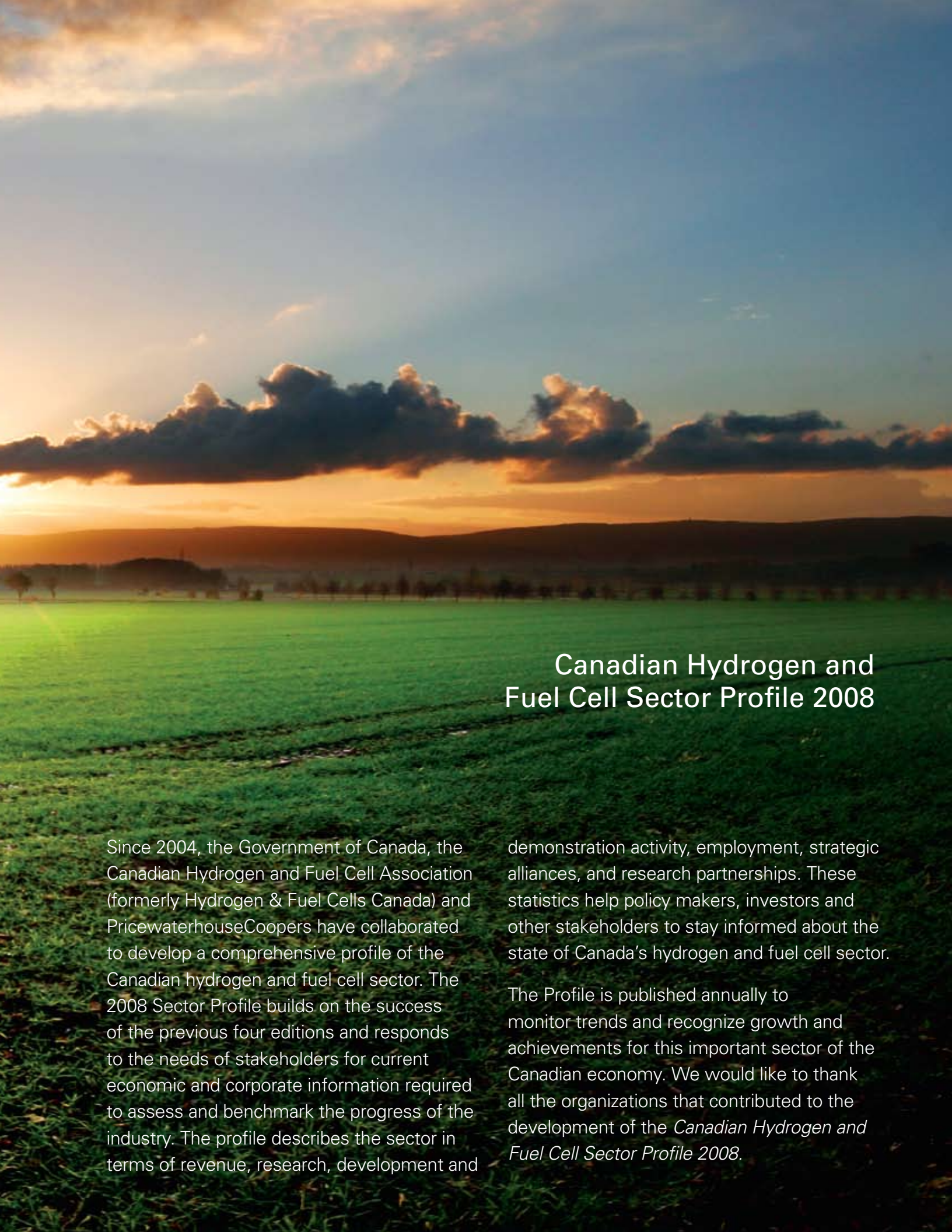
Canadian Hydrogen and Fuel Cell
Sector Profile 2008

Canadian Hydrogen and Fuel Cell Association

Canada

PricewaterhouseCoopers



Canadian Hydrogen and Fuel Cell Sector Profile 2008

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 2008 Sector Profile builds on the success of the previous four editions and responds to the needs of stakeholders for current economic and corporate information required to assess and benchmark the progress of the industry. 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 2008*.

Introduction

The Canadian Hydrogen and Fuel Cell Sector Profile 2008 measures key performance indicators and helps to provide an objective assessment of Canada's position within the increasingly competitive global industry. 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. Notable in this year's profile is the continued commitment of the hydrogen and fuel cell sector to partnerships and investment in clean energy research and development in Canada.

The Industry at a Glance in 2007:

- Revenue increased to $168 million.
- Product sales generated $83 million of revenue.
- Research, development and demonstration expenditures were $321 million.
- Employment stands firm at 2,001.
- There were 106 demonstration projects reported.
- The number of strategic alliances reported was 77.
- There were 478 research partnerships reported.

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Organization Profile

Organization Type

The 2008 survey divides the corporate category into private, public, and division/subsidiary company subcategories. In aggregate, corporate organizations represented 69% of total survey participants. More than one third (37%) of total respondents were private companies, followed closely by publicly owned and subsidiary companies (32%). The remaining contributors were government, academia and non-profit organizations.

Headquarters

Most respondents (90%) reported headquarters of hydrogen and fuel cell activities in Canada. Others were headquartered in the United States and Germany.

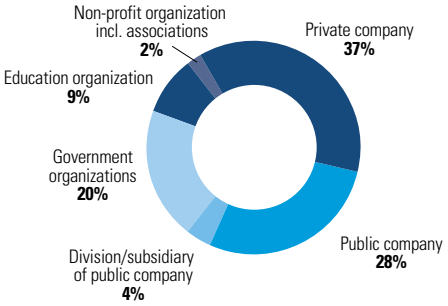
Years of Involvement in Hydrogen and Fuel Cell Activities

The majority of organizations (59%) reported involvement in hydrogen and fuel cell activities for ten years or less.

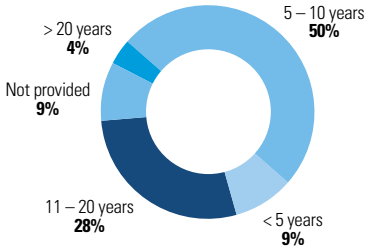
Areas of Expertise

Fuel cell developers or manufacturers (17%) and research organizations (17%) were the main areas of industry expertise. Suppliers to developers or manufacturers followed at 13%, as did commercialization support at 11%. Each of the remaining ten areas of industry expertise accounted for less than 10% of overall responses. The 'other' area of expertise category included hydrogen internal combustion engines, inverter power conversion, natural gas dispenser manufacturing, and detection systems for other gas industries.

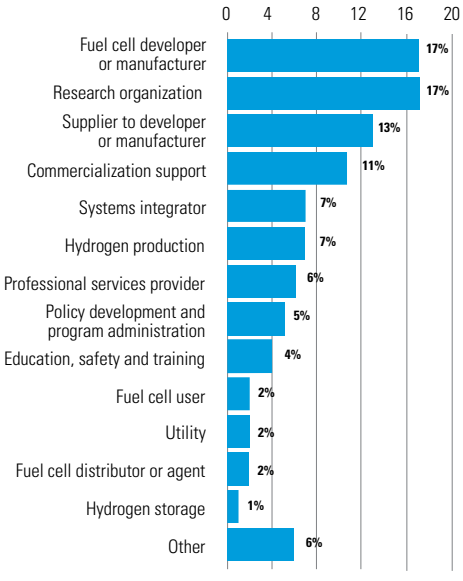
Organization Type



Years of Involvement in Hydrogen and Fuel Cell Activities



Areas of Expertise



Market Focus

Stationary applications, including both small and large subcategories, continued to represent the largest area of market focus at 36%. The combined mobile application subcategories of primary power and drivetrain and auxiliary power represented the second largest area of market focus at 29%. Areas of market focus remained consistent with findings from the 2007 study.

Technology Focus

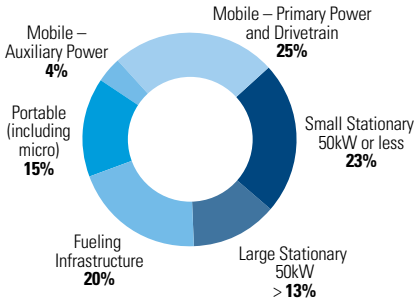
Proton Exchange Membrane (PEM) fuel cells continued to dominate the focus of technology activities at 40%. This finding supports Canada's global reputation as a leader in the development of PEM fuel cell technology for mobile, small stationary and portable applications. The 'other' area of technology 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

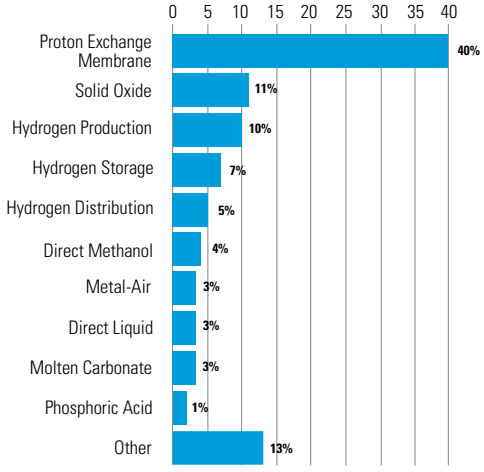
Survey participants reported 83 locations for hydrogen and fuel cell facilities and activities in 2007. 73% were located in Canada, 13% in the United States, the remaining 14% were overseas in Germany, Japan, Belgium, China, Italy, and the Netherlands.

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, Alberta, Saskatchewan, Manitoba, Quebec, Newfoundland and Labrador, New Brunswick and Prince Edward Island.

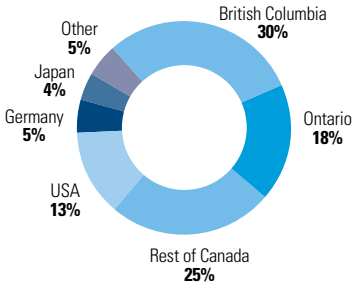
Market Focus



Technology Focus



Hydrogen and Fuel Cell Facilities by Region



Revenue

Almost half (46%) of respondents participated in revenue generating activities in 2007. The reported revenue from hydrogen and fuel cell activities was $168 million. In 2006, survey participants reported revenue of $133 million.

52% of companies surveyed had revenue of less than $1 million. 24% had revenue between $1 and $5 million and 24% had more than $5 million of revenue.

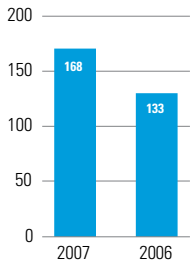
In 2007, the three categories that generated the most revenue were product sales with revenue of $83 million, R&D contracts, (excluding government funded contracts) of $29 million, and provision of services of $21 million. Revenue from product sales was reported to be $89 million in 2006.

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

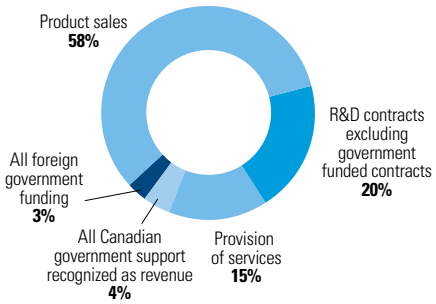
Regional breakdown of revenue was reported for $150 of the $168 million of revenue. The three countries with the most hydrogen and fuel cells related sales were the United States at 40%, Germany at 17% and Japan at 10%.

Sales for Canada as a whole were slightly less than Japan. The province of Ontario had the most sales, followed by British Columbia and Newfoundland and Labrador.

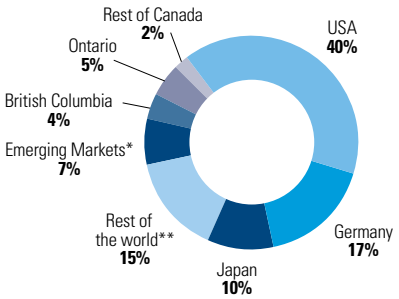
Total Revenue
($ millions)



Revenue by Category



Revenue by Region



* Emerging markets: *includes Brazil, Latin America and Russia*
** Rest of the World: *includes Asia, Australia and non disclosed*

Research, Development and Demonstration (RD&D)

77% of respondents participated in RD&D activities in 2007 reporting a total expenditure of $321 million. Total research and development (R&D) expenditure was $211 million or 66% of the total and demonstration expenditure was $111 million. In 2006, the RD&D expenditure reported by survey participants was $193 million.

Reported in RD&D expenditure for 2007 is a one time appropriation of $90 million by the BC Government for a fleet of fuel cell buses. This funding will be spent over the life of the project.

2007 Total RD&D Expenditure ($ millions)

	R&D	Demonstration	Total
Corporate	$181.9	$13.8	$195.7
Government	$24.0	$96.8	$120.8
Academic and non-profit	$4.8	–	$4.8
Total RD&D	**$210.7**	**$110.6**	**$321.3**

Photo: Ballard Power Systems

Research and Development

Sources of Funding for R&D

The sources of funding were provided for $159 of the $211 million of R&D expenditure in 2007. Most funding was from corporate operations (47%), parent affiliated or subsidiary organizations (27%), and Canadian governments (16%). The 'other' category of funding included private equity and R&D contracts with private companies. The chart below identifies sources of funding by organization type.

R&D by Region

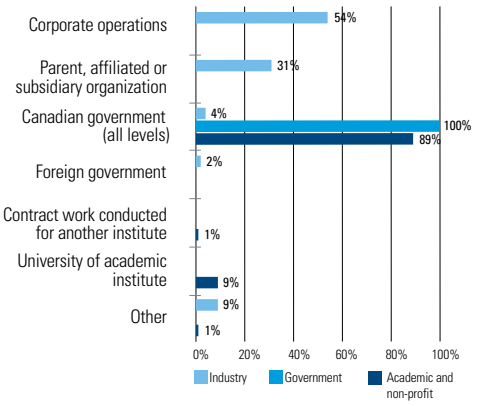
Geographic data was provided for $169 million of R&D expenditure. British Columbia led all regions with 71% of R&D expenditure followed by Ontario with 11%. Regions not listed on the chart below where R&D expenditure occurred include Belgium, China and the provinces of Alberta, Saskatchewan, Manitoba, New Brunswick and Prince Edward Island.

People Involved in Research

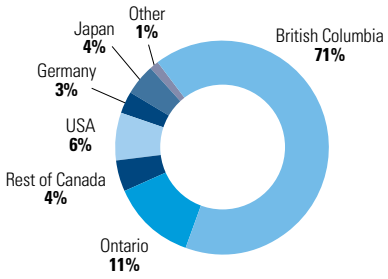
Academia participants reported that 78 people were involved in hydrogen and fuel cell related research activity. Of the 78 people, 40% were Canadian graduate and postgraduate students, 23% were academic/research staff, and 17% were undergraduates.

Sources of Funding for R&D Expenditure	$ millions	%
Corporate operations	$ 74.4	47%
Parent, affiliated or subsidiary organization	$ 43.2	27%
Canadian government (all levels)	$ 24.6	16%
Foreign government	$ 3.3	2%
Contract work conducted for another institute	$ 0.4	–
University or academic institute	$ 0.5	–
Research, non-profit, non-governmental institute	–	–
Other	$ 12.2	8%
Total	**$ 158.6**	**100%**

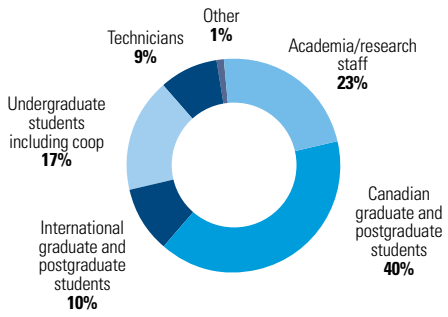
Sources of Funding for R&D Expenditure by Organization



R&D by Region



People Involved in Research



Demonstration Projects

Survey participants reported involvement in 106 worldwide demonstration projects in 2007. Government reported involvement in 57 projects, corporate organizations in 42, and academia in 7 projects.

Sources of Funding for Demonstration

In 2007, most of the reported $111 million demonstration expenditure was funded from Canadian governments (90%) and corporate operations (9%).

The overall focus of demonstration projects was fueling infrastructure at 59%. Almost all of government projects were focused on fuelling infrastructure while corporate organizations projects were focused on mobile application and stationary projects.

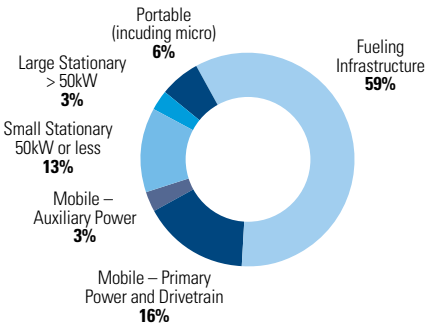
Demonstration by Region

Of the 106 demonstration projects reported, 42% took place in British Columbia, 31% in Ontario, and 7% in the United States. Projects were also reported in the provinces of Alberta, Saskatchewan, Manitoba, Quebec, New Brunswick, and Prince Edward Island.

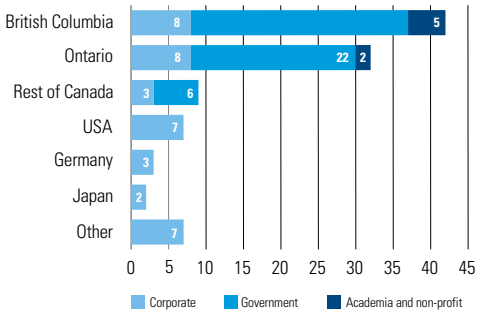
Patents

Corporate organizations reported 615 newly approved patents for 2007 and 866 patents pending approval. In 2006, survey participants held 84 patents. This demonstrates the continued commitment to innovation within the Canadian and global industry.

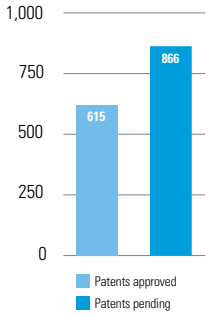
Focus of Demonstration Projects



Demonstration Projects by Region
(Involvement in Projects)



Patents



Employment

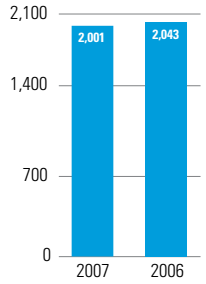
Survey participants reported a total of 2,001 employees focused on hydrogen and fuel cell activities in 2007. A breakdown by region was reported for 1,866 of the 2,001 employees. 84% of employees were located in Canada, 11% in the United States, and the remaining 5% overseas in Belgium, China, Germany, and Japan.

The 2008 survey asked participants to provide a breakdown by region of employees engaged in hydrogen and fuel cell activities in Canada. Most employees were located in British Columbia (1,182), followed by Ontario. The 'rest of Canada' category was made up of employees from Alberta, Manitoba, Quebec, New Brunswick and Prince Edward Island.

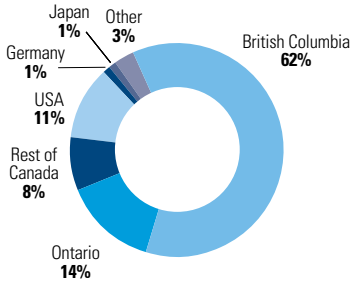
46% of companies surveyed had fewer than 10 employees. 23% had 10 to 25 employees, 14% had between 25 and 50, and 17% had more than 50 employees.

Based on the data provided for number of employees and total salaries, the average annual salary paid to employees was $62,272. Extrapolating the average salary for 2007 to the 1,567 employees in Canada, the sector contributed $98 million in salaries to the national economy.

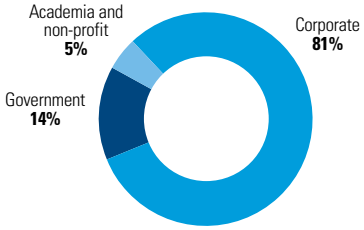
Employment

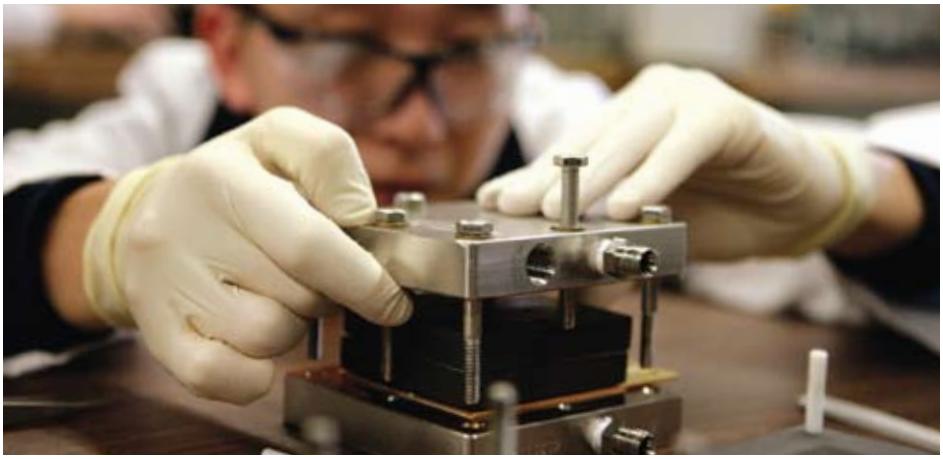


Employment by Region



Employment by Organization





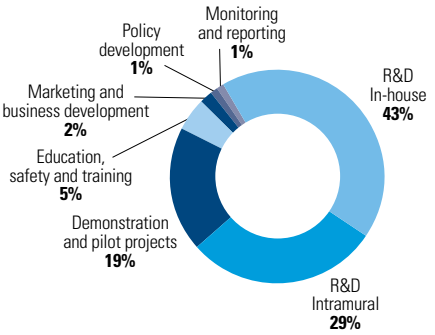
Photos: *Top* – Courtesy of BC Hydrogen Highway; *Lower Left* – Sacré-Davey; *Lower Right* – Plug Power

Funding Requirements

Continued education of governments and public capital markets 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 in-house R&D (43%), intramural R&D (29%), and demonstration and pilot projects (19%). British Columbia received 58% of the funding allocation, 28% went to Ontario, and the remaining 14% to Alberta, Saskatchewan, Manitoba, Quebec, New Brunswick and Prince Edward Island.

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



Corporate

Corporate participants report the top three sources of funding for 2007 from operations (45%), private equity (21%) and government (18%). The financial requirements for the next five years are estimated to be $712 million with funding expected to come from operations (38%), private equity (36%), public capital markets (9%), government (9%), venture capital (5%) and other (3%).

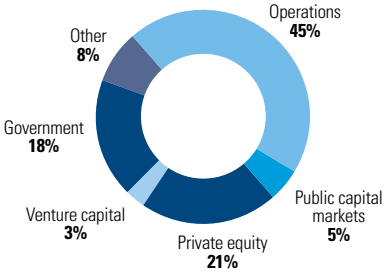
Government

The total budget for hydrogen and fuel cell related activities reported for 2007 for which government was directly responsible, (including employee salaries and benefits) was $40 million. Sources of funding for 2007 were programs (57%), A-base operations (26%). The details for the 'other' category (17%) were not provided.

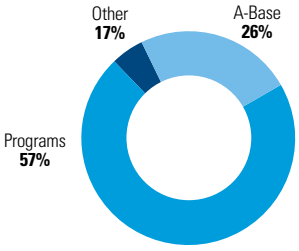
Academia and Non-Profit

The total budget for hydrogen and fuel cell related activities reported for 2007, for which academia and non-profit was directly responsible, (including employee salaries and benefits) was $5 million. The top three sources of funding for 2007 were from the National Science and Engineering Research Council of Canada (NSERC)/Canadian Foundation for Innovation (29%), other federal funding, (26%), and departmental budget allocation (17%).

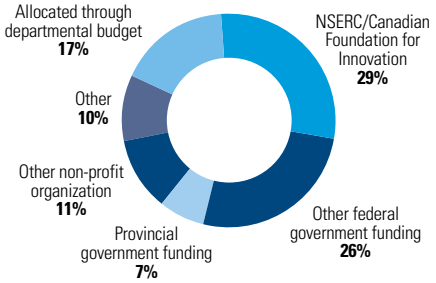
Sources of Funding – Corporate



Sources of Funding – Government



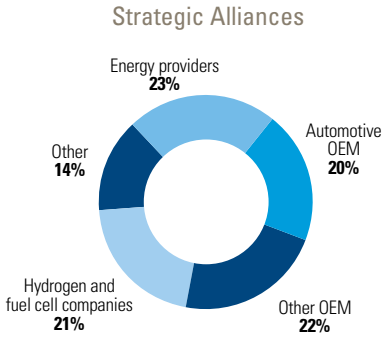
Sources of Funding – Academia and Non-Profit



Strategic Alliances

A total of 77 strategic partnerships and alliances were reported in 2007, confirming the continued value and importance of key relationships and partnerships to the industry. There were 124 strategic alliances reported by participants in 2006.

Energy providers represented almost a quarter (23%) of strategic partnerships. Other original equipment manufacturer (OEM) accounted for 22%, hydrogen and fuel cell companies 21%, and automotive OEM 20%.



Research Partnerships

Research partnerships promote closer collaboration between the university research community and other sectors, including government and Canadian industry. There were 478 research partnerships reported in 2007. There were 221 research partnerships reported in 2006. Partnerships with industry in Canada represented almost half (46%) of all research partnerships. Eleven percent of organizations were in partnership with Canadian governments.

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)	Corporate	Government	Academia and Non-Profit	Total
In partnership with Canadian governments (federal, provincial/territorial and municipal)	32	10	12	54
In partnership with foreign government	6	15	–	21
In partnership with Canadian academia/ non-profit/associations	13	6	11	30
In partnership with industry in Canada	144	56	19	219
In partnership with industry out of Canada	127	1	–	128
Other	26	–	–	26
Total	**348**	**88**	**42**	**478**

Photo: Enbridge Gas Distribution and Fuel Cell Energy | *Direct Fuel Cell-Energy Recover Generation Power Plant in Toronto, Ontario*

Methodology and Response Rates

The 2008 Sector Profile is the fifth 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.

All monetary results are presented in Canadian dollars.

A total of eighty-seven organizations associated with hydrogen and fuel cells in Canada were invited to participate in the development of this sector profile. Fifty-six completed responses were received, representing an overall response rate of 64%. A complete participation 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.

Presentation of Data

Figures presented for 2007 were collected by an online questionnaire in 2008/09. Figures presented for 2006 are as reported in the 2007 Sector Profile and therefore may not be fully comparable due to differing respondents and/or basis of individual responses.

Profile Participation Rate

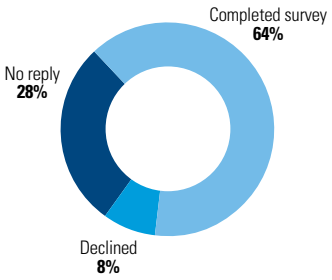


Photo: Courtesy of BC Hydrogen Highway

Conclusion

In 2007, the Canadian hydrogen and fuel cell sector reported:

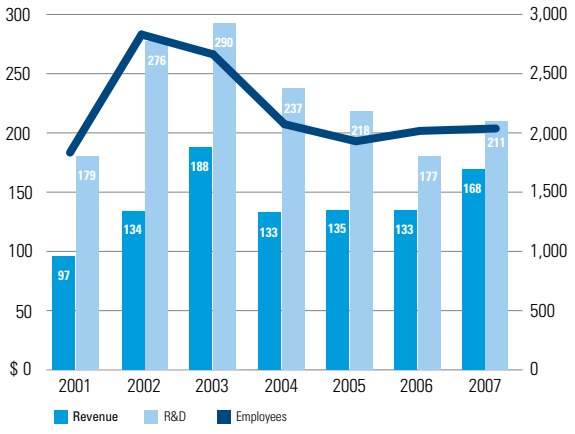
- revenue of $168 million in 2007 with the United States representing the largest revenue region,
- continued commitment to RD&D with $321 million of expenditure,
- employment stability at 2,001,
- a small decline since 2006 in the number of demonstration projects (106) and a substantial expenditure in demonstration projects ($111 million),
- fewer strategic alliances (77) and more than double the number of research partnerships (478) compared to prior years,
- hydrogen and fuel cell related facilities and activity, RD&D expenditure and employment largely clustered 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.

Growth Since 2001

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, we can see significant growth in the industry over the seven-year period:

- Revenue has grown 73% — from $97 million in 2001 to $168 million in 2007
- R&D expenditures have increased 18% from $179 million in 2001 to $211 million in 2007. Adding demonstration expenditure brings the RD&D total of $321 million
- Employment in the industry has seen an increase of 13% from 1,772 in 2001 to 2,001 in 2007



Growth Since 2001

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 (H_2FCC). 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 opportunitites 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 Alternative Energy network of professional staff drawn from over 150,000 people in over 150 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.

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2008 Participants

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Air Liquide Canada
Alberta Research Council Inc.
Angstrom Power Inc.
Armstrong Monitoring Corporation
Atlantic Hydrogen Inc.
Automotive Fuel Cell Corporation
Ballard Power Systems Inc.
BC Hydro
BC Transit
Canadian Hydrogen and Fuel Cells Association
Dana Canada Corporation
Dpoint Technologies
Enbridge Gas Distribution
Energyor Technologies Inc
FuelCon Systems Inc.
General Motors of Canada
Government of BC, Ministry of Energy, Mines Petroleum
Government of Manitoba
Greenlight Innovation
Heliocentris Energy Systems
Hydrogenics Corporation
Hyteon Inc.
Industry Canada – Resource Processing Industries Branch
Industry Canada – Industrial Technologies Office (formerly TPC h2EA and TPC R&D)
Institute for Integrated Energy Systems (IESVic) University of Victoria
Kraus Global Inc.
Ku Group
MagPower Systems Inc.
McGill University
Membrane Reactor Technologies Ltd.
National Research Council Canada, Institute for Chemical Process and Environmental Technology
National Research Council, Institute for Fuel Cell Innovation
Natural Resources Canada, CANMET
Natural Sciences and Engineering Council of Canada
Neodym Technologies
New Flyer Industries
NextGen Integrated Engineering
NORAM Engineering & Constructors Ltd.
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Palcan Power Systems
Plug Power Canada
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Queens RMC Fuel Cell Research Centre
QuestAir Technologies Inc.
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Versa Power Systems
Western Economic Diversification Canada
Westport Innovations Inc.

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