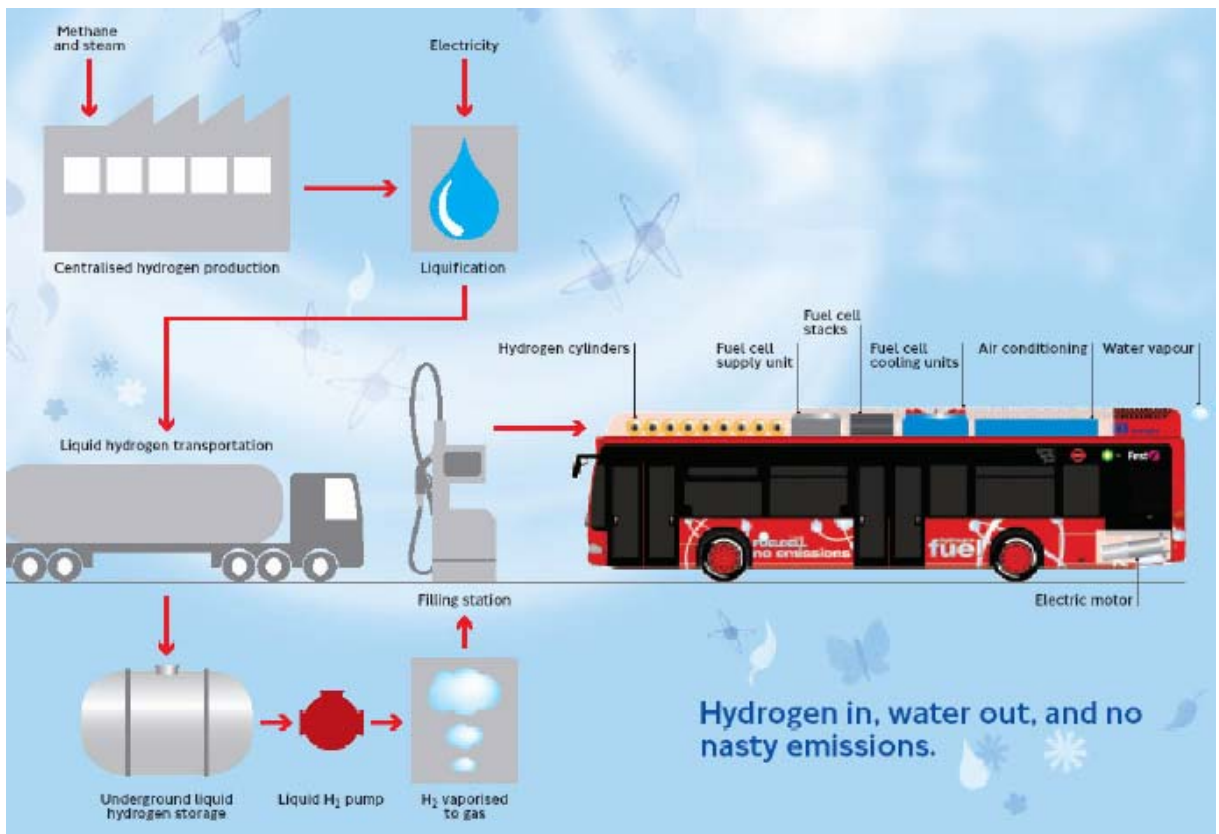


Figure 5: The process chain for the hydrogen filling station in Hornchurch for the London busses

2.3.4 Funding for filling stations

2.3.4.1 Grant for installations and stations

The Department for Transport offers a grant for installations of alternative refuelling stations⁸⁹. This shall help improve the country's refuelling network and will then encourage the uptake of clean, alternatively-fuelled road vehicles in the UK. Funding is provided on a first come first served basis. 30% of eligible costs are permitted for natural gas/biogas, hydrogen and bioethanol refuelling stations, pumps and dispensers, an additional 5% is permitted for a specific location and operator.

2.3.4.2 First-year capital allowances

Budget 2002 of the Treasury introduced 100% first-year capital allowances for investments in hydrogen refuelling infrastructure. Interestingly hydrogen fuel is therefore defined in an act. This act is the Capital allowances Act 2001, s.45E, inserted by the Finance Act 2002, s. 61 and Schedule 20. There "hydrogen fuel" means a fuel consisting of gaseous or cryogenic liquid hydrogen which is used for propelling vehicles. The section regulates a first-year qualifying expenditure on unused and not second-handed plant or machinery for a gas refuelling station for vehicle refuelling. It includes the storage tank, any compressor, pump, control or meter and any equipment for dispensing hydrogen fuel to fuel the tank of a vehicle. The amount of the first-year allowances is 100%⁹⁰. The period for the expenditure is ending with 31st March 2008. There are special rules for cars costing more than £12,000. They restrict the annual allowances that can be claimed to a maximum of £3,000. They also restrict the deductions for tax that a business can make for its lease rental payments if it leases the car. The expenditure is incurred between 17 April 2002 and 31 March 2008.

⁸⁹ <http://www.est.org.uk/fleet/Vehicles/Alternativefuels/Fundingforalternativerefuellingstations/>

⁹⁰ S. 52 of the Capital Allowances Act 2001

2.3.5 Fuel duty

Pilot projects for the use of hydrogen in transport have been exempted from fuel duty, with the intention of maintaining this exemption “for a limited period to encourage its further development and early take-up”. This includes hydrogen from any source. In principle, setting a limited period of time for duty exclusion is unhelpful, and stronger signals could be sent to existing and potential users of hydrogen if a volume of hydrogen were used instead. In this way the exemption could be either stopped or tapered off as the use of the fuel became more widespread, allowing those involved the time to anticipate and develop their supplies⁹¹.

2.3.5.1 Road fuel gas and hydrogen

The definition for “road fuel gas” has different meanings in the acts and regulations. In the Finance Act 1998, section 60, it means any substance which is gaseous in normal environment. There is an amendment to the Taxes Act 1988⁹². The section 168AB reduced the price of the road fuel gas cars as regards each relevant year shall be treated as the price given by section 168A, reduced by so much of that price as it is reasonable to attribute to the car's being manufactured in that way rather than in such a way as to be capable of running only on petrol. Section 168AB was repealed by the Income Tax (Earnings and Pensions) Act 2003⁹³.

In s.5 of the Hydrocarbon Oil Duties Act 1979 (HODA) “road fuel gas” means any substance which is gaseous at a temperature of 15°C and under a pressure of 1013.25 millibars, and which is for use as fuel in road vehicles. The same meaning is used in s.171 of the Income Tax (Earnings and Pensions) Act 2003.

From the logical aspect hydrogen is a road fuel gas, because in the Capital Allowance Act 2001 in section 45E hydrogen fuel is apart of the definition for gas refuelling stations. Then it is not far-fetched to see hydrogen as a road fuel gas, too.

This is further supported by the HMRC Reference to the VAT Act 1994, Notice 701/19 from January 2002. Under point 4.4 they say supplies of gases for use as road fuel are always standard-rated. VAT is due on the total value, including the excise duty. Point 4.3 names hydrogen as example of gas. On an enquiry at HMRC they would rely on the definition on HODA 1979.

2.3.5.2 Excise duty

At s.8 on HODA 1979⁹⁴ the consideration is that hydrogen is used as fuel for the engine provided for propelling the vehicle. The current excise duty 2006 is £ 0.1221 a kilogram if its not natural road fuel gas (£ 0.1081 a kilogram).

Fuel cells vehicles could be part of this excise duty as well, if the second definition of fuel applies also for an engine which draws its fuel from the same supply as that engine (the engine provided for propelling the vehicle). The second engine refers to any other engine - essentially the sort that powers ancillary machinery like a refrigeration system on an HGV used to carry foodstuffs, but might also include the sort of fuel cells engine. There should be more clearance from HMRC unit of expertise dealing with gas as road fuel. Because the excise duty shall range widely we assume the definition of a second engine which draws its fuel from the same tank could include fuel cells which are connected upstream of an electric engine. Otherwise following the phrase fuel cells are not in the meaning and the aspect of government's help for the wide range market launch of fuel cells is unaccounted for.

⁹¹ UK Carbon reduction potential from technologies in the transport sector for UK Department for Transport and Energy Review Team by E4tech, Final Report, 10th May 2006; point 1.8.1.2

⁹² Income and Corporation Taxes Act 1988 (c. 1),

⁹³ Repealed by the Income Tax (Earnings and Pensions) Act 2003, ss 722, 724(1), Sch 6, Pt 1, paras 1, 24, Sch 8, Pt 1.

⁹⁴ in the sub-section (6) of the s.8 of the Hydrocarbon Oil Duties Act 1979

2.3.5.3 Renewable Transport Fuel Obligation (RTFO)

The RTFO places a legal requirement on transport fuel suppliers to ensure that a specified percentage of their overall fuel sales is from a renewable source. In the Energy Act 2004, renewable transport fuel is defined as

- any solid, liquid or gaseous fuel (other than fossil fuel or nuclear fuel) which is produced:
 - a) wholly by energy from a renewable source; or
 - b) wholly by a process powered wholly by such energy; or
- any solid, liquid or gaseous fuel which is of a description of fuel designated by an RTF order as renewable transport fuel.

This would mean that hydrogen from electrolysis using renewable electricity (e.g. sunlight, waterpower or wind) or from biomass routes, would be included in this definition, and should therefore count towards RTFO targets, and so be supported by the Obligation. Hydrogen from fossil or nuclear energy sources would be excluded. Only hydrogen produced wholly from renewables or biomass (presumably with wholly renewable inputs) would be included at this juncture, which may be excessively strict. Note, however, that the Energy Act allows for the RTFO to be amended to include other renewable transport fuels, or to make provisions on how different fuels are to be counted towards the discharging of an obligation, relating, amongst other things, to fuel descriptions, specific substances, sources of energy, methods and processes. The levels of obligation for the years 2008/9 (2.5%) to 2010/11 (5%) were set out in Budget 2006.

2.4. Production, servicing and recycling of hydrogen vehicles

2.4.1 EC-type approval

European type approval definitions⁹⁵ which provide that Member States must set up a system for granting EC type approval for light passenger vehicles was implemented in The Motor Vehicles (EC Type Approval) Regulations 1998⁹⁶. The Directives contain provisions which prohibit Member States registering or permitting the sale or entry into service of such vehicles, unless they are accompanied by a valid EC certificate of conformity. Automotive EC Directives and ECE Regulations require third party approval - testing, certification and production conformity assessment by an independent body. Each Member State is required to appoint an Approval Authority to issue the approvals and a Technical Service to carry out the testing to the Directives and Regulations. An approval issued by one Authority will be accepted in all the Member States.

In the UK, the Vehicle Certification Agency⁹⁷ (VCA) is both Approval Authority and Technical Service. Part II of these Regulations contains provisions relating to applications to the Secretary of State for EC type approval and the duties of holders of type approval granted by the Secretary of State including a duty to supply an EC certificate of conformity with each vehicle and to affix an approval mark to each part that conforms with the approved type. Subject to specified exceptions, Part III of the Regulations prevents the Secretary of State from issuing a first licence or registering a light passenger vehicle, unless it either has an EC certificate of conformity or has a Minister's approval certificate issued under s. 58(1) of the Road Traffic Act 1988.

2.4.2 Product related Regulations

2.4.2.1 Registration and licensing

The Road Vehicles (Registration and Licensing) Regulations 2002⁹⁸ revoke and consolidate, with amendments the old regulation from 1971. These Regulations implement the Directive 1999/96/EC relating to measures to be taken against the emission of gaseous and particulate pollutants from compression ignition engines and positive ignition engines fuelled with natural gas or liquefied

⁹⁵ Annex II of the European Council Directive 70/156/EEC, as amended by Council Directive 92/53/EEC, Commission Directive 93/81/EEC and Commission Directive 98/14/EC

⁹⁶ SI 1998/2051

⁹⁷ <http://www.vca.gov.uk>

⁹⁸ SI 2002/2742

petroleum gas for use in vehicles and the Directive 1999/37/EC on the registration documents for vehicles as amended by Commission Directive 2003/127/EC. S.5 enables the Secretary of State to require an applicant for a vehicle licence at one of the rates of duty applicable to vehicles which satisfy the reduced pollution requirements to furnish a reduced pollution certificate, as to which Schedule 2 makes detailed provision. Altogether these Regulations concern, like the name suggests, the registration and licensing of vehicles in relation to the Secretary of State.

2.4.2.2 Product safety and liability

In the safety field, The Consumer Protection Act 1987 establishes a civil law right of redress for death, or injury, caused by using defective consumer goods (the so-called 'product liability' provisions). This right now lies against any supplier (including the manufacturer, or importer), rather than simply the person from whom the goods were purchased, as was formerly the case.

The Act implements Directive 85/374/EEC on to establish a 'general safety requirement' namely, that all goods for domestic use must be reasonably safe, bearing in mind all the circumstances. This requirement has extended even further the Service's involvement with the safety of goods. The Service works closely with inspectors from HM Customs in checking goods at point of importation. Powers under the Act allow suspect goods to be 'suspended' from sale for up to six months, while checks on safety are conducted. If faulty, the goods may be destroyed.

These safety provisions have been extended by The General Product Safety Regulations 2005⁹⁹ which applies the requirement to be safe to all domestic consumer goods. The General Product Safety Regulations 2005¹⁰⁰ implement Directive 2001/95/EC. This Directive superseded Council Directive 92/59/EEC on general product safety which was implemented by The General Product Safety Regulations 1994¹⁰¹ which are consequently revoked by s. 1(2) of these Regulations.

These Regulations impose requirements concerning the safety of products intended for consumers or which are likely to be used by consumers. Consumer vehicles of all kinds as well as products supplied in the course of a service are covered by these Regulations. The regulations also cover vehicles which might be used by consumers although they are intended for professional use only. Regulation 2 defines other key terms such as enforcement authority, distributor and producer. Regulation 3 provides that the Regulations apply except where there are no other specific provisions in rules of Community law other than the Directive. Where there are those other rules apply. The enforcement authorities are defined in s. 10(4) as the different councils (county council, district council, London Borough Council, etc). Where an enforcement authority has reasonable grounds for suspecting that it has been contraventions or could pose risks in certain conditions (e.g. as dangerous good), the authority may serve a suspension notice, a requirement to warn and to mark or a withdrawal or recall notice.

Biofuel and CO₂ emission Regulations are not relevant for hydrogen vehicles. This is lined out in chapter 2.6.1.

2.4.3 End-of-life vehicles

The End-of-Life Vehicles Regulations 2003¹⁰² partially implement Directive 2000/53/EC. End-of-Life Vehicles are vehicles which are waste within the meaning of Article 1(a) of the Waste Directive 75/442/EC and do not apply to vehicles produced in small series as defined in Article 8(2)(a) of Directive 70/156/EC. These Regulations apply to all vehicles independent from the fuel type and concept. A producer is required to use material and component coding standards to facilitate the identification of those materials and components which are suitable for reuse and recovery. It is required that producers publish information on the recoverability and recyclability of vehicles. Part V of the Regulations introduces the Certificate of Destruction (CoD). It is provided that when an end-of-life vehicle is transferred to it for treatment, an authorised treatment facility may issue a CoD to the last holder/owner of the end-of-life vehicle. The Secretary of State will enforce the treatment of end-of-life vehicles put on the market on or after 1st July 2002 by means of a certificate of compliance procedure. Schedule 3 provide for the form and content of the CoD.

⁹⁹ SI 2005/1803

¹⁰⁰ SI 2005/1803

¹⁰¹ SI 1994/2328

¹⁰² SI 2003/2635

2.4.4 Health and safety at production and service plants

The use of hydrogen at production plants for testing the vehicle will supposedly proceed in the same way like conventional vehicles. For the health and safety at work with stored hydrogen the same Regulations like at the industrial production of hydrogen, chapter 2.1.2, and at filling stations, chapter 2.3.3, are relevant for this chapter.

In addition to trained personnel in a generic support base for hydrogen vehicles, hydrogen compatible maintenance facilities are required¹⁰³. The requirements for hydrogen maintenance facilities are fairly onerous. The facilities must have:

- Good ventilation
- Hydrogen detection throughout
- A strategy for explosions (often requiring explosion relieving walls)
- A full safety procedure to avoid explosion in the event of hydrogen detection
- Limits on other materials stored in the vicinity of the hydrogen (e.g. Oxygen)

Converting an existing garaging facility to allow hydrogen maintenance will require considerable expense for the proprietor. A secured revenue stream will be required before an independent operator will look to equip their garage for hydrogen operation.

2.5 Use of hydrogen vehicles

2.5.1 First year allowance

As also announced in Budget 2002, subject to the outcome of a Green Fuel Challenge pilot project, the Government intends to exempt hydrogen from fuel duty for a limited period in the future to encourage further development and early take-up. The Government discussed with stakeholders the issues raised by the taxation of hydrogen fuel production for road transport to ensure that the necessary analysis is in place to implement the exemption and to make decisions about the fiscal framework in the future. First-year allowances of 100% are available for electrically-propelled and new cars with CO₂ emissions no greater than 120 mg/km, s.45D on The Capital Allowances Act 2001. The CO₂ emission figure may not exceed 120 mg/km and the car is registered on the basis of an EC certificate of conformity, or an UK approval certificate. The expenditure is incurred between 17 April 2002 and 31 March 2008.

2.5.2 Vehicles emission

The Directive 2005/55/EC and Directive 2005/78/EC relating to the measures to be taken against the emission of gaseous and particulate pollutants from compression-ignition engines for use in vehicles, and the emission of gaseous pollutants from positive-ignition engines fuelled with natural gas or liquefied petroleum gas for use in vehicles is one of the separate Directives under the type-approval procedure laid down by Directive 70/156/EEC as specified in Article 1 with the exception of those vehicles of category N1, N2 and M2 for which type-approval has been granted under Directive 70/220/EEC on measures to be taken against air pollution by emissions from motor vehicles.

In the UK and in Germany this Directive is not implemented yet. The UK published a revised draft on The Road Vehicles (Construction and Use) and Motor Vehicles (Type Approval for Goods Vehicles) (Great Britain) (Amendment) Regulations 2006¹⁰⁴. These Regulations amend the Road Vehicles (Construction and Use) Regulations 1986 to incorporate the requirements of Directives 2005/55/EC and 2005/78/EC, as amended by Directive 2006/51/EC, on vehicle emissions into the domestic requirements concerning the design, construction, equipment and use of vehicles. They also amend the provisions relating to emissions requirements for end-of-series vehicles to ensure that European law is fully implemented. Finally, they align the calculation of the maximum number of vehicles from 50 to 100 that may enter into service under the emissions end-of-series provisions, both under the Construction and Use Regulations and under the Motor Vehicles (Type Approval for Goods Vehicles) (Great Britain) 1982 with that used in European law.

¹⁰³ LHP transport projects – Near term deployment plan for the LHP, Ch. 6.1

¹⁰⁴ http://www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_612037.pdf

Vehicles not used on the road, e.g. purely for internal transport on-site, are not subject to the Road Vehicles (Construction and Use) Regulations 1986 but are subject to the Health and Safety at Work Act 1974¹⁰⁵.

The Directive has effects on developers of techniques of the service life examination, selective catalytic reduction (SCR) catalyser as well as for the necessary inspection techniques. SCR means the catalytic transformation of harmful exhaust gases into natural air components. The SCR catalyst in the diesel engine converts the nitrogen oxides contained in the exhaust gas by reduction into water and nitrogen. The SCR technology is momentarily one of three variants, in order to keep the EURO V threshold. The Euro IV standard from the 98/69/EC is the relevant standard for NO_x and PM thresholds. The discussion of halve the values of the Euro IV standards is obsolete. Euro V will come into force from 2009. The NO_x emission for Otto engines, which is the relevant value for hydrogen vehicles, will be reduced from 80 to 70 mg/km. The PM of both Otto and Diesel engines shall become 5 mg/km.

2.5.3 Vehicle Excise Duty

All businesses making payments of excise duties when excise goods including alcohol, tobacco and oils are removed to the UK home market from either a producer's premises or an excise warehouse. The Graduated Vehicle Excise Duty (VED) is the UK annual circulation tax on vehicles. The system of VED for hydrogen powered vehicles is based on the European type approval definitions. If a vehicle is of a type for which the manufacturer has an approval certificate that specifies a CO₂ emissions figure in terms of grams per kilometre (g/km) driven it is treated as a car and taxed according to CO₂ emissions and a prescribed fuel type.

2.5.3.1 CO₂ emission figure

An approved CO₂ emissions figure for vehicle benefit purposes is available if the vehicle is type approved M1. Vehicles from other EU countries have been subject to similar rules about type approval to those that have applied for UK vehicles since 1 January 1998. You can therefore expect vehicles first registered in other EU countries and then imported into the UK to have an approved CO₂ emissions figure¹⁰⁶. The rules operated by the various vehicle registration bodies about what constitutes a type of vehicle are quite broad and vehicle manufacturers have taken different approaches to the amount of detail in which they define a vehicle type. But at the very least we would expect there to be separate approval certificates and therefore separate CO₂ emissions figures for different models of vehicle, and within each model range for different:

- engine sizes
- engine types
- fuel types
- transmissions (whether manual or automatic transmission)
- body styles (estate/hatchback/saloon) and number of doors
- model years (the same car produced at different times with different specifications).

Company car taxes are also based on CO₂ emission. There will not necessarily be separate approval certificates for different levels of trim/fitting out of the car. An altered vehicle is more or less a normal car from a series of a manufacturer. A type approval could, if necessary, revert to the existing type approval.

¹⁰⁵ <http://www.hse.gov.uk/LAU/LACS/52-6rev.htm>

¹⁰⁶ <http://www.hmrc.gov.uk/manuals/eimanual/EIM23375.htm>



Figure 6: BMW Hydrogen 7, the world's first hydrogen-powered luxury performance car

Car benefits for hydrogen vehicles without a first year allowances or other funding could be in the following way. A hydrogen car, like in Figure 6, would be a type B car, which are bi-fuel cars and cars that run on gas alone¹⁰⁷. The lower threshold of CO₂ emissions (135 g/km) has appropriate percentages of 15% for a petrol-powered car. The reduction from the basic car benefit charge 2006/07 is 2%. Extra adjustment formerly available for very low CO₂ emission cars no longer applies. These reductions do not apply to qualifying low emissions cars (QUALECs). Section 139 of the Income Tax (Earnings and Pensions) Act 2003¹⁰⁸ inserts QUALECs which is a car with a CO₂ emissions figure which does not exceed a statutory limit for the tax year. QUALECs apply from 2008/09 only. Subject to the adjustments below, the appropriate percentage for QUALECs is 10%. However, there are no further reductions if the QUALEC uses alternative fuels. Therefore hydrogen fuel profits sparsely from this regulation, not more than LPG and CNG.

Cars with no CO₂ emissions figure will be taxed according to engine size. If the car has an internal combustion engine with one or more reciprocating pistons, the appropriate percentage (of its price) for the year is ascertained from the following Table:

Table 7: Tax for cars with no CO₂ emission figure

Cylinder capacity of car in cubic centimetres (ccm)	Appropriate percentage
1,400 or less	15%
More than 1,400 but less than 2,000	25%
More than 2,000	35%

A hydrogen propelled car with no CO₂ emission figure would be part of the last group. The BMW Hydrogen 7, for instance, has a cylinder capacity of 6000 ccm. The Ford Focus C-MAX H2 ICE uses the normal 2300 ccm engine. The Mazda RX- 8 Hydrogen RE with 1300 ccm would cover the first group. Within the definition "road fuel gas" these cars have a CO₂ emission figure.

¹⁰⁷ Sections 125(3) and 137 ITEPA 2003; Regulation 6 of The Income Tax (Car Benefits) (Reduction of Value of Appropriate Percentage) Regulations 2001, SI 2001/1123

¹⁰⁸ ITEPA, as amended by Finance Act 2006, s.59

2.5.3.2 Prescribed Types of Fuel

The fuels currently listed in the Graduated VED (Prescribed Types of Fuel) Regulations 2001¹⁰⁹ are road fuels gas propelling a vehicle only, or vehicles capable of being propelled by petrol and road fuel gas, or electricity and either petrol or diesel, or bio-ethanol. Section 5 on The Vehicle Excise and Registration Act 1994 exempts specified vehicles from the VED. But because there is no specification in Schedule 2 (there is no Schedule 2) this section is a drafting provision.

Budget 2006 announced the reduction of the VED rate to zero for cars in Band A, reductions for bands B and C, increases for Band F and the new Band G. If hydrogen would not be one of the prescribed fuel types, a hydrogen vehicle would be out of the scope of the Graduated VED scheme. Such a vehicle would fall to be licensed according to cylinder capacity in the Private and Light Goods taxation class.

On request at HMRC and for logical aspects shown above hydrogen is a "road fuel gas" and therefore a prescribed type of fuel. Then the CO₂ emission figure Band A is the relevant VED class, because the CO₂ emission of a pure hydrogen vehicle is zero, for a bi-fuel hydrogen vehicle it depends on the petrol CO₂ emission. The Band A says an emission of less than 100 g/km. The information on request at the HMRC the unit of expertise dealing with gas as road fuel was that the tax liability of hydrogen fuel cells is currently under review, and as such no definitive answer can be given at this moment.

The Euro 4 Light Goods Vehicles tax class (light goods vehicles registered on or after 1st March 2003, which have EURO 4 status) will close as of 31st December 2006 to new registrations. If hydrogen vehicles will be implemented there, is not likely.

2.5.4 VAT for private use of road fuel

The Value Added Tax (Consideration for Fuel Provided for Private Use) Order 2006 implements Article 2 of Directive 86/356/EEC in the s.56, 57 of the Value Added Tax Act 1994 which requires flat-rates for road fuel. VAT is payable if road fuel of a business is used for private motoring.

In a 12 month period an engine with more than 2,000 ccm has to pay £ 2,035 in 2006, increased by 11% since 2005.

2.5.5 Motor Insurance

Directive 2005/14/EC amending Directives 72/166/EEC, 84/5/EEC, 88/357/EEC and 90/232/EEC and Directive 2000/26/EC are relating to insurance against civil liability in respect of the use of motor vehicles. In the UK the minimum legal requirement for Car Insurance is Third Party Only Cover. Car Insurance companies will generally offer three types of Car Insurance cover. The Road Traffic Act 1988 as amended by Road Traffic Act 1991 deals not only with the car insurance but also with many aspects of road law. Part 6 is the most important section so far as motor insurance is concerned. It sets out the compulsory requirements for the minimum cover and what a motor insurance policy needs to include to be compliant with the law. It also sets out what information should be included on a certificate of motor insurance. This section also includes the requirements of motor insurance policies to include provision for payment of emergency treatment fees for hospital treatment of traffic casualties.

2.5.6 Power Shift and allowances

No grants for cleaner vehicles have been available from PowerShift since March 2005. This means that there is currently no financial support for individuals wishing to buy hybrid, battery or flex fuel vehicle.

The PowerShift register is the authoritative source for information regarding vehicles which are eligible for discount from the Transport for London congestion charge scheme. Full electric vehicles are not included on the PowerShift register, which regards the CO₂ emission, as they are already exempt from the congestion charge scheme, free from road tax, free or discounted from parking fees;

¹⁰⁹ Graduated Vehicle Excise Duty (Prescribed Types of Fuel) Regulations 2001, SI 2001/93

owners still need to register their vehicles with Transport for London. Hydrogen vehicles can sign in the PowerShift register to save the congestion charge¹¹⁰.

2.6 Miscellaneous

2.6.1 Regulations not occurred to hydrogen

Hydrogen is not related to the following Regulations:

- The Climate Change Levy (Fuel Use and Recycling Processes) Regulations 2005
- The Manufacture and Storage of Explosives Regulations 2005
- The Biofuels and Other Fuel Substitutes (Payment of Excise Duties etc.) Regulations 2004
- The Biofuel (Labelling) Regulations 2004
- Passenger Car (Fuel Consumption and CO₂ Emissions Information) Regulations 2001

Climate Change Levy (CCL) is charged on supplies of electricity, gas and solid fuels that are not for domestic or charity use. Supplies for non-fuel use are exempt from the levy if the person to whom the supply is made intends to cause the commodity to be used otherwise than as fuel, as are supplies for fuel use in a prescribed recycling process¹¹¹. It depends on Schedule 1 of The Climate Change Levy (Fuel Use and Recycling Processes) Regulations 2005¹¹² (CCL 2005). What is listed shall not be seen as fuel. On the other hand, what is not listed is to be taken as fuel. Natural gas as feedstock to produce hydrogen and for hydrogenation reactions is listed and therefore with the Schedule 6, s. 18(1), on The Finance Act 2000 exempted from the levy; also electricity in electrolysis for the production of basic materials directly from an ore or other compound (electrowinning). Hydrogen itself is not part of Schedule 1 but as road fuel gas exempted from taxable commodity, s. 3(2) of Schedule 6.

The Manufacture and Storage of Explosives Regulations 2005¹¹³ relies to explosives of class 1 of UN ID, but hydrogen is class 2.

The Biofuels and Other Fuel Substitutes (Payment of Excise Duties etc.) Regulations 2004¹¹⁴ occurs not to hydrogen, because "fuel substitute" means a liquid that is charged with fuel substitute duty¹¹⁵. A definition of a substitute which is not a liquid is not available in these Regulations.

The Biofuel (Labelling) Regulations 2004¹¹⁶, which extend to the UK, transpose Article 3.5 of Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport explains biofuel as liquid or gaseous fuel for transport produced from biomass. Hydrogen, if produced wholly from biomass (biohydrogen), would be part under this definition. But section 3 just demands only bioethanol, biodiesel or any blend containing more than 5% by volume of biofuel, whether bioethanol, biodiesel, or both for labelling requirements. Therefore biohydrogen is not part of these regulations.

The Passenger Car (Fuel Consumption and CO₂ Emissions Information) Regulations 2001¹¹⁷ implement Council Directive 1999/94/EC which relates to the availability of consumer information on fuel economy and CO₂ emissions in respect of the marketing of new passenger cars. Such information is measured in accordance with Council Directive 80/1268/EEC and is referred to in these Regulations as "official fuel consumption" and "official specific emissions of CO₂" figures. The Regulations apply to all new passenger cars for which an EC certificate of conformity has been issued. The provisions of the Passenger Car Fuel Consumption Order 1983¹¹⁸ which also regulate this area, are disapplied in respect of such vehicles. Duties are imposed on suppliers of and dealers in passenger cars to which the Regulations apply. S.4 of these Regulations apply to motor vehicles with at least four wheels which are within category M1 of Annex II of Directive 70/156/EEC, amended by Directive 2000/40/EC. In the definition it says motor vehicles are those which emit at any time CO₂,

¹¹⁰ <http://www.est.org.uk/fleet/Informationcentre/FundingandGrants/LondonCongestionChargediscount/>

The final decision for eligibility remains with Transport for London

¹¹¹ S. 18(1) of The Finance Act 2000, Schedule 6 (Exemption: supply not used as fuel)

¹¹² Climate Change Levy (Fuel Use and Recycling Processes) Regulations 2005, SI 2005/1715

¹¹³ SI 2005/1082

¹¹⁴ SI 2004/2065

¹¹⁵ Defined in s. 6A(7) of The Hydrocarbon Oil Duties Act 1979

¹¹⁶ SI 2204/3349, amended by the Biofuel (Labelling) (Amendment) Regulations 2005 to correct relations to Scotland

¹¹⁷ SI 2001/3523

¹¹⁸ SI 1983/1486

hydrocarbons or carbon monoxide. Hydrogen vehicles do not emit carbon compounds at any time. Also, there are no standardised testing procedures for hydrogen vehicles.

2.6.2 Politics and policy

2.6.2.1 The CUTE and the Hyfleet:CUTE Project

There are a number of fuel cell vehicle demonstration projects currently running in London, including three fuel cell buses, a fuel cell taxi, a park utility vehicle. Clean Urban Transport for Europe (CUTE) is an EU project for the demonstration of hydrogen fuel cell bus fleets in major cities across Europe. The project is mainly EU-funded, but it is also provided significant funding through the Transport Energy New Vehicle Technology Fund. The Busses have been refilled at a BP hydrogen filling station in Hornchurch which is close to London. The problems in the planning procedure occurred because the station was built in the Green Belt of London. The CUTE-Project and Hyfleet:CUTE as the follow-up project in Europe run out and the station in London shall be closed at the beginning of 2007. Because of the great public acceptance the busses run further. London plans 17 hydrogen busses until 2010 and the idea in 2004 was to establish 5-12% of all new busses in the UK using hydrogen fuel cells.

Soon, up to a dozen buses will be added as London spends tens of millions on its experimental fleet of "hydro-vehicles". If the test proves successful, London's bus fleet could switch to hydrogen sometime in the next decade. By 2010, the hydro-fleet shall have grown to 70. There could also be expected hydrogen-powered emergency vehicles, police cars and road sweepers¹¹⁹. For another EU Member state Shell and MAN signed a contract in September 2006 to implement 20 hydrogen busses in Rotterdam.



Figure 7: CUTE Bus at work in East London, 2004

2.6.2.2 The UK Energy White Paper 2003

The UK Energy White Paper 2003 provides an entry point to thinking about the hydrogen economy in the UK policy context. The White Paper offered an acknowledgment of a series of issues – environmental, in particular climate change; declining indigenous energy supplies; and ageing energy infrastructures – facing UK energy policy and posited a number of goals for addressing these issues. These included: cutting UK carbon dioxide emissions by 60 per cent ‘by about’ 2050 with ‘real progress’ by 2020; maintaining the reliability of energy supplies; the promotion of competitive markets both domestically and internationally in addressing ‘sustainable’ economic growth and improving productivity; and ensuring that every home is adequately and affordably heated.

A series of policy measures were set out in the White Paper which outlined a role for hydrogen and fuel cells as part of a future ‘fuel mix’ with an emphasis on the contribution of energy efficiency and renewables, but with a deferment of a decision on a possible future nuclear contribution.

¹¹⁹ <http://technology.guardian.co.uk/weekly/story/0,,1823961,00.html>

In this the White Paper pointed out that:

“We do not propose to set targets for the share of total energy or electricity supply to be met from different fuels. We do not believe Government is equipped to decide the composition of the fuel mix. We prefer to create a market framework, reinforced by long-term policy measures, which will give investors, business and consumers the right incentives to find the balance that will most effectively meet our overall goals.”

In view of this, the White Paper outlined a role for hydrogen and fuel cells in which: ‘Hydrogen looks likely to play a key role in future low-carbon energy systems’ and in particular ‘seems likely to play a key role in future transport technologies’. Support for this in the White Paper was detailed around a number of measures including, for example, support for fuel cell research part-funding of the trialling of fuel cell buses by Transport for London in 2003 and the supporting hydrogen fuelling station being installed by BP in Hornchurch; and working with London and other local and regional organisations on a wider network of demonstration trials, including linkages with existing local hydrogen distribution networks such as that on Teesside.

The Energy White Paper did, however, emphasise local and regional scales, suggesting that local authorities and bodies and also Regional Development Agencies ‘make decisions that are vital for energy policy - for example on planning, regeneration and development, procurement, housing, transport and sustainable development’. The White Paper highlighted building on these relationships to ‘develop a new package of measures to promote national objectives through local and regional decision-making’. In many senses this view suggests that the local and regional levels are sites for the implementation of national policy measures.

Appendix 1

Properties of hydrogen

Hydrogen is a chemical element in the periodic table that has the symbol **H** and atomic number 1. The enthalpy of combustion for hydrogen is -286 kJ/mol. The melting point is 14 K (-259.14 °C, -434.45 °F) and more important boiling point is the 20.28 K (-252.87 °C, -423.17 °F). At standard temperature and pressure it is a colorless, odorless, nonmetallic, univalent, tasteless, highly flammable diatomic gas (H₂). The gas is extremely flammable and will burn at concentrations as low as 4% H₂ in air, the explosion limits are going from 4 - 75% while the detonation limit is 18.3 – 59%. When mixed with oxygen across a wide range of proportions, hydrogen explodes upon ignition. Uniquely, hydrogen-oxygen flames are nearly invisible to the naked eye, as illustrated by the faintness of flame from the main Space Shuttle engines (as opposed to the easily visible flames from the shuttle boosters). Another characteristic of hydrogen fires is that the flames tend to ascend rapidly with the gas in air, causing less damage than hydrocarbon fires. Generally it is compressed with 350 bar but high pressure tanks with 700 bar cylinders have been also certified worldwide. Improved tanks for liquid hydrogen storage are developed and required to minimize losses from hydrogen boil-off. The energy density of hydrogen is always 33.3 kWh/kg.

Table 8: Properties of hydrogen as fuel compared with traditional fuel

Fuel	Energy density by volume	Weight
Hydrogen at 350 bar / 5.000 psi	0.8 kWh/liter	22.9 kg/m ³
Hydrogen at 700 bar / 10.000 psi	1.3 kWh/liter	39.3 kg/m ³
Liquid Hydrogen	2.36 kWh/liter	70.8 kg/m ³
Diesel / Petrol	9.7 / 8.8 kWh/liter	~ 80 kg/m ³

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Stefan Garche

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