



dti

**A FUEL CELL VISION FOR
THE UK - THE FIRST STEPS**

Taking the white
paper forward

May 2003



The DTI drives our ambition of 'prosperity for all' by working to create the best environment for business success in the UK. We help people and companies become more productive by promoting enterprise, innovation and creativity.

We champion UK business at home and abroad. We invest heavily in world-class science and technology. We protect the rights of working people and consumers. And we stand up for fair and open markets in the UK, Europe and the world.



An introduction from the Minister



Brian Wilson

“The emerging nature of fuel cell markets and technologies creates a near term opportunity for the UK to influence developments for the long term.”

Today fuel cells stand at the crossroads. No longer a laboratory curiosity, substantial public and private sector investments are being made globally on the basis that commercialisation - long promised - is finally underway. Yet there is also a growing awareness that mass-market applications, particularly the use of fuel cells to replace the internal combustion engine in passenger cars, are still many years away.

The Department of Trade and Industry, together with the Carbon Trust, commissioned a study of the ‘Commercial Potential of Fuel Cells in the UK’¹. One of the key findings of the report (produced by E4tech, and from which the above quotation was taken) was that there was a need for a unified ‘vision’ for the UK fuel cell sector. The Energy White Paper included the development of such a vision as a key objective, along with the establishment of an industry body, Fuel Cells UK.

This document, being published on the day of the launch of Fuel Cells UK, is **not** the UK fuel cell vision. Rather it is a first attempt at a framework from which a common vision can emerge, put together by DTI, EPSRC and Carbon Trust together with Fuel Cells UK. **The development of the vision will require the full engagement of industry, Government and the research community**, and Fuel Cells UK will play a leading role in driving this forward. It certainly represents a considerable challenge, but one to which we are confident the sector will rise.

A handwritten signature in black ink, appearing to read 'Brian Wilson', with a small horizontal line underneath.

¹ See www.dti.gov.uk/energy/publications/pdfs/index.shtml or www.thecarbontrust.co.uk

What is the purpose of this document?

This document is intended to be the starting point for the development of a UK fuel cell vision. Comments and inputs relevant to the development of the vision are invited and can be made directly to Fuel Cells UK and will also be sought via a number of workshops and meetings - details of these are provided in the 'What next?' section at the end of this document. The aim is to launch the UK fuel cell vision at the Grove Fuel Cell Symposium in September 2003. This shared vision is a crucial first step in developing a framework within which strategic actions and investments by all parties can be placed.

A corporate vision statement expresses the ultimate aim to which an organisation aspires and includes the concept of change. The UK fuel cell vision will be written for a whole sector and includes the objectives for the sector at different stages along the way to a long term aim. This vision is intended to reflect realistically attainable positions, whilst setting those positions at a level that will inspire action in order to deliver real benefits for UK plc. The vision will provide a mutually agreed framework for action for all those who participate in, support and follow the UK fuel cell sector. Note that this document is not intended as a business plan or action checklist, though these would be a logical next step for many of the organisations involved in working towards the vision.

Global context

Fuel cells are experiencing a sharp increase in worldwide attention from governments and industry. This is a result of a range of demand and supply side factors, which together identify fuel cells as potentially being a major component of a low carbon economy. On the demand side, there is growing interest in low carbon and low air pollutant emissions technologies, together with concerns over energy security. On the supply side, technologies are approaching the performance and cost targets necessary for entry into the first fuel cell markets, and the long-term market potential is seen as very large. Though the balance of these factors varies by country, several governments have been active in supporting development of the fuel cell sector through integrated strategies. Key examples of this are Canada, the US, Japan and Germany.

Canada is one of the leading countries in fuel cell development and supply, with 17 companies whose primary market focus is fuel cell production and/or integration, and another 80 companies who are suppliers or service providers to the sector. Overall in Canada low and high temperature fuel cells and hydrogen technologies, support over 1,800 jobs. The DTI International Technology Service's mission to Canada in September 2002 found that the development of the industry has been enabled by strong and co-ordinated government support, in the form of direct funding and strategic guidance. For example, government and industry co-operation in road mapping has focused activity in technology and commercialisation. Industry clusters, where research, components and system players are based in the same geographical area, have also enabled considerable collaboration and support.

The US government invested an estimated \$220 million in fuel cell research in 2002. The new integrated Office of Hydrogen, Fuel Cells and Infrastructure Technologies is working with industry, academia and national laboratories to achieve technical goals for fuel cell cost and performance. It is also working with existing Department of Energy initiatives such as the FreedomCAR programme. These have been supplemented by state initiatives, such as the California Fuel Cell Partnership, to provide a regional focus and support for demonstration projects.

Japan is also investing heavily in fuel cell research, investing \$210 million in 2002, and this is expected to increase to around \$240 million in 2003. Federal and local incentives for fuel cells include targets for fuel cell cars and cash and tax incentives for stationary (particularly domestic CHP) and automotive fuel cell use. The Japan Fuel Cell and Hydrogen Project supports vehicle demonstrations and early hydrogen infrastructure and integrates with the long-term World Energy Network national hydrogen program.

The German government has provided significant research funding for fuel cells, and is now shifting resources to encouraging implementation by supporting projects with shared costs, and to acquiring fuel cell power units, buses and infrastructure. Fuel cells are being integrated into legislation, with combined heat and power legislation facilitating fuel cell entry into the stationary power market.

Overall, it is clear that for the UK to benefit from the emergence of fuel cells, it must play a more prominent role on the international stage, and that in order for this to happen it must focus its resources accordingly.

UK context

The Department of Trade and Industry (DTI) has funded research into fuel cell technology since 1992, contributing to total funding of over £92 million. Bids for funding have been assessed by the independent Fuel Cell Advisory Panel, supported by technology route mapping. The Carbon Trust's Low Carbon Technology Assessment also highlighted the relevance of fuel cells, leading to contracts for fuel cell/hydrogen related projects being supported under the Low Carbon Innovation Programme. The EPSRC continues to fund research into fuel cells both at fundamental and applied levels.

Other UK fuel cell activity has included application-specific Government initiatives such as the Low Carbon Vehicle Partnership, announced in the Powering Future Vehicles strategy, to support development of fuel cell and other low carbon vehicle technologies. The Fuel Cell Network, set up in 1998 and now managed by the University of Birmingham, has also facilitated research linkages between members of the UK fuel cell community.

In both high and low temperature fuel cells, the UK now has several companies involved in developing stacks and fuel cell systems. They are supported by a strong technology base, with world class research and development in materials and components both in universities and industry.

In 2002, the DTI and Carbon Trust commissioned a review of the commercial potential for fuel cells in the UK. The aim of this review was to allow DTI and Carbon Trust to develop a shared understanding of fuel cells, their applications and markets, and to use this as a basis for complementary, targeted action. The review identified possible opportunities for the UK in the fuel cell supply chain and in early fuel cell markets. Opportunities were highlighted in the following areas in particular:

- high value application areas such as stationary power systems, auxiliary power units for vehicles and specialist compact portable fuel cells
- IP-led areas of the supply chain such as low temperature fuel cell stack components, high temperature fuel cell systems and materials and some areas within balance of plant

The Energy White Paper, published in February 2003, described an increasing role for fuel cells in the UK's energy system. A key commitment of the White Paper was for government to work with industry to develop a shared vision for how benefit from fuel cell opportunities can be maximised. Other initiatives announced within the Energy White Paper included the launch of the industry network Fuel Cells UK, work with the EPSRC and Carbon Trust to fund fuel cell research, promotion of participation in European projects and support for new start-ups in the sector.

DTI is also developing a web based Fuel Cells Forum, a central hub for academia, industry, venture capitalists and Government stakeholders to exchange and disseminate information and focus on strategic issues. It will provide rapid notification of new developments in areas of fuel cell related news, research, business developments and patents, with the involvement of Science and Technology attachés overseas DTIs International Technology Service.

Developing a shared fuel cells vision for the UK will help inform the development of a framework within which actions can be undertaken to effectively boost the UK fuel cell sector by focusing activity and resources. This investment will come from both government and industry, and as such mutual understanding of roles and goals is essential.

Fuel cell support in the UK

This document has been prepared by DTI, Carbon Trust and EPSRC to act as the platform upon which the wider sector is invited and encouraged to contribute and develop its vision. All three organisations will remain fully engaged as the vision develops and each expects to incorporate it within their future activities. The organisations are also committed to coordinating their actions so that they act in a complementary manner so as to provide comprehensive and appropriate support to the emerging fuel cell sector.

The DTI Advanced Fuel Cells Programme

DTI has been supporting industrial research on fuel cells since 1992 under its Advanced Fuel Cell Programme (part of the Renewable Energy Programme). During its lifetime the focus of the programme has changed from supporting studies designed to inform the Department and the industry regarding the prospects for fuel cells to work to support the development of UK capabilities.

DTI now operate an approach based on the development of a technology route map (prepared in consultation with industry) and regular calls for proposals. The independent Fuel Cells Advisory Panel considers proposals.

Since its inception the programme has supported a total of 156 projects involving total DTI expenditure of £12.4m (total project value £92.4m). Currently the programme is running at about £2m per annum.

EPSRC

The mission of the Engineering and Physical Sciences Research Council (EPSRC) is to support basic strategic and applied research and related postgraduate training in the engineering and physical sciences. In allocating those funds, it is required to pay due attention to meeting the needs of the users of research and training in industry, commerce, government and the service sector and to underpin the quality of life of the UK's citizens.

Research into new and renewable energy technology forms an important part of the portfolio of research targeted at improving quality of life in the UK through improvements to sustainability in energy generation. The portfolio also includes research on photovoltaics, fuel cells, wind power, wave power, biomass and other technology approaches such as the hydrogen economy.

COMPLEMENTARY ACTIONS

The Carbon Trust

The role of the Carbon Trust is to support the innovation required to underpin the commercialisation of new and emerging low carbon technologies. Through its Low Carbon Innovation Programme, it is developing a range of financial instruments to implement this role. In addition, the Carbon Trust uses its influential and impartial position to broker more productive relations in the fuel cells sector and between the sector and Government. The goal here is to help build a solid, robust, commercially vibrant industry sector, focusing on those elements of the emerging fuel cell business (including system design and balance of plant) where the UK can compete successfully.

A common framework

The initial vision is expressed under several categories over the short, medium and long term. The categories and their interaction are summarised in the following graphic and explained in the text below:

Drivers

- direct UK customer demand for fuel cell benefits
- societal benefits which are currently or are expected to be underpinned with policies in the UK
- supplier benefits which result in a better value proposition to customers.

These are relevant for the vision in that they may evolve over time and therefore affect the manner in which the sector should respond

Actors

main types of UK organisations involved (industry, government, research etc)

Applications

uses for which fuel cell systems are developed in the UK

Technologies

main fuel cell families developed or sold in the UK

Fuels

sources and types of fuels available for fuel cells in the UK

Enablers

- UK research priorities
- skills availability for research and development in the UK
- institutions to support fuel cell activities in the UK
- UK pre-commercial demonstrations
- finance availability for fuel cell development
- fuel infrastructure to improve availability of fuels in the UK

Goals

- markets which can be accessed, defined in terms of geography and customers
- sales volumes in these markets
- costs of systems, stacks and key components
- typical financial returns being made by UK players in the fuel cell sector
- environmental benefits being generated by the use of fuel cells in the UK

Initial views

The timescales proposed for development under the categories in the previous section are intended to reflect a conceivable future rather than a very long term horizon. A position for each of these categories is shown in the following table, with blanks left where no initial view is offered.

Category	Sub-category	Short term 2003-2007	Medium term 2008-2012	Long term 2013-2023
Drivers	CUSTOMER BENEFITS	A few will pay premium in niche applications.	Benefits recognised and some will pay premium.	Benefits widely understood and in demand.
	SOCIETAL BENEFITS	International legislation will encourage motor manufacturers to develop FCVs. Financial incentives for purchase of stationary power systems.	Continuing incentives for low emissions stationary power/CHP. Vehicle development encouraged through long term regulation framework.	Benefits internalised through fiscal mechanisms (eg fuel tax) - and no need for explicit subsidy.
	SUPPLIER BENEFITS	Very few. Option play in anticipation of mass market	Some see simplification and diversification benefits.	Fuel cells become lowest cost approach.

Category	Short term 2003-2007	Medium term 2008-2012	Long term 2013-2023
Actors	Typically IP-led spinouts/ startups/ SMEs in fuel cell development.	Companies growing via consolidation. Increasing interest in fuel cell supply chain opportunities from engineering companies.	Global corporations. Low/medium power systems commoditised and made in low cost economies.
Applications	Standalone power systems, domestic CHP, APUs.	Also: Stationary power and CHP.	Entering general use for many stationary and mobile applications.
Technologies	PEMFC, SOFC, MCFC, PAFC, AFC.	PEMFC, SOFC, MCFC, AFC.	
Fuels	Low temp systems mainly cylinder hydrogen, high temp systems mainly natural gas.	Reformers available for most hydrocarbons.	Growing bulk hydrogen infrastructure. Renewable hydrogen emerges later in period.

Category	Sub-category	Short term 2003-2007	Medium term 2008-2012	Long term 2013-2023
Enablers	RESEARCH	Integrated programme by DTI, EPSRC and Carbon Trust. Strong industry-university collaboration mechanisms.	Studies of social, legal and economic impacts. Focus on catalysts/ membranes, fuels (especially renewable), reforming, hydrogen storage, hydrogen economy, integrated FC systems.	Next generation systems focus, low temperature systems.
	SKILLS	Relevant skills are specialist in nature and scarce.	Required skills are becoming mainstream.	Skill sets are readily accessible.
	INSTITUTIONS	Fuel Cells UK and FC Forum focus on supply chain development, capability guide and international networking. Low Carbon Vehicle partnership supports APU development.	Trade Body is supported by the industry.	
	FINANCE AVAILABILITY	Restricted and with high risk premium.	Improving, with lower risk premium.	Simple and varied.
	DEMONSTRATIONS	Limited government support for stationary power/CHP (5-300kW) and transport demos (buses, urban cars).	Large fleet trials in priority urban areas. Large scale stationary power systems (100kw-50MW).	Demonstrations driven and funded by industry for incremental improvements.
	FUEL INFRASTRUCTURE	Little needed or available.	Some for vehicles.	Established hydrogen infrastructure towards end of period.

Category	Sub-category	Short term 2003-2007	Medium term 2008-2012	Long term 2013-2023
Goals	MARKETS	Niches. UPS, remote power, some portable power, military.	Premium applications.	Significant passenger car penetration begins at end of period. Widespread.
	SALES VOLUMES	~10MW/year.	10-100MW/year.	100+MW/year.
	COSTS	£2000-3000/kW.	£200-400/kW. Custom designs attract premium. Lower cost systems result from R&D based on first generation technology. Established manufacturing standards and modular design also.	£50-100/kW. Stacks are second or third generation technology and use low cost material/ manufacture.
	FINANCIAL RETURNS	Not viable without incentives. Highest value in IP, particularly stacks and key components.	Value moving downstream towards integration and O&M. Sales are cash positive, but do not recoup R&D investment.	Commercial. Majority of value in integration, O&M and additional support. UK focus on materials, MEAs and integration.
	ENVIRONMENTAL BENEFITS	Not calculated or given a monetary value.	Calculated.	Calculated and internalised.

What next?

Over the coming months, Fuel Cells UK will seek the full and active engagement of the UK fuel cell sector to develop a UK fuel cell vision. With the aim of launching the agreed Vision at the Grove Symposium in September 2003, the next steps will be:

- 1 Seek initial and general feedback from industry through the launch of Fuel Cells UK (May).**
- 2 Develop the vision further through consultation with the Fuel Cells UK Steering Group (provisional timing: early June).**
- 3 Carry out more structured consultation with industry through the Fuel Cells Forum (provisional timing: early July).**
- 4 Test and consolidate Vision through a Workshop with industry (Provisional timing: early August).**

Fuel Cells UK welcomes informal input to the development of the Vision throughout the process. The vision that emerges will be a dynamic one, and its relevance will be kept under review.

Please email your comments to info@fuelcellsuk.org

DTI would like to thank all those organisations who aided the production of this document.





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