
Canadian Hydrogen and Fuel Cell

Sector Profile 2011

May 22, 2012



Canada 



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1. Background and introduction

1.1 Background

Since 2004, the Government of Canada, the Canadian Hydrogen and Fuel Cell Association (CHFCA) and PricewaterhouseCoopers LLP (PwC) have collaborated to provide an extensive profile of the Canadian hydrogen and fuel cell sector. The 2011 Sector Profile follows a similar format to the previous seven editions and provides industry insight on Canada's hydrogen and fuel cell sector for policy makers, investors and other stakeholders. The research adds value to business strategies, investment decisions, and the overall expertise across our country.

The Profile is published annually to monitor trends and recognize growth and achievements for this key influence 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 2011.

This report supersedes the report issued on March 29, 2012 to reflect information that became available after the March 29, 2012 report was issued to the Government of Canada and the CHFCA.

1.2 Introduction

The Canadian Hydrogen and Fuel Cell Sector Profile 2011 measures performance indicators and provides industry insight to assess Canada's position within an increasingly competitive global industry. Interest in clean energy research and technologies continues to gain momentum worldwide driven by concerns over the environment, economic development, and energy pricing. Hydrogen and fuel cells have become an increasingly viable commercial resource, and the Canadian sector is well positioned as an established leader in this field. By supporting hydrogen and fuel cell technology to help address climate change and sustainable energy issues, the Government of Canada, CHFCA and PwC create the opportunity to provide products and solutions for greenhouse gas emissions, air quality, energy security and economic development.

The industry at a glance in 2010:

Revenue was \$194 million.

Product sales generated \$91 million of revenue.

Research, development and demonstration expenditures were \$184.4 million.

Employment was 1,991.

128 demonstration projects were reported.

364 research partnerships were reported.

1.3 Methodology and response rate

The 2011 Sector Profile is the eighth 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 2004 survey, sections relating to research, development and demonstration (RD&D) and funding, specific questions were asked for three types of stakeholders:

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

In the 2010 study, the organization profile questions were restructured to better align with the Worldwide Fuel Cell Survey and additional data was requested on funding requirements, revenue priorities/challenges and planned changes in employment. All monetary results are presented in Canadian dollars.

In order to capture more information, the 2011 Sector Profile is also supplemented by publicly available information.

A total of 127 organizations associated with hydrogen and fuel cells in Canada were invited to participate in the development of this sector profile. This is a 30% increase in the number of invitations sent out for the 2010 Sector Profile. Seventy-two completed responses were received, representing an overall response rate of 57%.

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.

A participant list is included at the end of the report.

Presentation of Data

Figures presented for 2010 were collected by an online questionnaire and are reported as of April 20, 2012. Figures presented for years prior to 2010 are as reported in previous sector profiles and, therefore, may not be fully comparable due to differing respondents and/or basis of individual responses.

1.4 Organization of the report

The remaining sections of the report are organized as follows:

- **Section 2** provides a profile of the organizations involved in hydrogen and fuel cells
- **Section 3** provides an overview of the revenue generating activities of survey participants
- **Section 4** provides a description of the research, development and demonstration activities
- **Section 5** provides details of reported demonstration projects and patents
- **Section 6** provides information on employees involved in hydrogen and fuel cell activities
- **Section 7** provides information on future funding requirements
- **Section 8** provides details on strategic alliances and research partnerships
- **Section 9** provides an outlook on the sector

1.5 Restrictions and limitations

PwC has relied upon the completeness, accuracy and fair presentation of all information, data, advice, opinions or representations obtained from public sources and the Client (collectively, the “Information”). The findings in the Report are conditional upon such completeness, accuracy and fair presentation of the Information. PwC has not verified independently the completeness, accuracy and fair presentation of the Information. We are providing no opinion, attestation or other form of assurance with respect to our work and we did not verify or audit any information provided to us.

PwC reserves the right at its discretion to withdraw or make revisions to the Report should PwC be made aware of facts existing at the date of the report that were not known to PwC when it prepared the Report. The conclusions

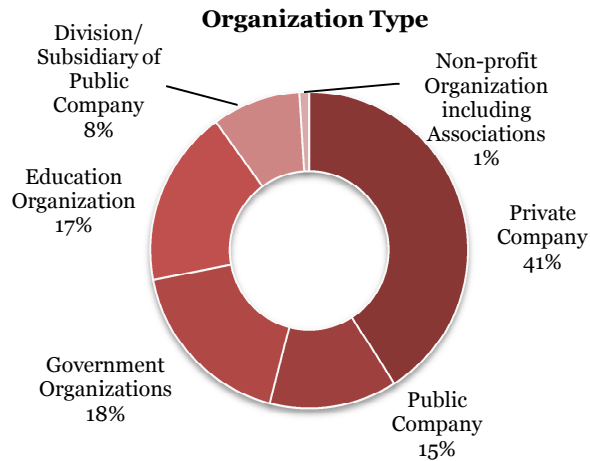
and recommendations are given as of the date hereof and PwC is under no obligation to advise any person of any change or matter brought to its attention after such date, which would affect the findings and conclusions and PwC reserves the right to change or withdraw the Report.

PwC understands this report will be made available to the government and may be made available to association members and to the general public. We do not accept responsibility for any losses arising from unauthorized or improper use of this Report.

2. Organization profile

Organization type

Corporate organizations, including public and private companies, and subsidiaries, represented 64% of total responses. Government organizations accounted for 18%, with education organizations, and non-profit organizations including associations representing the remaining 18% of respondents.

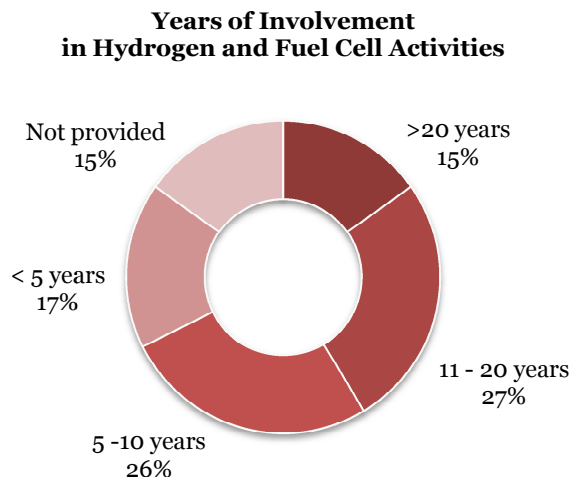


Headquarters

The majority of respondents (88%) reported headquarters of hydrogen and fuel cell activities in Canada. Others were headquartered in the United States and Europe.

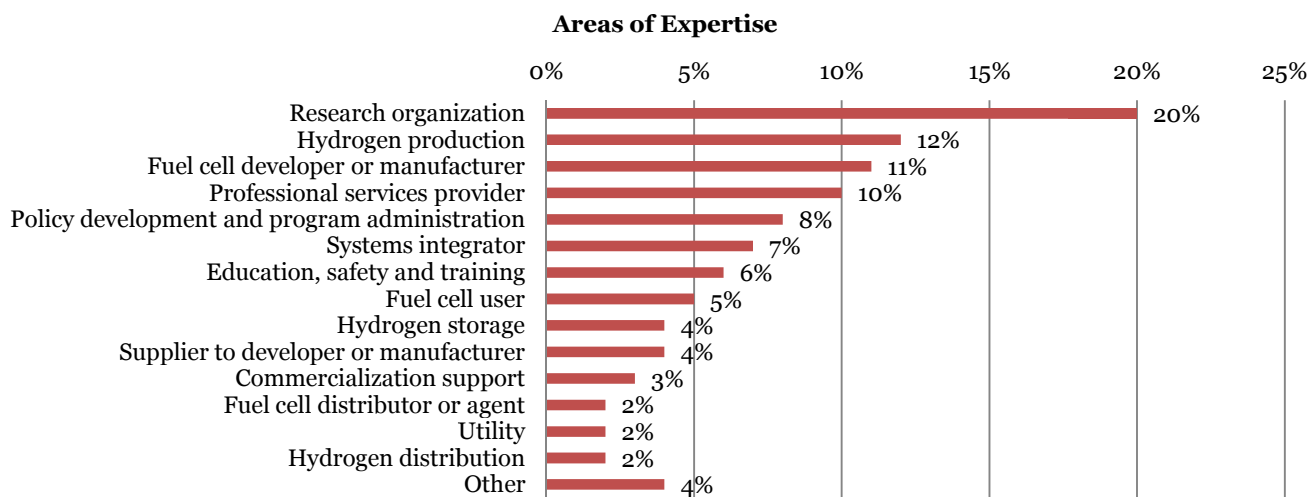
Years of involvement in hydrogen and fuel cell activities

Forty-two percent of respondents reported involvement in hydrogen and fuel cell activities for more than ten years.



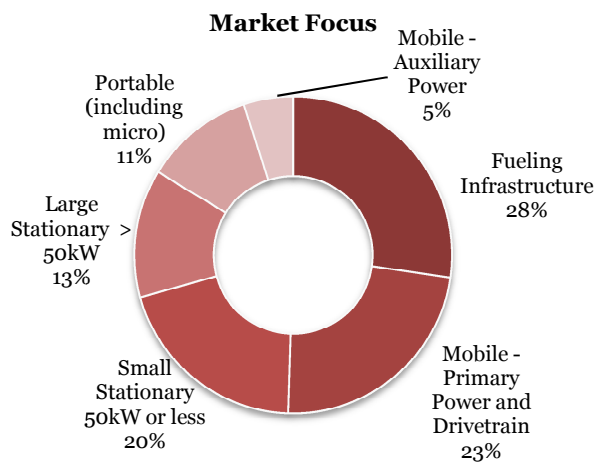
Areas of Expertise

The main area of expertise was research organizations (20%). Hydrogen production and fuel cell developer or manufacturer represented 12% and 11% respectively, followed by professional service provider (10%). Policy development and program administration represented 8% while systems integrator represented 7%, followed by education, safety and training (6%). Fuel cell user occupied 5% while hydrogen storage and supplier to developer or manufacturer each accounted for 4%. Commercialization support represented 3%, followed by, fuel cell distributor or agent, utility and hydrogen distribution (2% each). The 'other' area of expertise category (4%) included hydrogen fueling infrastructure, chemical metallurgy, hydrogen compression/dispensing as well as code compliance assessment.



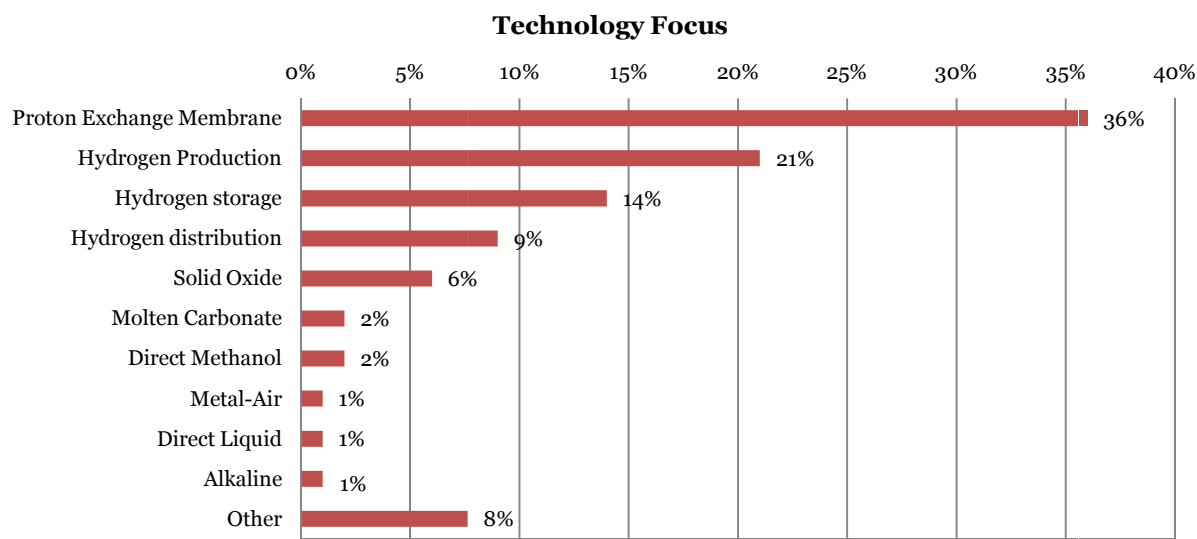
Market Focus

Stationary applications, including both small (20%) and large (13%) subcategories, combined represented the largest area of market focus at 33%. Fueling infrastructure, which includes hydrogen production, distribution and storage, represented the second largest stand alone area of market focus at 28%. In addition, the combined mobile application subcategories of portable (11%), primary power and drivetrain (23%) and auxiliary power (5%) represented 39% of the market focus. The results show decreases in fueling infrastructure and stationary applications from the 2010 Sector Profile.



Technology Focus

Proton Exchange Membrane (PEM) fuel cells dominated the focus of technology activities at 36% with hydrogen production coming in second at 20%, followed closely by hydrogen storage at 14%. Hydrogen distribution represented 9%, solid oxide fuel cells represented 6% and the remaining categories represented 7% of the industry's technological focus. The 'other' area of technology focus (8%) includes hydrogen infrastructure and safety.

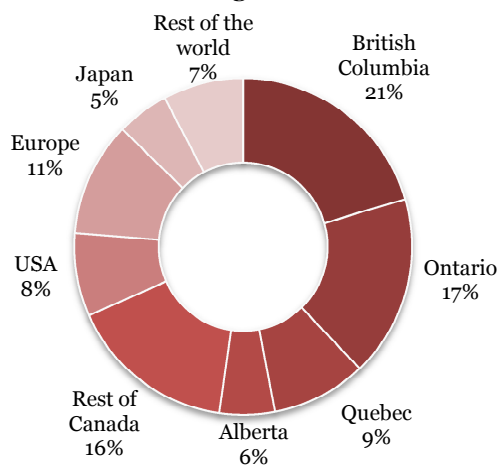


Hydrogen and Fuel Cell Facilities by Region

Survey participants reported 133 locations for hydrogen and fuel cell facilities and activities in 2010. In total, 69% of facilities were located in Canada, 11% in Europe, 8% in the United States and 5% in Japan. The remaining 7% were overseas in China, South Korea, India, Taiwan and Singapore.

Hydrogen and fuel cell activities took place in most provinces within Canada. The majority of facilities and activities resided in British Columbia, followed by Ontario, Quebec, Alberta, Saskatchewan, Manitoba, Prince Edward Island, and New Brunswick.

Hydrogen and Fuel Cell Facilities by Region



3. Revenue

In 2010, 46% of respondents participated in revenue generating activities. Survey participants reported revenue from hydrogen and fuel cell activities of \$194 million. Half of the companies surveyed reported less than \$1 million in revenue in 2010. In addition, 19% had more than \$5 million of revenue and 31% of respondents reported revenue between \$1 and \$5 million.

Some survey respondents did not provide detailed information on revenue generation and therefore a breakdown of revenue was provided for \$153 million of the \$191 million reported. In 2010, the two categories that generated the most revenue were product sales with revenue of \$91 million, and provision of services producing revenue of \$53 million.

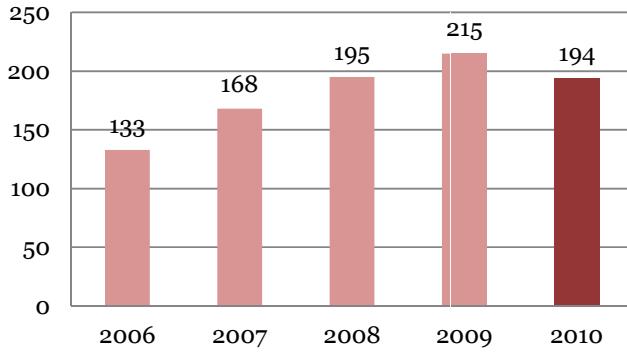
Foreign government funding and Canadian government support were recognized as revenue and together represented 2% of overall revenue in 2010. Additional details for government funding are provided in the research, development and demonstration and funding sections of this study.

A breakdown by region was provided for \$190 million of the \$191 million reported. The three countries with the most hydrogen and fuel cells related sales were USA at 30%, Canada at 29% and Germany at 28%. The results indicate that most of the Canadian revenue was generated in British Columbia (26%).

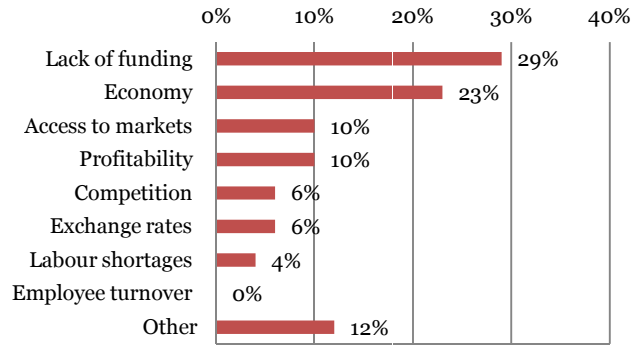
Top three priorities identified by survey participants to enhance competitive performance were: technology development (21%), collaboration and strategic alliances (18%), better targeting of customers (13%).

Survey participants were asked to identify challenges faced by their organization in 2010. The main challenge faced by survey participants was lack of funding (29%). The economy (23%), access to markets (10%) and profitability (10%) were also identified. Competition and exchange rates each represented 6% followed by labour shortages, which accounted for 4%. Other challenges identified by companies included cost reductions and overcoming barriers to commercialization.

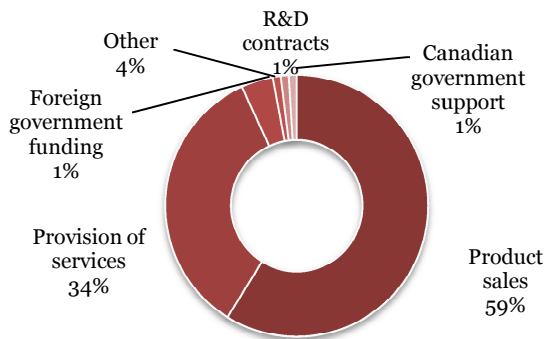
Total Revenue (\$millions)



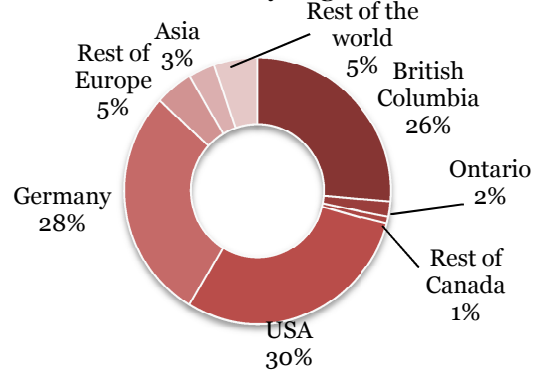
Challenges Faced in 2010



Revenue by Category



Revenue by Region



4. Research, development and demonstration

In 2010, 66% of respondents participated in RD&D activities, reporting total RD&D expenditure of approximately \$184.4 million. Total research and development (R&D) expenditure amounted to \$161.0 million or 87% of total RD&D spending. Demonstration expenditure for 2010 was \$23.4 million.

2010 Total RD&D Expenditure (\$ millions)			
	R&D	Demonstration	Total
Corporate	127.7	15.0	142.7
Government	22.3	8.4	30.7
Academic and non-profit	11.0	-	11.0
Total RD&D	161.0	23.4	184.4

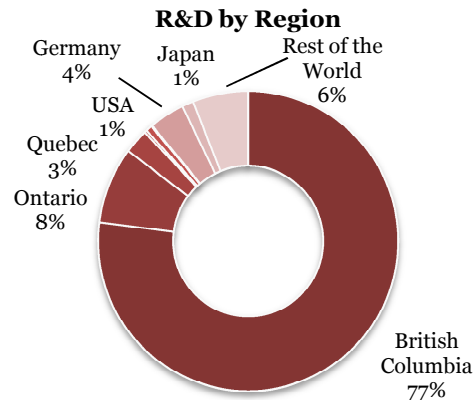
Sources of Funding for R&D expenditure

The table below provides a breakdown of funding for R&D and demonstration expenditures by source. For R&D expenditures, sources of funding were only provided for \$89.4 million of the \$161.0 million reported by respondents as expenditure in 2010. Parent, affiliated or subsidiary sources funded almost half of the overall R&D expenditure (47%), followed by Canadian government and corporate operations funding of 28% and 19% of overall R&D expenditure. Corporate operations funded 72% while Canadian government funded 22% of the overall demonstration expenditure.

2010 Sources of Funding for RD&D Expenditure	R&D		Demonstration		Total	
	\$ million	%	\$ million	%	\$ million	%
Parent, affiliated or subsidiary organization	42.3	47%	0.6	3%	42.9	40%
Canadian government (all levels)	25.1	28%	3.8	21%	28.9	27%
Corporate operations	16.6	19%	12.7	72%	29.3	27%
University or academic institute	1.9	2%	-		1.9	2%
Foreign Government	1.6	2%	0.5	3%	2.1	2%
Research, non-profit, non-governmental institute	0.9	1%	-		0.9	1%
Other	1.0	1%	0.1	1%	1.1	1%
Total	89.4	100%	17.7	100%	107.1	100%

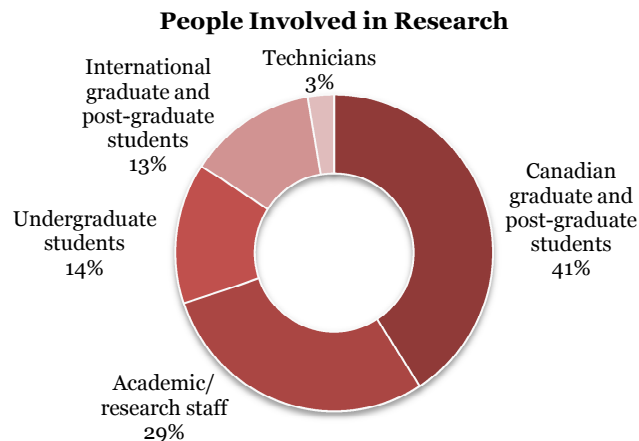
R&D by Region

Geographic data was provided for \$88 million of R&D expenditure. British Columbia led all regions with 77% of R&D expenditure. Ontario and Quebec contributed 8% and 3%. Globally, Germany provided 4% with the USA and Japan each providing 1% of the R&D expenditure respectively. Regions included in the Rest of the World category (6%) include France, Denmark, Belgium and China.



People Involved in Research

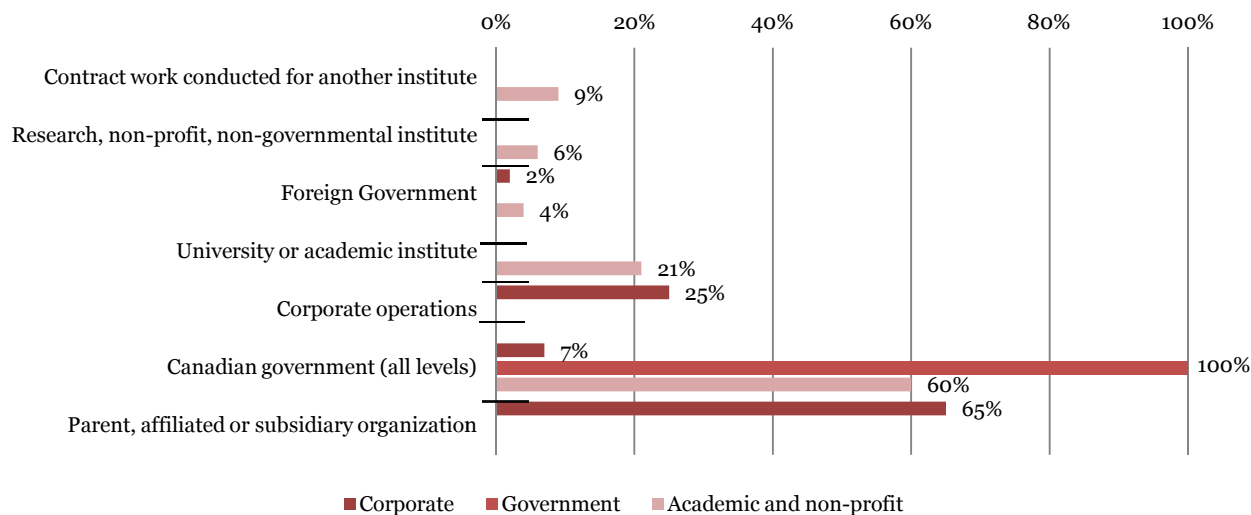
Participants reported that a total of 298 people were involved in hydrogen and fuel cell related research activity. Of the total people involved in research, 41% were Canadian graduate and post graduate students, 29% were academic/research staff, 14% were undergraduate and post-graduate students, and 3% were technicians.



Sources of funding for R&D expenditure

The bar chart below represents sources of funding for R&D expenditure by type of organization. Corporate respondents received most of their funding from parent, affiliated or subsidiary sources (65%). Government organizations received all of their funding from Canadian government sources (100%). Academic and non-profit organizations also received most of their funding from Canadian government sources (60%).

Sources of Funding for R&D Expenditure by Organization



5. Demonstration projects and patents

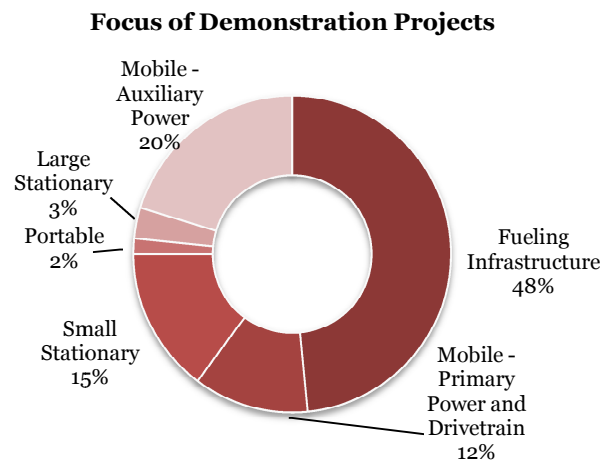
Demonstration projects

In 2010, survey participants reported their participation in 128 demonstration projects around the world. Corporate organizations reported involvement in 108 demonstration projects, while government and academic respondents reported their involvement in 10 demonstrations each.

Sources of Funding for Demonstration

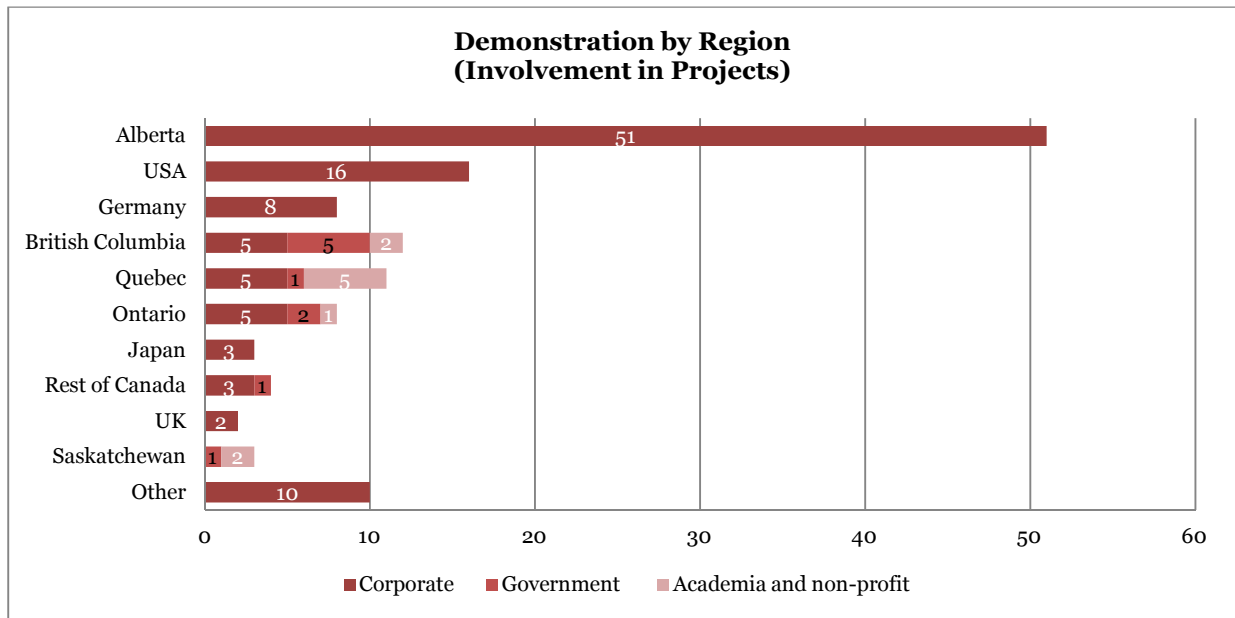
In 2010, Canadian governments funded 22% of the reported \$23.4 million demonstration expenditure and corporate operations funded 72%.

Fueling infrastructure was the main area of focus at 48% of overall demonstration projects. A majority (90%) of government projects focused on fueling infrastructure. Corporate organizations focused most (46%) of their attention on fueling infrastructure with 23% of their efforts spent on mobile – auxiliary power projects.



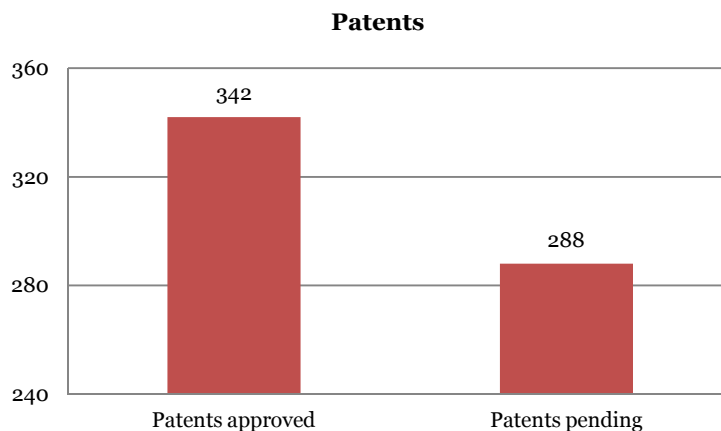
Demonstration by Region

Canadian provinces hosted a total of 70% of demonstration projects. The majority (40%) of total demonstrations took place in Alberta, followed by USA hosting 13% of total demonstrations. British Columbia and Quebec each hosted 9% of total demonstrations. Other Canadian provinces accounted for 11% of demonstrations. Germany and Ontario combined each hosted 6% while Japan hosted 2% of demonstration projects. The rest of the demonstrations (16%) took place in other regions including: the United Kingdom (UK), France, Netherlands and China.



Patents

In 2010, corporate respondents reported 342 newly approved patents and 288 patents awaiting approval.



6. Employment

Survey participants reported a total of 1,991 employees involved in hydrogen and fuel cell activities in 2010. This is a nearly 13% increase from 1,765 employees reported in 2009 and an almost 30% increase from levels reported during the recession in 2008. Survey participants only provided a breakdown by region for 1,592 of the 1,991 employees.

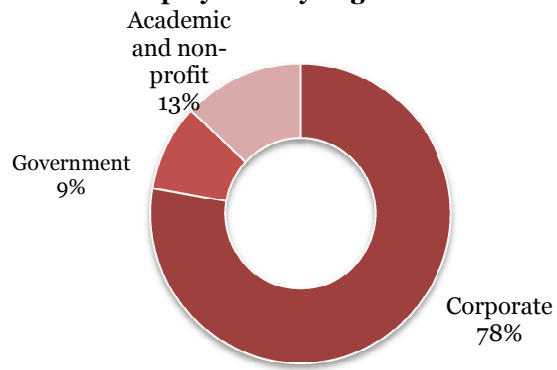
In 2010, the largest proportion (approximately 84%) of industry employees was located in Canada, 5% in the United States, and the remaining 11% overseas in the UK, France, Denmark, Belgium, Germany, China and Singapore. In Canada, most employees were located in British Columbia (949), followed by Ontario (172) and Quebec (146) with the remaining 68 employees distributed across Canada.

53% of companies surveyed had fewer than 10 employees, 20% had 10 to 25 employees, 11% had between 25 and 50, and 16% had more than 50 employees.

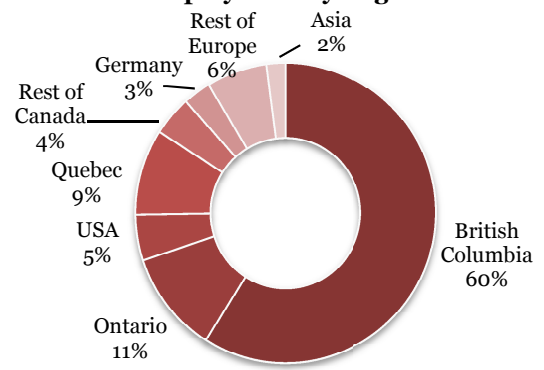
Based on the data provided for the number of employees and total salaries, the average annual salary paid to employees was \$66,342. Extrapolating the average salary for 2010 to the 1,335 employees in Canada, the sector contributed approximately \$88.6 million in direct salaries to the national economy.



Employment by Organization



Employment by Region



7. *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.

About 82% of government funding was allocated to R&D, both in-house and intramural. Academic and non-profit organizations funding was allocated primarily to in-house R&D (70%). British Columbia received 68% of the funding allocation, 23% went to Ontario, 6% went to Quebec and the remaining 3% went to Prince Edward Island and Saskatchewan.

Corporate

Corporate participants report the top three sources of funding for 2010 from operations (50%), private equity (18%) and government (13%). The financial requirements for the next five years are estimated to be \$610 million with funding expected to come from private equity (42%), public capital markets (17%), operations (14%), and government (8%) and 18% from other sources.

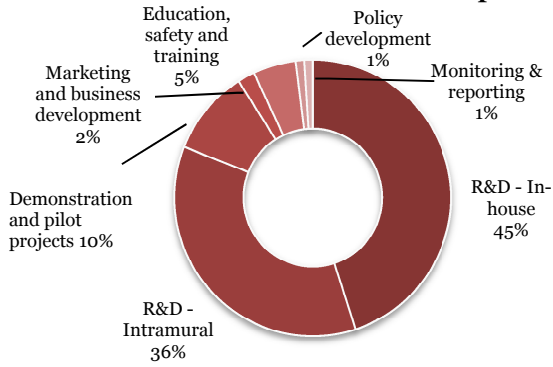
Government

The total budget for hydrogen and fuel cell related activities reported for 2010 for which government was directly responsible, (including employee salaries and benefits) was \$30 million. Programs contributed 35% of funding requirements with A-base operations contributing 65%.

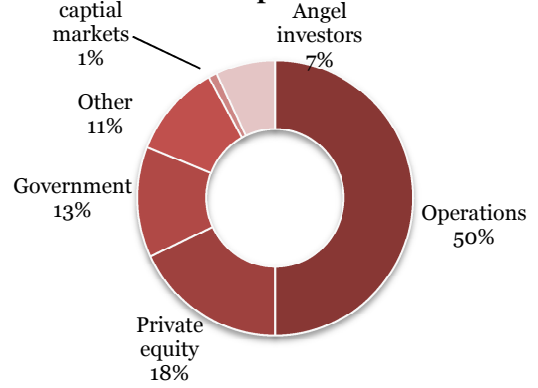
Academic and Non-Profit

The total budget for hydrogen and fuel cell related activities reported for 2010, for which academic and non-profit was directly responsible, (including employee salaries and benefits) was \$6 million. The sources of funding for 2010 were from Natural Science and Engineering Research Council of Canada (NSERC)/Canadian Foundation for Innovation (47%), departmental budget allocation (17%), private investor (12%), the other federal government funding (12%), other non-profit organization (10%), and provincial government funding (2%).

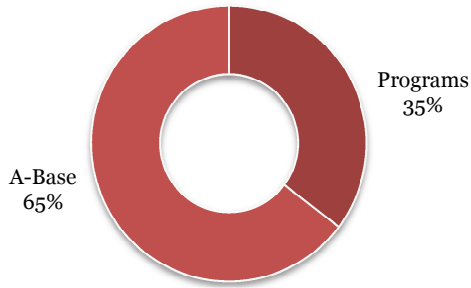
**Funding Allocation by Area
Government & Academia & Non-profit**



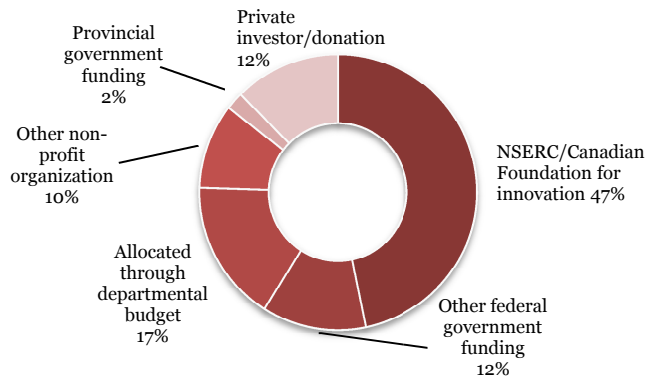
**Sources of Funding
Corporate**



**Sources of Funding
Government**



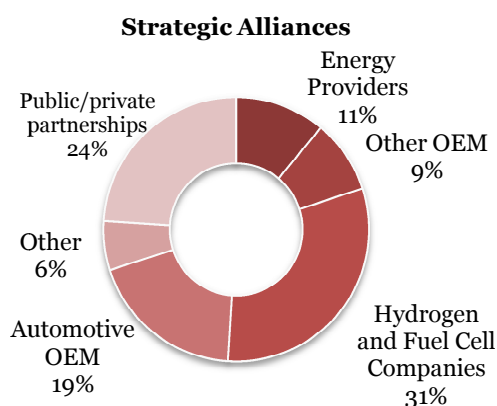
**Sources of Funding
Academic and non-profit**



8. Strategic alliances and research partnerships

Strategic alliances

In 2010, respondents reported 118 strategic partnerships and alliances, demonstrating the value and importance of relationships and partnerships to the industry. Hydrogen and fuel cell companies represented 31% and public/private partnerships represented 24% of strategic partnerships. Automotive original equipment manufacturer (OEM) represented 19% of partnerships, followed by energy providers and other OEM with 11% and 9% respectively.



Research partnerships

Research partnerships promote closer collaboration between the university research community and other sectors, including government and Canadian industry. Survey respondents indicated there were 364 research partnerships in 2010. Because survey respondents may report partnerships that they have with each other, there is a possibility that the number of research partnerships are overstated. However, research partnerships as a percentage of the total should be representative of actual partnerships. Partnerships with academic/non-profit/associations represented 51% of total research partnerships. Partnerships with industry in Canada represented 18% of all research partnerships. The number of research partnerships signifies the necessity of pre-commercial collaboration in order to address common technical challenges. The table below illustrates the many varied types of partnerships and collaborations in the hydrogen and fuel cell sector within Canada and outside the country.

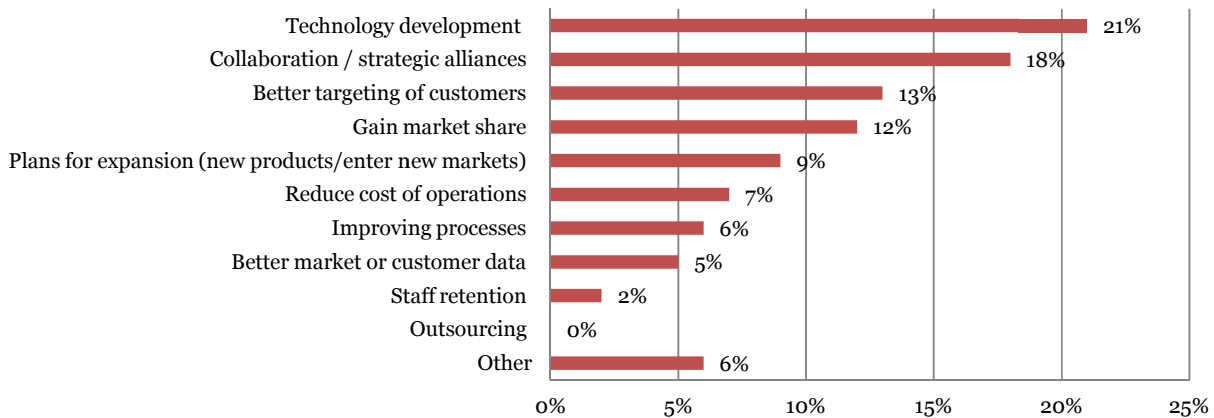
Number of Research Partnerships	
	Total
In partnership with Canadian academia/non-profit/associations	185
In partnership with industry in Canada	66
In partnership with industry outside of Canada	42
In partnership with Canadian government	40
In partnership with foreign government	23
Other	8
Total	364

9. Outlook

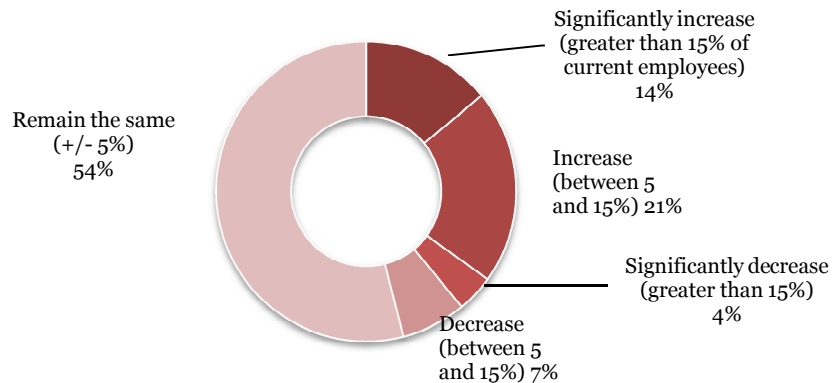
Looking ahead to 2012, participants were asked to identify the top three priorities to enhance competitive performance. Responses varied with technology development identified as the top priority at 21%, followed by collaboration / strategic alliances and better targeting of customers at 18% and at 13%. Gaining market share and plans for expansion represented 12% and 9% respectively. Reduced costs of operations, improving processes, better market or customer data and staff retention were identified as priorities for 21% of respondents.

Thirty-five percent of organizations surveyed indicate plans to increase employment within the next 18 months. Eleven percent of organizations plan to reduce employment, while just over half (54%) anticipate that employment will remain the same.

Priorities to Enhance competitive Performance in 2012



Plans to change employment in the next 18 months



Conclusion

The Canadian hydrogen and fuel cell sector is recognized for its role in the development of clean technology applications. In 2010, approximately 43% of respondents reported involvement in hydrogen and fuel cell activities for over 10 years suggesting a relatively stable industry. From this base, the industry continues to draw RD&D investment and talent. As reported by survey participants, more Canadian graduate and post-graduate students conducted research related to hydrogen and fuel cells suggesting the sector is attracting new and younger players. The industry also continues to be innovative with a 20% increase in the total number of approved and pending patents from 527 in 2009 to 630 in 2010.

In 2010, the Canadian hydrogen and fuel cell sector reported:

- employment at 1,991;
- revenue of \$194 million in 2010 with British Columbia representing the largest revenue region within Canada;
- continued commitment to RD&D with \$184.4 million of expenditures;
- a significant increase in the number of demonstration projects (128) compared to 86 in 2009 and a decrease in expenditure in demonstration projects (\$23 million) compared to \$44 million in 2009;
- a considerable increase in the number of strategic alliances (118) from 2009 and a slight increase in research partnerships (364) compared to prior years; and
- hydrogen and fuel cell related facilities and activity, RD&D expenditure and employment were largely concentrated in British Columbia.

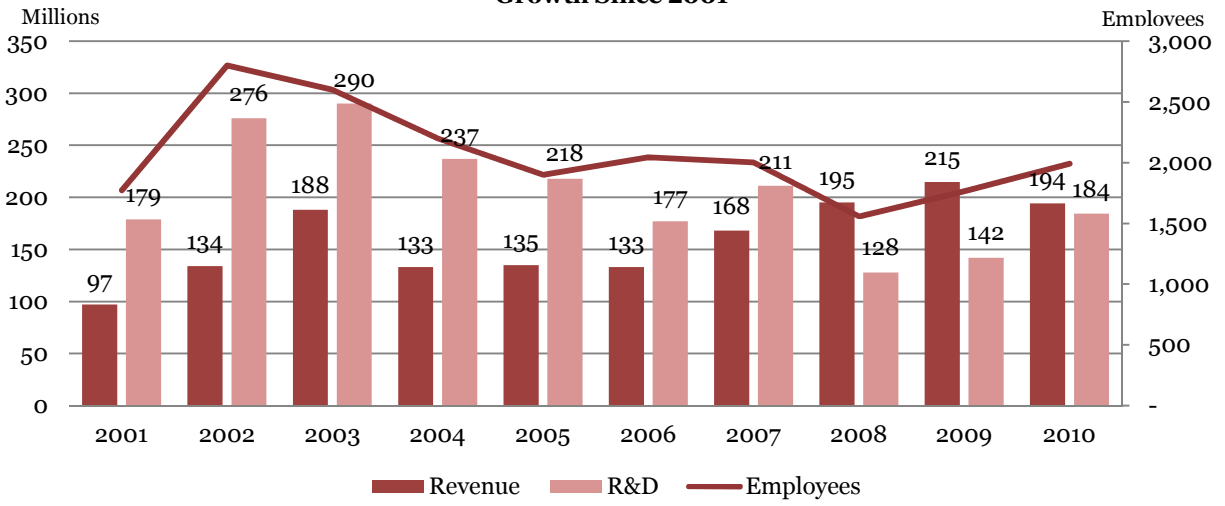
Growth since 2001

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 and response rates, we can see significant growth in the industry between 2001 and 2010:

- Revenue has doubled from \$97 million in 2001 to \$194 million in 2010
- R&D expenditures have increased by 3% from \$179 million in 2001 to \$184 million in 2010.
- Employment in the industry has increased by 12% from 1,772 in 2001 to 1,991 in 2010.

The Government of Canada, the Canadian Hydrogen and Fuel Cell Association and PwC would like to thank the organizations that took part in this survey. By participating, stakeholders from private industry, government and academic 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



2011 Participants

Partial List of Participants
A.V. Tchouvelev & Associates Inc.
Air Liquide Canada
Atlantic Hydrogen Inc.
Automotive Fuel Cell Cooperation (AFCC)
Ballard Power Systems Inc.
Bereskin & Parr
Canadian Hydrogen and Fuel Cells Association
CCS Global Group Inc.
Dana Canada Corporation
dPoint Technologies Inc.
Enbridge Gas Distribution Inc.
FCTEK Holdings Ltd.,
Greenlight Innovation
HRH Consulting Services Inc.
HTEC Hydrogen Technology & Energy Corp.
Hummingbird Hydrogen Corporation
Hydrogen Link
Hydrogenics Corporation
Hyteon Inc.
Industry Canada
Isowater Corporation
Ku Group
Lambton College of Applied Arts and Technology
McMaster University
Mercedes-Benz Canada
Nalcor Energy
National Research Council (NRC)
Natural Resources Canada, CANMET
Natural Sciences and Engineering Council of Canada
New Flyer Industries Canada UL
Next Hydrogen Corporation
NORAM Engineering & Constructors Ltd.
Palcan Fuel Cells Ltd.
Phoenix Canada
PowerDisc Development Corporation Ltd.
Powertech Labs Inc
Profile Composites
Ryerson University
Sacré-Davey Engineering
Saskatchewan Research Council
Simon Fraser University
Tekion Inc
TISEC Inc
Transport Canada

Université du Québec à Trois-Rivières
University of Alberta
University of British Columbia - CERC
University of Ottawa
University of Toronto, Mechanical & Industrial Engineering Department
Walmart Canada

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 development, 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 & Fuels 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 programs and services.

PwC

PwC understands and supports the fuel cell industry in Canada and around the world. Our Alternative Energy network of professional staff drawn from over 154,000 people in over 153 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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