Canadian Hydrogen and Fuel Cell

SECTOR PROFILE 2009

Canadian Hydrogen and Fuel Cell Association

Canada

PricewaterhouseCoopers

Canadian Hydrogen and Fuel Cell Sector Profile 2009

Since 2004, the Government of Canada, the Canadian Hydrogen and Fuel Cell Association (formerly Hydrogen & Fuel Cells Canada) and PricewaterhouseCoopers have collaborated to develop a comprehensive profile of the Canadian hydrogen and fuel cell sector. The 2009 Sector Profile follows the previous five editions and provides an overview of the sector's activity. The profile describes the sector in terms of revenue, research, development and demonstration activity, employment, strategic alliances, and research partnerships. These statistics help policy makers, investors and other stakeholders to stay informed about the state of Canada's hydrogen and fuel cell sector.

The Profile is published annually to monitor trends and recognize growth and achievements for this important sector of the Canadian economy. We would like to thank all the organizations that contributed to the development of the Canadian Hydrogen and Fuel Cell Sector Profile 2009.

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Introduction

The Canadian Hydrogen and Fuel Cell Sector Profile 2009 measures key performance indicators and helps to provide an objective assessment of Canada's position within the increasingly competitive global industry. The interest in clean energy research and technologies continues to gain momentum, driven by concerns over the environment and energy security in addition to opportunities associated with industrial development. As the industry advances towards commercialization, the Canadian sector continues to be a world-recognized leader in the field of hydrogen and fuel cell technology. Consistent with other industry sectors in Canada, however, the results of this year's profile suggest that the hydrogen and fuel cell sector experienced the detrimental effects of the global economic downturn and credit crisis in the form of reduced employment and expenditures.

The Industry at a Glance in 2008:

- Revenue was **$195 million**.
- Product sales generated **$88 million** of revenue.
- Research, development and demonstration expenditures were **$142 million**.
- Employment was **1,556**.
- There were **103** demonstration projects reported.
- The number of strategic alliances reported was **79**.
- There were **124** research partnerships reported.

Organization Profile

Organization Type

The 2009 survey divides the corporate category into private, public, and division/subsidiary company subcategories. Overall, corporate organizations represented 64% of total survey participants. Nearly half (49%) of total respondents were private companies, followed closely by government organizations (21%). Public companies and education organizations each made up 11% of respondents. The remaining contributors were subsidiaries of public companies, non-profit organizations and non-government organizations.

Headquarters

Most respondents (95%) reported headquarters of hydrogen and fuel cell activities in Canada. Others were headquartered in the United States and Europe.

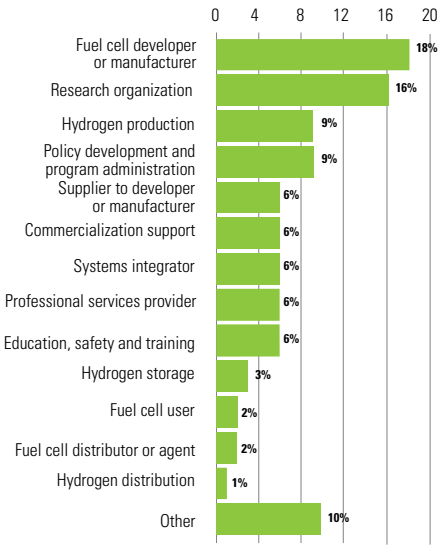
Years of Involvement in Hydrogen and Fuel Cell Activities

Over half of respondents (53%) reported involvement in hydrogen and fuel cell activities for ten years or less.

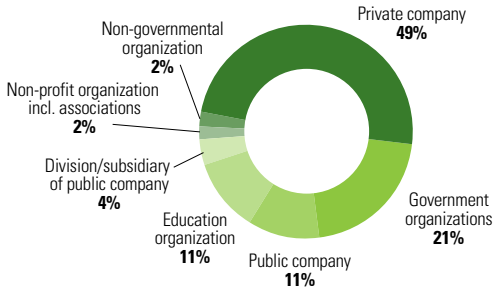
Areas of Expertise

The main areas of expertise were fuel cell developers or manufacturers (18%) and research organizations (16%). Hydrogen production and policy development and program administration each occupied 9% of industry expertise. The 'other' area of expertise category (10%) includes legal services, hydrogen fueling infrastructure and research funding. Each of the remaining areas of industry expertise accounted for less than 9% of overall responses.

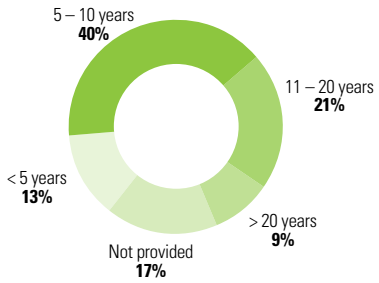
Areas of Expertise



Organization Type



Years of Involvement in Hydrogen and Fuel Cell Activities



Man with hard hat | *Sacre-Davey Engineering*

Market Focus

Stationary applications, including both small and large subcategories, combined represent the largest area of market focus at 36%. The combined mobile application subcategories of portable, primary power and drivetrain and auxiliary power represented the next largest area of market focus at 33%. Fueling infrastructure was another area of focus in 2008 with 31% of respondents listing fueling infrastructure as their main area of focus. The results are broadly in line with those of the 2007 survey.

Technology Focus

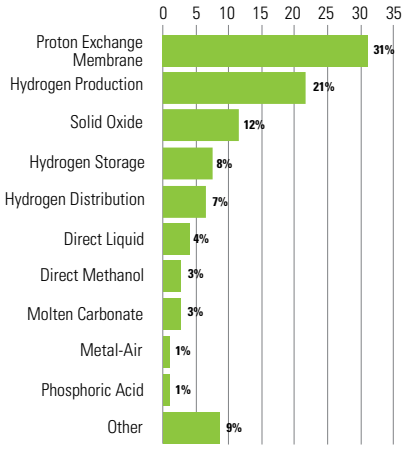
Proton Exchange Membrane (PEM) fuel cells continued to dominate the focus of technology activities at 31%. This finding supports Canada's global reputation as a leader in the development of PEM fuel cell technology for mobile, small stationary and portable applications. The 'other' area of technology focus included the government focused areas of policy development, program administration, and commercialization support, as well as the areas of hydrogen internal combustion engines, fuelling infrastructure, inverter, and control systems.

Hydrogen and Fuel Cell Facilities by Region

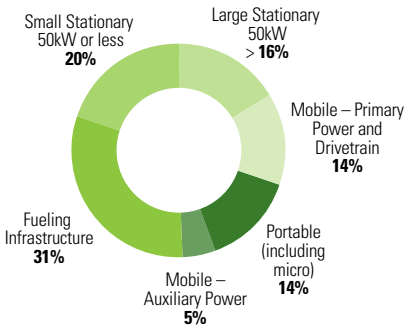
Survey participants reported 84 locations for hydrogen and fuel cell facilities and activities in 2008. In total, 80% of facilities were located in Canada, 10% in the United States, the remaining 10% were overseas in Germany, Japan, Denmark, Belgium, South Korea, Italy, and the UAE.

Within Canada almost every province was engaged in hydrogen and fuel cell activities. The majority of facilities and activities resided in British Columbia, followed by Ontario, Quebec, Alberta, Saskatchewan, Manitoba, Prince Edward Island, New Brunswick, Newfoundland and Labrador, Saskatchewan and Nova Scotia.

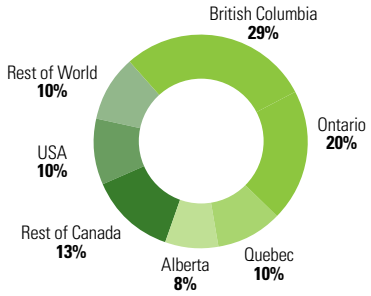
Technology Focus



Market Focus



Hydrogen and Fuel Cell Facilities by Region



Revenue

In 2008, nearly (47%) of respondents participated in revenue generating activities. Survey participants reported revenue from hydrogen and fuel cell activities of $195 million. In 2007, survey respondents reported revenue of $168 million.

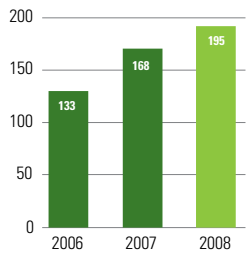
33% of companies surveyed reported more than $5 million in revenue in 2008. Similarly, 29% of respondents reporting revenue had revenue between $1 and $5 million, and 29% had less than $1 million of revenue.

A breakdown of revenue was provided for $176 million of the $195 million of revenue reported. In 2008, the three categories that generated the most revenue were product sales with revenue of $88 million ($83 million in 2007), R&D contracts, (excluding government funded contracts) which generated revenue of $44 million, and provision of services producing revenue of $32 million.

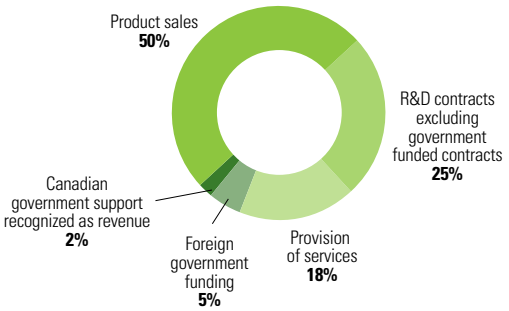
Foreign government funding and Canadian government support were recognized as revenue and together represented 7% of overall revenue in 2008. Additional details for government funding are provided in the research, development and demonstration and funding sections of this study.

Total regional revenue made up $174 million of total revenue of $195 million. The two countries with the most hydrogen and fuel cells related sales were Germany at 28% and the USA at 25%. Canada generated 19% of total revenue. The results indicate that most Canadian revenue was generated in British Columbia.

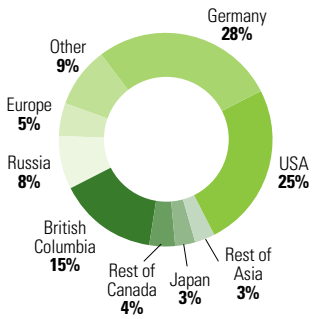
Total Revenue ($ millions)



Revenue by Category



Revenue by Region



Research, Development and Demonstration (RD&D)

In 2008, 53% of respondents participated in RD&D activities, reporting total RD&D expenditure of $142 million. Total research and development (R&D) expenditure amounted to $128 million or 90% of total RD&D spending. Demonstration expenditure for 2008 was $12 million. The $2 million in RD&D spending by Academia and Non-Profit organizations was reported in aggregate.

R&D expenditure reported in 2007 was $211 million which suggests that consistent with other industries in Canada, expenditure activity was affected by the economic downturn and credit crisis.

2008 Total RD&D Expenditure ($ millions)				
	R&D	Demonstration	RD&D*	Total
Corporate	$124.1	$6.1	–	$130.2
Government	$3.7	$6.1	–	$9.8
Academic and non-profit*	–	–	$2.2	$2.2
Total RD&D	**$127.8**	**$12.2**	**$2.2**	**$142.2**

* Reported in aggregate

Night-time stationary fuel cell | *Enbridge Gas Distribution*

Research and Development

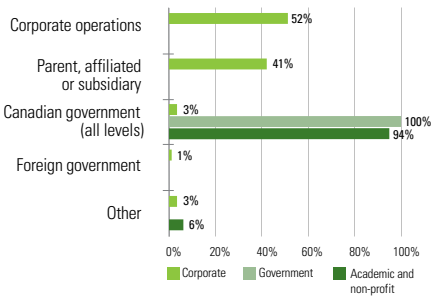
Sources of Funding for R&D

Of the $128 million total reported for R&D expenditure, the various funding sources was provided for only $87 million. Corporate operations supplied funding for 49% of R&D expenditure in 2008, followed by parent affiliated or subsidiary organizations (39%), and Canadian governments (8%). The 'other' category of funding included tax credits.

People Involved in Research

Participants reported that a total of 298 people were involved in hydrogen and fuel cell related research activity. Of the total research people, 32% were Canadian graduate and postgraduate students, 25% were academic/research staff, and 18% were international students.

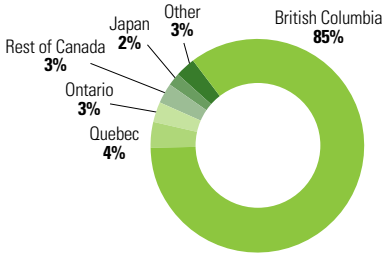
Sources of Funding for R&D Expenditure by Organization



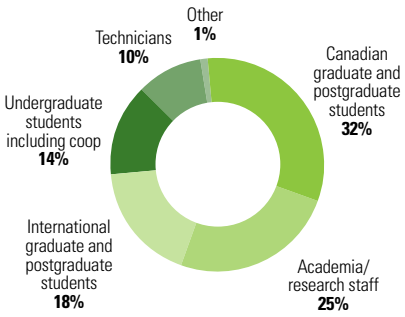
R&D by Region

Geographic data was provided for $94 million of R&D expenditure. British Columbia led all regions with 85% of R&D expenditure. Quebec and Ontario contributed 4% and 3% respectively with the rest of Canada making up a further 3%. Regions included in the 'other' category (3%) include Denmark and China.

R&D by Region



People Involved in Research



2008 Sources of Funding for RD&D Expenditure	R&D $ millions	R&D %	Demonstration $ millions	Demonstration %	Total $ millions	Total %
Corporate operations	$ 43.2	49%	$ 1.6	13%	$ 44.8	45%
Parent, affiliated or subsidiary organization	$ 34.3	39%	$ 0.7	6%	$ 35.0	35%
Canadian government (all levels)	$ 6.8	8%	$ 8.2	67%	$ 15.0	15%
Foreign government	$ 0.6	1%	$ 0.6	5%	$ 1.2	1%
Other	$ 2.4	3%	$ 1.1	9%	$ 3.5	4%
Total	**$ 87.3**	**100%**	**$ 12.2**	**100%**	**$ 99.5**	**100%**

Demonstration Projects

In 2008, survey participants reported their participation in 103 demonstration projects around the world. Government respondents reported their involvement in 55 demonstrations, while corporate organizations took part in 40 demonstrations. Survey respondents from academia took part in 8 demonstration projects.

Sources of Funding for Demonstration

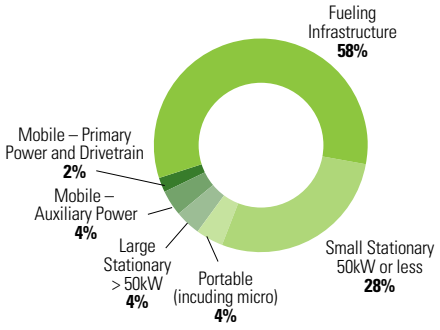
In 2008, Canadian governments funded 67% of the reported $12 million demonstration expenditure and corporate operations funded 13%.

Fueling infrastructure was the main area of focus in 58% of overall demonstration projects. Some 73% of government projects focused on fueling infrastructure. Corporate organizations also focused most (53%) of their attention on demonstrating fuel infrastructure projects with 32% of their efforts spent on small stationary projects.

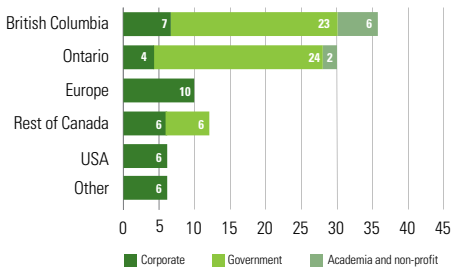
Demonstration by Region

36% of demonstrations took place in British Columbia, followed by Ontario hosting 30% of total demonstrations. Europe and 'other' locations hosted 16% of total demonstrations (including Germany, Scandinavia, Italy, the Netherlands and China). Other Canadian provinces accounted for 12% of demonstrations with the USA hosting the remaining 6% of demonstration projects.

Focus of Demonstration Projects



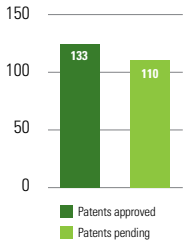
Demonstration Projects by Region (Involvement in Projects)



Patents

In 2008, corporate respondents reported 133 newly approved patents and 110 patents awaiting approval. In 2007, survey participants held 615 patents.

Patents



Employment

Consistent with other industry sectors in Canada, the employment trend suggests that the hydrogen and fuel cell sector experienced the effects of the economic downturn and credit crisis.

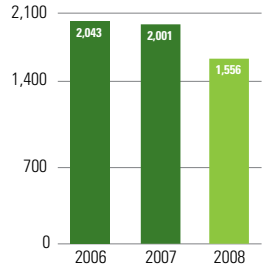
Survey participants reported a total of 1,556 employees involved in hydrogen and fuel cell activities in 2008. A breakdown by region was reported for 1,348 of the 1,556 employees. In 2008, the largest proportion of industry employees was located in Canada at 89%, 5% in the United States, and the remaining 6% overseas in Scandinavia, Belgium, China and Germany.

In Canada, most employees were located in British Columbia (874), followed by Ontario, Alberta and Quebec.

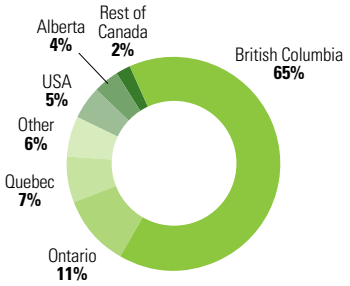
49% of companies surveyed had fewer than 10 employees. 27% had 10 to 25 employees, 8% had between 25 and 50, and 16% had more than 50 employees.

Based on the data provided for number of employees and total salaries, the average annual salary paid to employees was $77,622. Extrapolating the average salary for 2008 to the 1,385 employees in Canada, the sector contributed $108 million in salaries to the national economy.

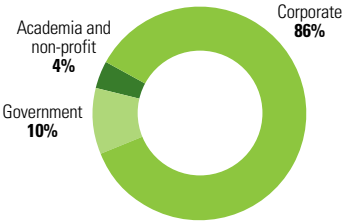
Employment



Employment by Region



Employment by Organization



Ballard Power Systems

Funding Requirements

Continued education of governments and the public on the benefits of investing in the hydrogen and fuel cell industry is an important part of the industry's efforts to secure funding. Given the industry's long development period and demanding RD&D requirements, adequate financing is necessary to bring commercial products to market.

For both government and academia and non-profit organizations funding was allocated primarily to the areas of R&D intramural (38%), in-house R&D (35%), and demonstration and pilot projects (18%). British Columbia received 57% of the funding allocation, 28% went to Ontario, and the remaining 15% to Quebec, Alberta, Prince Edward Island, and Saskatchewan.

Corporate

Corporate participants report the top three sources of funding for 2008 from operations (48%), government (25%) and private equity (17%). The financial requirements for the next five years are estimated to be $271 million with funding expected to come from private equity (73%), operations (16%), and government (7%).

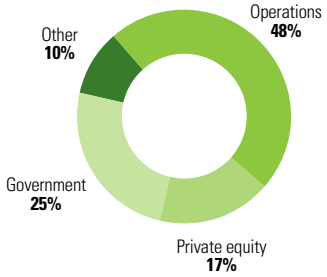
Government

The total budget for hydrogen and fuel cell related activities reported for 2008, for which government was directly responsible, (including employee salaries and benefits) was $26 million. Programs contributed 51% of funding requirements with A-base operations contributing 42%. Details of the 'other' category were not provided.

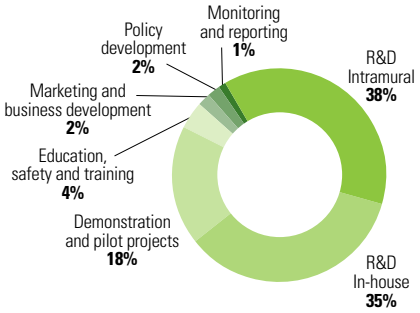
Academia and Non-Profit

The total budget for hydrogen and fuel cell related activities reported for 2008, for which academia and non-profit was directly responsible, (including employee salaries and benefits) was $15 million. The top three sources of funding for 2008 were from the Natural Science and Engineering Research Council of Canada (NSERC)/Canadian Foundation for Innovation (30%), other federal funding, (27%), and departmental budget allocation (22%).

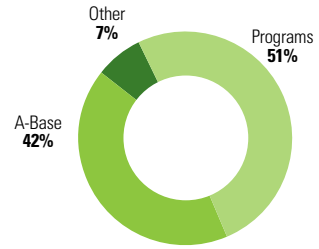
Sources of Funding – Corporate



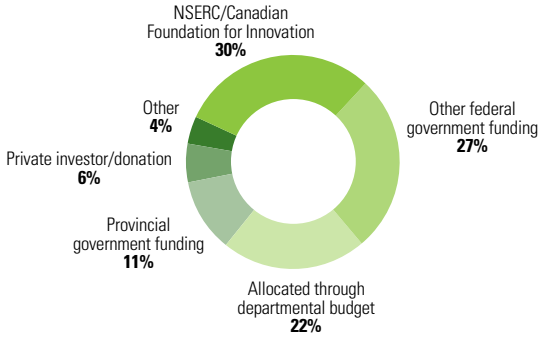
Funding Allocation by Area – Government & Academia & Non-profit



Sources of Funding – Government



Sources of Funding – Academia and Non-Profit

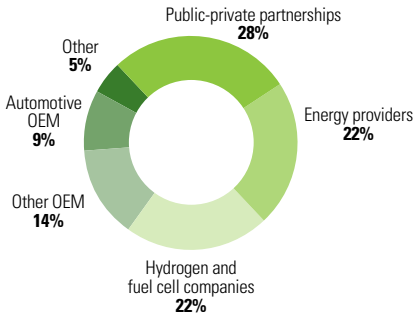


Strategic Alliances

In 2008, respondents reported 79 strategic partnerships and alliances, demonstrating the value and importance of relationships and partnerships to the industry. There were 77 strategic alliances reported by participants in 2007.

Public/private partnerships represented 28% of strategic partnerships. Energy providers and hydrogen and fuel cell companies each made up 22% of partnerships. Other original equipment manufacturer (OEM) accounted for 14%, while automotive OEM made up 9% of partnerships.

Strategic Alliances



Research Partnerships

Research partnerships promote closer collaboration between the university research community and other sectors, including government and Canadian industry. There were 124 research partnerships reported in 2008. Partnerships with industry in Canada represented nearly a third (31%) of all research partnerships. Partnerships with academia/non-profit/associations represents 28% of total research partnerships.

The number of research partnerships signifies the necessity of pre-commercial collaboration in order to address common technical challenges.

The chart below illustrates the many varied types of partnerships and collaboration in the hydrogen and fuel cell sector within Canada and outside the country.

Research Partnerships (Number of Partnerships)	Total
In partnership with industry in Canada	39
In partnership with Canadian academia/ non-profit/associations	35
In partnership with industry outside of Canada	18
In partnership with foreign government	16
In partnership with Canadian governments (federal, provincial/territorial and municipal)	14
Other	2
Total	**124**

Methodology and Response Rates

The 2009 Sector Profile is the sixth annual publication of information on the Canadian Hydrogen and Fuel Cell Industry. As in previous years, existing and potential members of Canadian Hydrogen and Fuel Cell Association, academic institutions, government stakeholders and partners in current hydrogen and fuel cell demonstration activities were asked to voluntarily complete a survey questionnaire.

While the survey questionnaire has remained substantially consistent from the survey's inception, each year the organizers have refined the questions to gather more detailed information to better reflect the industry and its trends. Since the 2007 survey, sections relating to RD&D and funding, specific questions were asked for three types of stakeholders:

- Corporate (public and private organizations);
- Government (government and government agencies); and
- Academia and non-profit (educational organizations, non-profit, and non-governmental organizations (NGO).

In the 2008 study, the organization profile questions were restructured to better align with the Worldwide Fuel Cell Survey and additional data was requested on funding requirements.

A total of 92 organizations associated with hydrogen and fuel cells in Canada were invited to participate in the development of this sector profile. Forty-seven completed responses were received, representing an overall response rate of 49%. A participant list is included at the end of this report.

Not all respondents provided information for every category requested. No investigation was conducted as to the completeness of the data provided by respondents or reasons for non-provision.

All monetary results are presented in Canadian dollars.

Presentation of Data

Figures presented for 2008 were collected by an online questionnaire in 2010. Figures presented for 2007 are as reported in the 2008 Sector Profile and, therefore, may not be fully comparable due to differing respondents and/or basis of individual responses.

Ford fuel cell vehicle | *BC Hydrogen Highway*

Conclusion

In 2008, the Canadian hydrogen and fuel cell sector reported:

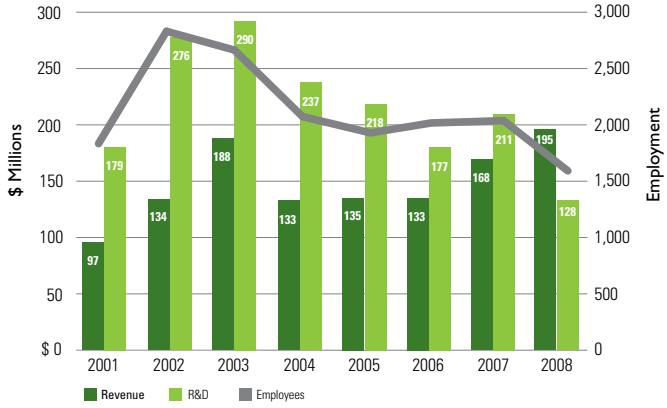
- revenue of $195 million in 2008 with Germany representing the largest revenue region,
- continued commitment to RD&D with $142 million of expenditure,
- employment at 1,556,
- a steady number of demonstration projects (103) since 2007 and a substantial decline in expenditure in demonstration projects ($13 million),
- a consistent number of strategic alliances (79) and fewer research partnerships (124) compared to prior years,
- hydrogen and fuel cell related facilities and activity, RD&D expenditure and employment were largely concentrated in British Columbia.

The Government of Canada, the Canadian Hydrogen and Fuel Cell Association and PricewaterhouseCoopers would like to thank the organizations that took part in this survey. By participating, stakeholders from private industry, government and academia showed their support for improving publicly available industry intelligence. This information will be used to support funding decisions, influence alliance partnerships, and strengthen the overall competitive position of the Canadian hydrogen and fuel cell industry.

Sector Profile Summary

An initial sector profile, The Economic Impact of Industrial Hydrogen Activity in Canada, conducted by Sypher Mueller and Natural Resources Canada in 2001, provided the first glimpse into the sector's early days. Subsequent Government of Canada, Canadian Hydrogen and Fuel Cell Association and PricewaterhouseCoopers Sector Profiles have updated the original industry benchmark study to demonstrate an active hydrogen and fuel cell sector within Canada. Although some data may not be fully comparable due to differing methodology, the chart provides a view of the industry over the eight year period. The results for 2008 suggest that like many, the sector is experiencing the challenges of the economic downturn and credit crisis.

- Revenue has grown 101% – from $97 million in 2001 to $195 million in 2008,
- R&D expenditures have decreased by 29% from $179 million in 2001 to $128 million in 2008. Adding demonstration expenditure brings the RD&D total of $142 million,
- Employment in the industry has decreased by 12% from 1,772 in 2001 to 1,556 in 2008.



Sector Profile Summary

Canadian Hydrogen and Fuel Cell Association (CHFCA)

The Canadian Hydrogen and Fuel Cell Association (CHFCA) is the national association accelerating Canada's world-recognized hydrogen and fuel cell sector. As the sector's collective voice, the CHFCA works to raise awareness of the economic, environmental and social benefits of hydrogen and fuel cells. We are a national, non-profit association providing services and support to Canadian corporations, governments and educational institutions promoting, developing, demonstrating and deploying hydrogen and fuel cell products and services in Canada. Our members cover most types of hydrogen and fuel cell technologies, components, systems supply and integration, fuelling systems, fuel storage, and engineering and financial services.

The CHFCA was formed in January of 2009 as a result of a merger between the Canadian Hydrogen Association (CHA) and Hydrogen & Fuel Cells Canada (H2FCC). The merger unites the members of the former associations to create a vibrant, influential association that represents the majority of the stakeholders in Canada's hydrogen and fuel cell sector.

Industry Canada

Industry Canada's goal is to enhance the competitiveness of Canadian industry. The organization is responsible for maintaining channels of communication with key sectors to facilitate informed advocacy of industry interests in government decision-making and to convey the government perspective back to industry; analyzing the challenges and opportunities that face key sectors in the economy; developing policy options for possible government response to extraordinary challenges and opportunities; and delivering the subsequent program and services.

PricewaterhouseCoopers

PricewaterhouseCoopers understands and supports the fuel cell industry in Canada and around the world. Our network of professional staff drawn from over 163,000 people in over 151 countries has a firm grasp of the issues facing companies in the industry as it evolves towards commercialization. We are continually expanding our knowledge and client base with the goal of being the pre-eminent advisor to the industry in local, national and global markets.

For more information on the Canadian hydrogen and fuel cell sector profile please contact:

John Tak
President and CEO,
Canadian Hydrogen and
Fuel Cell Association

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2009 Participants

Air Liquide Canada

Angstrom Power Inc.

Atlantic Hydrogen Inc.

Automotive Fuel Cell Cooperation

Ballard Power Systems Inc.

Bereskin & Parr LLP

Canadian Hydrogen and Fuel Cell Association

CERC Clean Energy Research Centre

Dantherm Power A/S

Department of National Defense

DMA Technical Services Inc.

dPoint Technologies Inc.

Enbridge Gas Distribution

Four Stones Ltd.

Government of BC, Ministry of Small Business, Technology, and Economic Development

Government of Ontario

Greenlight Innovation

HRH Consulting Services Inc.

HTEC Hydrogen Technology & Energy Corp.

Hydrogen Research Institute

Hydrogenics Corporation

Hyteon Inc.

Industry Canada – Industrial Technologies Office (formerly TPC h2EA and TPC R&D)

Industry Canada – Resource Processing Industries Branch

Kraus Global Inc.

Ku Group

Membrane Reactor Technologies Ltd.

National Research Council Canada

Natural Resources Canada, CANMET Energy

Natural Sciences and Engineering Research Council of Canada

NORAM Engineering & Constructors Ltd.

Palcan Energy Corporation

Plug Power Canada

Powertech Labs Inc.

Sacré-Davey Engineering

Sarnia-Lambton Economic Partnership

Tekion Inc.

TISEC Inc.

University of Calgary

University of Ontario Institute of Technology

University of Toronto, Mechanical & Industrial Engineering Department

University of Toronto Mississauga

Versa Power Systems

Western Economic Diversification Canada

Xebec Adsorption Inc. (merger of Xebec Adsoprtion Inc. and QuestAir Technologies Inc.)

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