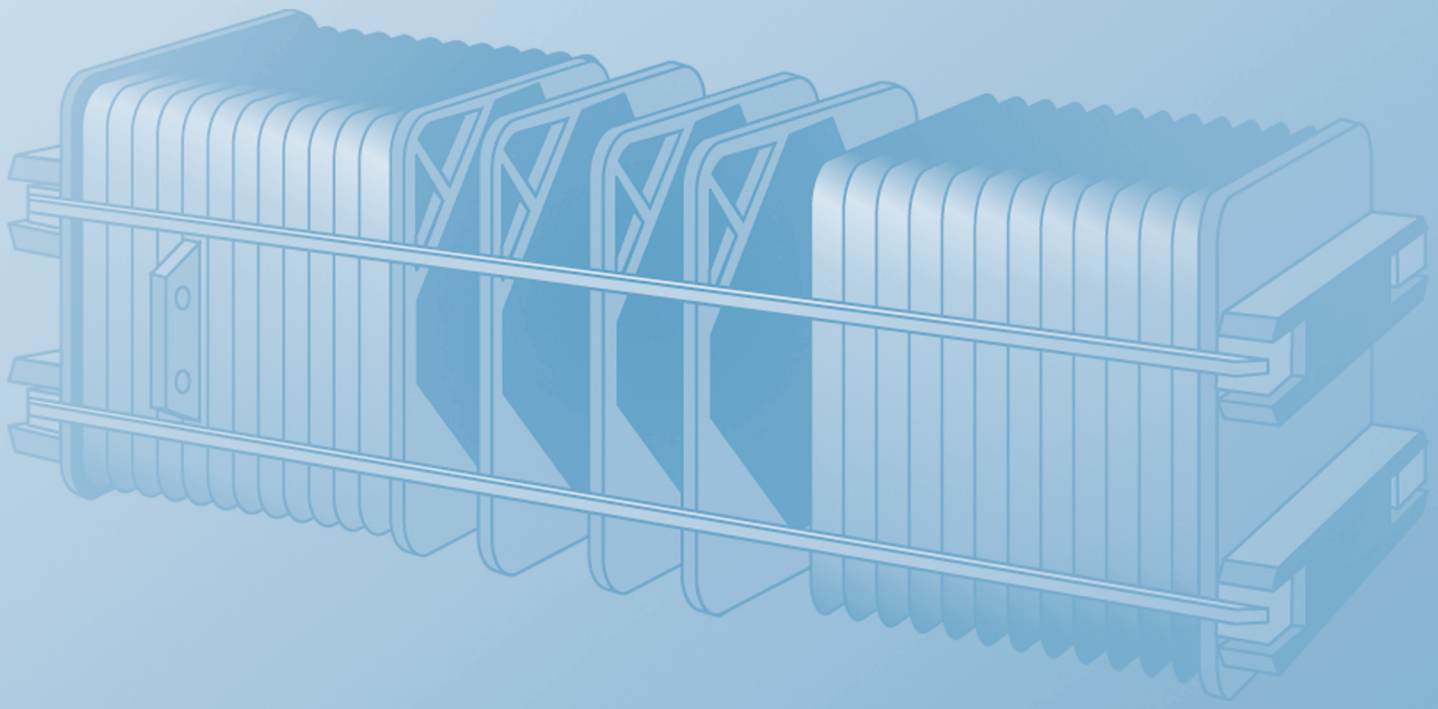
Fuel Cell Vehicle World Survey 2003

Breakthrough Technologies Institute
Washington, D.C. 20006

February 2004



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Notes

Organization. We have organized the auto industry reports alphabetically. The automobile industry is interconnected via cross ownership, and fuel cell research projects are often collaborations. This leads to some duplication in our reports, but we hope it helps the reader to find specific information quickly.

Quotes. The field visits and telephone calls were on a not-for-attribution basis. Any material appearing in quotations in the document comes from published sources.

Photographs and Art Work. We believe that all photos and artwork contained herein are in the public domain. BTI would be happy to attribute these materials to their author wherever appropriate. Please send comments and requests to Jennifer Gangi, Jennifer@fuelcells.org

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Disclaimer

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Executive Summary

Fuel cell vehicles are rapidly appearing all over the globe. In less than 10 years, fuel cell vehicles have gone from mere research novelties to operating prototypes and demonstration models. At the same time, government and industry have teamed up to invest billions of dollars in partnerships intended to commercialize fuel cell vehicles within the early years of the 21st century.

The purpose of this project was to take a snapshot of the global fuel cell vehicle market as it existed at the end of 2003. Although certainly not comprehensive, it provides a good overview of the major fuel cell vehicle products and programs existing at the time.

The picture that emerged from this snapshot is truly amazing. Significant government/industry partnerships are operating in at least 11 major countries and the European Union. These partnerships are pursuing a variety of projects, including the development of "hydrogen highways," fuel cell buses, and fuel cell bicycles and scooters.

At the same time, we identified nearly 20 companies developing light-duty fuel cell vehicles and components. These include nearly all of the world's major vehicle manufacturers, such as Toyota, DaimlerChrysler, Ford, General Motors, Honda, and Mitsubishi. We also identified at least 12 companies or partnerships developing or demonstrating fuel cell buses. This group also included most of the world's leading players, including DaimlerChrysler, Man, Toyota, Volvo, New Flyer, North American Bus Industries, and New Flyer.

Although there are challenges ahead for fuel cell vehicles, one thing is clear: both government and industry appear fully committed to developing and deploying hydrogen- powered vehicles and the related infrastructure. Some countries, like Canada and Iceland, appear fully committed to transitioning from petroleum-based economies to hydrogen-based economies. Although this transition will take decades to complete, it appears that the necessary foundation is beginning to be developed.

Fuel cell vehicles hold great promise. They offer a zero-emission mobility option that is critical for the healthy development of the world's urban centers. They also have great economic potential, as shown by the significant investments made by the private sector to develop and demonstrate fuel cell vehicles.

We are pleased to present this snapshot of the fuel cell vehicle industry as it existed at the end of 2003. We hope that this report will provide a useful tool for policymakers, businesses, and others interested in exploring and developing fuel cell vehicles. We welcome any comments and suggestions.

Selected Research and Demonstration Projects
(12/2003)

COUNTRY	FUNDING
Canada	
Canadian Transportation Fuel Cell Alliance (CTFCA)	CAN$23 million (Canadian Government) to demonstrate fueling options for fuel cell vehicles
Hydrogen Early Adopters ("h2EA") Program	CAN$215 million (Canadian Government) for new concepts, including hydrogen highways
Fuel Cells Canada Hydrogen Village Partnership	Demonstration of hydrogen infrastructure in Toronto
Vancouver Fuel Cell Project	CAN$5.8 million over 3 years
Hybrid Fuel Cell Transit Bus Project (with Hydrogenics Corp.)	CAN$8 million (Natural Resources Canada: CAN$2 million in Phase I, CAN$1 million Phase II. Hydrogenics and its partners are contributing the remainder)
China	Chinese Government pledged $20 million a year for 5 years to FCV research; Chinese Academy of Science to invest $12 million over 3 years on hydrogen technology; GEF will provide $12 million for fuel cell bus development; national and local governments will provide $20 million, with $4 million pledged from private companies
Europe	
European Union	€2.8 billion on hydrogen by 2015; €500 million by 2007; €1.2 billion in 2007–2012
CUTE (Clean Urban Transport for Europe)	EU is contributing €18.5 million to demonstrate fuel cell buses and fueling infrastructure in nine cities (3 buses in each city)
France	€40 million over five years for Clean Vehicles; €5.8 million allocated to fuel cells
Germany	~€55–€60 million in combined federal and state funding for power generation and vehicle development and demonstration
Italy	~€15 million annually, proposed to double to ~€30 million annually for the next three years
Iceland	
Ecological City Transport System (ECTOS)	Demonstration of three fuel cell buses; hydrogen infrastructure activities. ~€9.5 million, €2.8 million from EU, ~€6.7 million from the commercial partners (Shell, VistOrka hf, Norsk Hydro, and DaimlerChrysler)

Japan	
Japan Hydrogen & Fuel Cell Demonstration Project (JHFC)	Multi-company road demonstration. Japanese Government contributed ¥2 billion in 2002 and ¥2.5 billion in 2003
Methanol FCV Project	Ministry of International Trade and Industry will contribute up to ¥300 million (of the ¥1 billion project cost)
United States	
Freedom Car/Hydrogen Fuel Initiative	Will invest total of $1.7 billion to develop hydrogen fuel cells, hydrogen infrastructure, and advanced automotive technologies
National Fuel Cell Bus Technology Initiative (NFCBTI)	Proposing to allocate $150 million in U.S. federal transportation funding for FC bus development and deployment
California Fuel Cell Bus program	Program budget is $18,450,000 for a total of seven buses in three jurisdictions
World Bank/GEF Fuel Cell Development Program	Bus demonstrations in Brazil, China, Egypt, India, Mexico. GEF commitment of 12/03: $24.2 million

Commercialization Timetables[1]

COMPANY	Comments
BMW	First commercial sales before 2008 (gasoline-liquid hydrogen hybrid 7-series, with fuel cell APU a possibility in later models); 25% market penetration after 2020 (if infrastructure can be developed).
DaimlerChrysler	"Fit for daily use" stage 2004 through 2007; "ramp up" and full commercialization stages starting 2010.
Fiat	States "long way from commercialization." Currently conducting on-road demonstration in Milan, Italy.
Ford	Commercialization timetable consistent with DOE's (2012–2015). Interested, with Mazda, in hydrogen combustion engines.
GM	Plans to establish high-volume fuel cell and fuel cell vehicle production capabilities by 2010; looking to sell hundreds of thousands of fuel cells and FCVs by 2020 by entering power generation markets first.
Honda	Announced plans to build 300 FCVs a year for sale in the United States and Japan. Developing its own systems — agreement with Ballard ends in 2005. Continuing to expand vehicle and infrastructure demonstrations.
Hyundai	Plans, with Kia , to test 32 FCVs in the United States beginning 2004; suggests it may sell 10,000 FCVs in Korea by 2010, with commercial production by 2020.
Mazda	Target of 2007 for initial production of hydrogen rotary IC engine.
Mitsubishi	Grandis approved for public roads in Japan in November 2003; plans to commercialize an electrolyzer to support fuel cell vehicles 2005.
Nissan	Long-range fuel cell production strategy is not public; has said it expects to have some FCV production capabilities by 2005.
PSA/Peugeot Citroën	Says technical barriers to FCVs would prevent consumer purchases before 2015; electric hybrids with small fuel cell APUs as range extenders could become commercial after 2005. Focus is on non-hydrogen fuels.
Renault	Unveiled its first and only functional FCV in 1997; dated plans call for prototypes of solid oxide fuel cell APUs by 2008 (a scenario now considered unlikely) and commercial products by 2015; announced plan to have FCV in production by 2010; working with Nissan on gasoline reforming.
Toyota	Asserted FCVs will not be commercial before 2010; generally supports DOE timetable of commercialization decision by 2015.
Volkswagen AG	No timetable announced. Demonstrating a van with a fuel cell APU. Audi, part of the Volkswagen Group, displayed its first-ever fuel-cell-powered vehicle (an Audi A2) powered by a 70-kW Ballard PEM fuel cell.
Bicycles and Scooters	Most companies working on fuel-cell-powered scooters project market introduction in 2004, although that target appears very ambitious.
Boats, Yachts, Submarines	Siemens AG has agreed to supply Greek navy with PEM modules for use as APUs/range extenders in 3 class 209 submarines, delivery to begin 2004.

[1] Data in this table generally represent public statements or inferences drawn from public statements. In many cases, officials in a given company have expressed conflicting views and estimates. Timetables announced in the 1990s generally have slipped.

Introduction

Interest in fuel cell vehicles has skyrocketed over the last 10 years. Government and industry across the globe are developing fuel cell cars, buses, and specialty vehicles, like golf carts and fork lifts.

The Breakthrough Technologies Institute, Inc. (BTI), entered a cooperative agreement with the U.S. Department of Energy (DOE) in 2002 to survey fuel cell vehicle developers, selected energy and component suppliers, and interested government agencies. Our purposes were to:

- Research, assess, and evaluate the current status, strategies, policies, and future plans of governments, major energy companies, major motor vehicle manufacturers, and developers of key components of fuel cells designed for use in motor vehicles in countries outside the United States;
- Attempt to measure the technical progress of companies in international markets against DOE's targets and goals; and
- Assess commercialization plans of companies and government programs to support commercialization.

The goals of the Fuel Cell Vehicle World Survey were revised twice to reflect the results of project outreach activities and the fast-changing fuel cell vehicle landscape. Originally, the goals were quite technical, but as the project progressed, the focus shifted to an overview and report on the status of demonstrations.

The result is this snapshot of fuel cell motor vehicle development and major vehicle demonstrations around the globe. We hope it is useful for U.S. policy makers tracking the worldwide race to commercialize fuel cells and for U.S. companies interested in participating in the coming hydrogen economy.

This is an extremely fast-paced arena. New vehicles are being unveiled and component announcements made at an extraordinary rate. We have made every effort to provide timely and up-to-date information. We welcome corrections, additions, and comments.

The project attempted to gather as much information as possible directly from automobile manufacturers, fuel cell component companies, major energy companies, and governments. There are hundreds, if not thousands, of companies throughout the world working on some aspect of vehicular fuel cell development. The number of governments making significant investments in the development of fuel cells is increasing. To help us reach as many companies as possible, BTI contracted with several consultants, each knowledgeable in a particular region of the world. Extensive additional research was required to assure that BTI adequately surveyed the field.

Three survey methods were chosen: site visits, telephone interviews, and mailed questionnaires. Generally, BTI selected companies that were large enough, well financed enough, or innovative

enough to be likely to play a significant role in the development and/or eventual commercialization of fuel cell automobiles or buses.

One of the early challenges to the study's success involved motivating potential respondents to participate. BTI, in consultation with DOE, decided that priority participants would appreciate a briefing by DOE officials in conjunction with a site visit. The event would be viewed as an exchange of useful information by all of those participating. Site visits were designed to be led by a consultant accompanied by DOE officials.

To encourage the participation of phone and mail respondents, a briefing paper outlining the current U.S. government approach to and initiatives supporting fuel cells for vehicular use was prepared for distribution.

We conducted a total of 53 site visits involving consultants and DOE representatives. Site visits were considered useful to both BTI and DOE personnel and the respondents. Meetings were held in Italy; Germany; the UK; China; Japan; South Korea; and Ottawa and Vancouver, Canada, and averaged two to three hours in length.

We distributed more than 150 questionnaires and made hundreds of telephone calls and additional site visits. Companies responding range widely in capitalization levels and workforce sizes.

Although some companies refused to participate in the study, many respondents were willing to discuss their business activities and their views on fuel cell development and the eventual commercialization of fuel cell vehicles as long as they were assured that their responses were not attributable. There was a greater reluctance to share technical data. We found similar attitudes in our telephone surveys and follow-up consultant visits. Overall, participants were extremely reluctant to share performance data and business projections.

A discussion of the project, including lists of consultants, visits and companies contacted, can be found in the appendices.