

# Canadian Hydrogen and Fuel Cell Sector Profile 2012



# Canadian Hydrogen and Fuel Cell Sector Profile 2012

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 2012 Sector Profile follows a similar format to the previous eight 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 2012*.

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# Introduction

The Canadian Hydrogen and Fuel Cell Sector Profile 2012 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 2011:

- Revenue was \$211 million.
- Product sales generated \$99 million of revenue.
- Research, development and demonstration expenditures were \$136.6 million.
- Employment was 2,025.
- 123 demonstration projects were reported.
- 582 research partnerships were reported.

Chevy Equinox Fuel Cell Electric Vehicle and Shell hydrogen fueling station designed, manufactured and commissioned by Powertech Labs



# Organization Profile

## ORGANIZATION TYPE

Corporate organizations, including public and private companies, and subsidiaries, represented 63% of total responses. Government organizations accounted for 18%, with education organizations, and non-profit organizations including associations representing the remaining 19% of respondents.

## HEADQUARTERS

The majority of respondents (89%) reported headquarters of hydrogen and fuel cell activities in Canada. Others were headquartered in the United States and Europe.

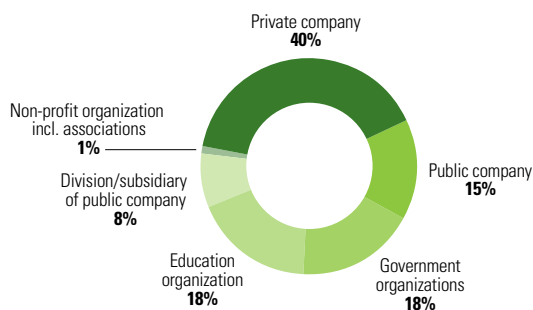
## YEARS OF INVOLVEMENT IN HYDROGEN AND FUEL CELL ACTIVITIES

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

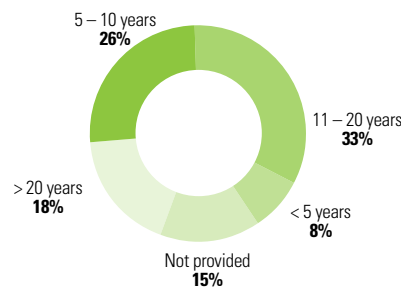
## AREAS OF EXPERTISE

The main area of expertise was research organizations (22%). Fuel cell developer or manufacturer and hydrogen production each represented 12%, followed by professional service provider (9%). 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 accounted for 4%. Supplier to developer or manufacturer and commercialization support each represented 3%, followed by fuel cell distributor or agent, hydrogen distribution and utility (2% each). The 'other' area of expertise category (3%) included hydrogen fueling infrastructure.

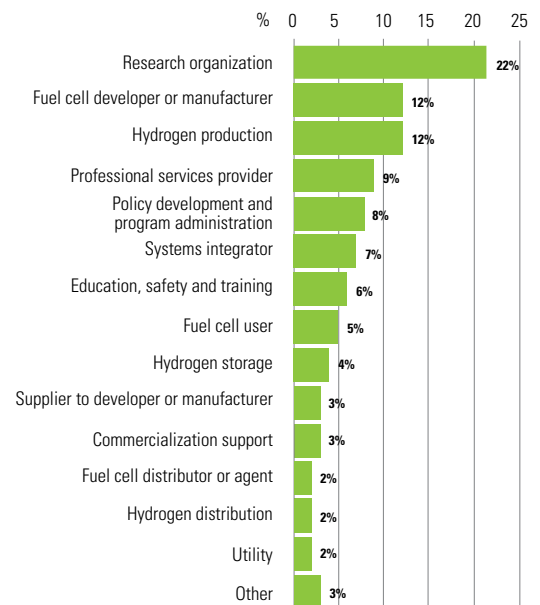
Organization Type



Years of Involvement in Hydrogen and Fuel Cell Activities



Areas of Expertise



## MARKET FOCUS

Stationary applications, including both small (19%) and large (14%) 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 27%. In addition, the combined mobile application subcategories of portable (11%), primary power and drivetrain (24%) and auxiliary power (5%) represented 40% of the market focus. The results show that the market focus has remained stable from the 2011 Sector Profile.

## TECHNOLOGY FOCUS

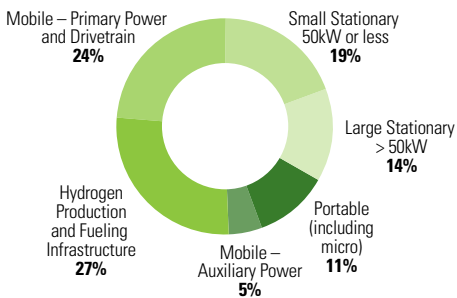
Proton Exchange Membrane (PEM) fuel cells dominated the focus of technology activities at 37% with hydrogen production coming in second at 20%, followed closely by hydrogen storage at 14%. Solid oxide fuel cells represented 8%, hydrogen distribution represented 7% and the remaining categories represented 7% of the industry's technological focus. The 'other' area of technology focus (7%) includes hydrogen infrastructure, reduction-oxidation, dual-fuel diesel engines, and safety.

## HYDROGEN AND FUEL CELL FACILITIES BY REGION

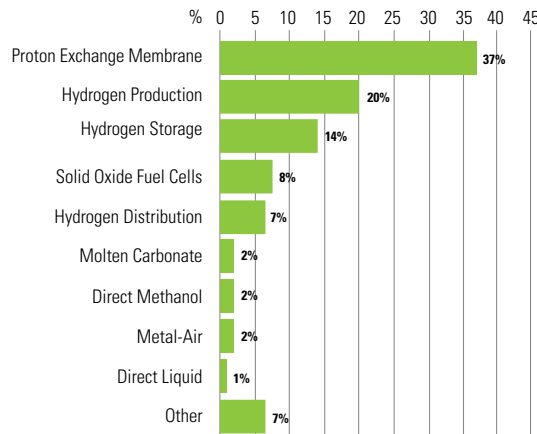
Survey participants reported 138 locations for hydrogen and fuel cell facilities and activities in 2011. In total, 70% of facilities were located in Canada, 11% in Europe, 8% in the United States and 4% in Japan. The remaining 7% were overseas in China, South Korea, India, Taiwan and Singapore.

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

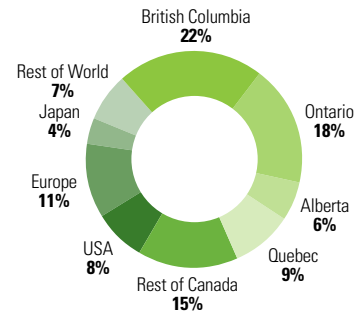
Market Focus



Technology Focus



Hydrogen and Fuel Cell Facilities by Region



# Revenue

In 2011, 42% of respondents participated in revenue generating activities. Survey participants reported revenue from hydrogen and fuel cell activities of \$211 million, up nearly 9% from \$194 million reported in 2010. Half of the companies surveyed reported less than \$1 million in revenue in 2011. In addition, 14% had more than \$5 million of revenue and 22% of respondents reported revenue between \$1 and \$5 million.

A breakdown of revenue was provided for \$170 million of the \$211 million reported. In 2011, the two categories that generated the most revenue were product sales with revenue of \$99 million, and provision of services producing revenue of \$62 million.

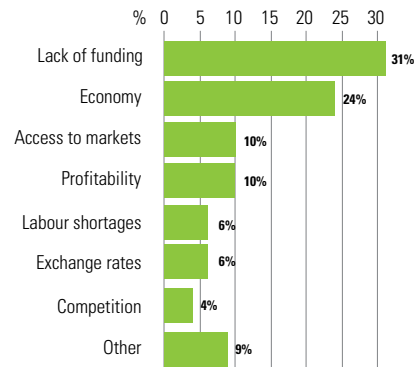
Foreign government funding and Canadian government support were recognized as revenue and together represented 2% of overall revenue in 2011. Additional details for government funding are provided in the research, development and demonstration and funding sections of this study.

A breakdown by region was provided for \$207 million of the \$211 million reported. The three countries with the most hydrogen and fuel cells related sales were Germany at 30%, Canada at 29% and USA at 25%. The results indicate that most of the Canadian revenue was generated in British Columbia (27%).

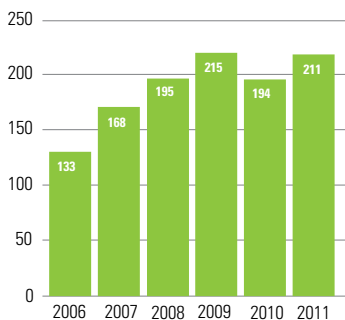
Top three priorities identified by survey participants to enhance competitive performance were: collaboration and strategic alliances (21%), technology development (19%), and gain market share (12%).

Survey participants were asked to identify challenges faced by their organization in 2011. The main challenge faced by survey participants was lack of funding (31%). The economy (24%), access to market (10%) and profitability (10%) were also identified. Labour shortages and exchange rates each represented 6% followed by competition, which accounted for 4%. Other challenges identified by companies included marketability, corporate reluctance in increasing R&D spending, and overcoming barriers to commercialization.

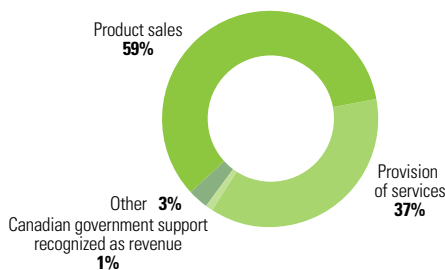
**Challenges Faced in 2011**



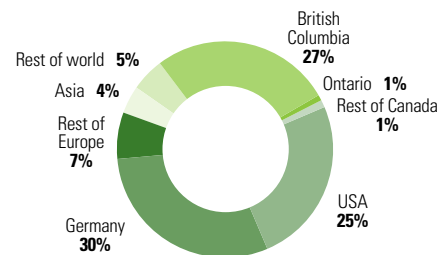
**Total Revenue (\$ millions)**



**Revenue by Category**



**Revenue by Region**



# Research, Development and Demonstration (RD&D)

In 2011, 67% of respondents participated in RD&D activities, reporting total RD&D expenditure of approximately \$136.6 million. Total research and development (R&D) expenditure amounted to \$116.2 million or 85% of total RD&D spending. Demonstration expenditure for 2011 was \$20.4 million.

2011 Total RD&D Expenditure (\$ millions)			
	R&D	Demonstration	Total
Corporate	83.0	13.3	96.3
Government	22.2	7.1	29.3
Academic and non-profit	11.0	–	11.0
<b>Total RD&amp;D</b>	<b>116.2</b>	<b>20.4</b>	<b>136.6</b>

## SOURCES OF FUNDING FOR RD&D EXPENDITURE

The table below provides a breakdown of funding for R&D and demonstration expenditure by source. For R&D expenditure, sources of funding were only provided for \$88.2 million of the \$116.2 million reported by respondents as expenditure in 2011. Parent, affiliated or subsidiary sources funded half of the overall R&D expenditure (50%), followed by Canadian government and corporate operations funding of 28% and 16% of overall R&D expenditure. Corporate operations funded 76% while Canadian government funded 16% of the overall demonstration expenditure.

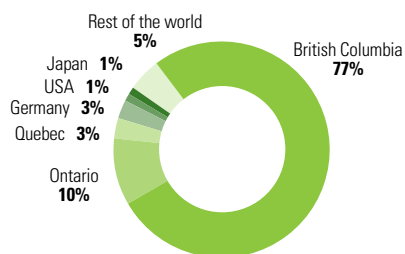
2011 Sources of Funding for RD&D Expenditure	R&D		Demonstration		Total	
	\$ millions	%	\$ millions	%	\$ millions	%
Corporate operations	\$14.5	16%	\$11.3	76%	\$25.8	25%
Parent, affiliated or subsidiary organization	\$43.7	50%	\$0.6	4%	\$44.3	43%
Canadian government (all levels)	\$24.9	28%	\$2.3	16%	\$27.2	26%
Foreign Government	\$1.2	1.5%	\$0.6	4%	\$1.8	2%
Contract work conducted for another institute	\$0.9	1%			\$0.9	1%
University or academic institute	\$1.3	1.5%			\$1.3	1%
Other	\$1.7	2%			\$1.7	2%
<b>Total</b>	<b>\$88.2</b>	<b>100%</b>	<b>\$14.8</b>	<b>100%</b>	<b>\$103.0</b>	<b>100%</b>

# Research and Development

## R&D BY REGION

Geographic data was provided for \$86.5 million of R&D expenditure. British Columbia led all regions with 77% of R&D expenditure. Ontario and Quebec contributed 10% and 3%. Globally, Germany provided 3% with the USA and Japan each providing 1% of the R&D expenditure. Regions included in the Rest of the World category (5%) include France, Denmark, Belgium and China.

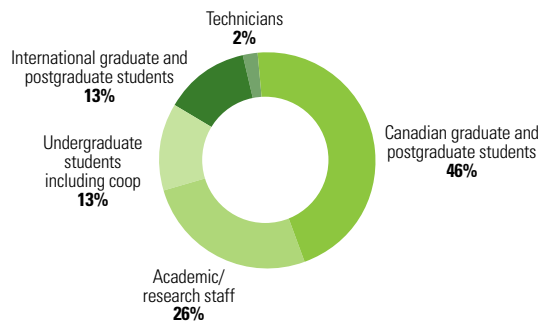
R&D by Region



## PEOPLE INVOLVED IN RESEARCH

Participants reported that a total of 392 people were involved in hydrogen and fuel cell related research activity. Of the total people involved in research, 46% were Canadian graduate and post graduate students, 26% were academic/ research staff, 13% were undergraduate and post-graduate students, 13% were international graduate and post-graduate students, and 2% were technicians.

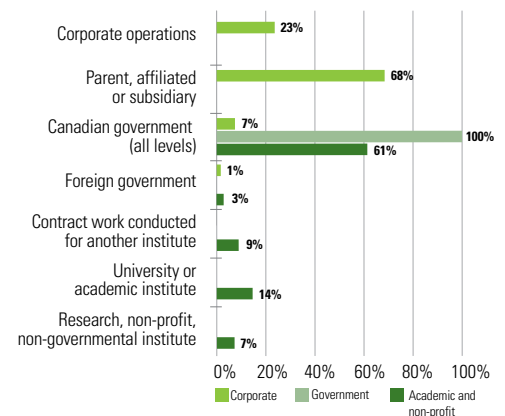
People Involved in Research



## 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 (68%). 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 (61%).

Sources of Funding for R&D Expenditure by Organization



Hydrogen fuel tank



# Demonstration Projects

In 2011, survey participants reported their participation in 123 demonstration projects around the world. Corporate organizations reported involvement in 110 demonstration projects, while government and academic respondents reported their involvement in 6 and 7 demonstrations respectively.

## SOURCES OF FUNDING FOR DEMONSTRATION

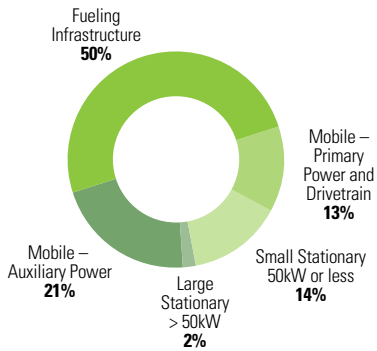
In 2011, Canadian governments funded 16% of the reported \$14.8 million demonstration expenditure and corporate operations funded 77%.

Fueling infrastructure was the main area of focus at 50% of overall demonstration projects. A majority (83%) of government projects focused on fueling infrastructure. Corporate organizations focused most (48%) of their attention on fueling infrastructure with 23% of their efforts spent on mobile – auxiliary power projects.

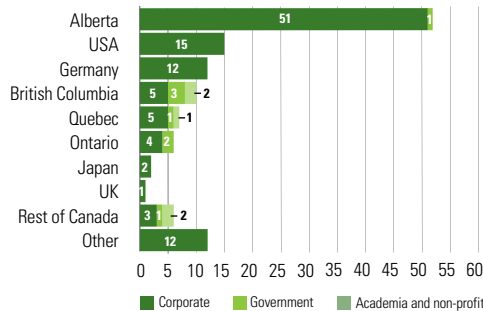
## DEMONSTRATION BY REGION

Canadian provinces hosted a total of 66% of demonstration projects. The majority (42%) of total demonstrations took place in Alberta, followed by USA (12%) and Germany (10%). British Columbia and Quebec hosted 8% and 6% of total demonstrations respectively. Other Canadian provinces accounted for 9% of demonstrations. Japan hosted 2% of demonstration projects. The rest of the demonstrations (11%) took place in other regions including: the United Kingdom (UK), France, Netherlands and China.

Focus of Demonstration Projects

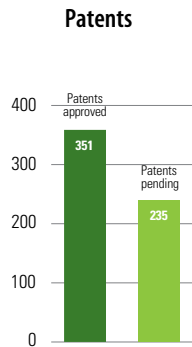


Demonstration Projects by Region (Involvement in Projects)



# Patents

In 2011, corporate respondents reported 351 newly approved patents and 235 patents awaiting approval.



# Employment

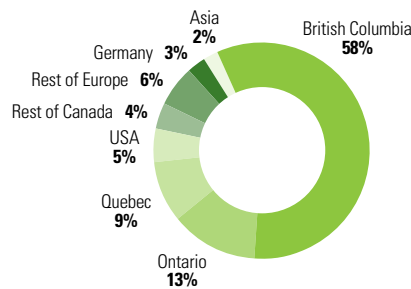
Survey participants reported a total of 2,025 employees involved in hydrogen and fuel cell activities in 2011. This is a nearly 2% increase from 1,991 employees reported in 2010 and a 30% increase from levels reported during the recession in 2008. Survey participants only provided a breakdown by region for 1,625 of the 2,025 employees.

In 2011, 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 (952), followed by Ontario (210) and Quebec (143) with the remaining 64 employees distributed across Canada.

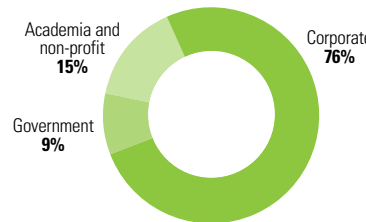
54% of companies surveyed had fewer than 10 employees, 20% had 10 to 25 employees, 11% had between 25 and 50, and 15% had more than 50 employees.

Based on the data provided for the number of employees and total salaries, the average annual salary paid to employees was \$57,180. Extrapolating the average salary for 2011 to the 1,369 employees in Canada, the sector contributed approximately \$78.3 million in direct salaries to the national economy.

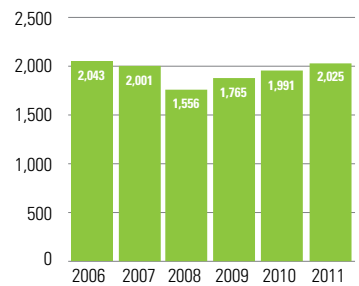
Employment by Region



Employment by Organization



Employment



The entire fleet of material handling equipment at the new Walmart Perishable Distribution Centre in Balzac Alberta is powered by hydrogen fuel cells

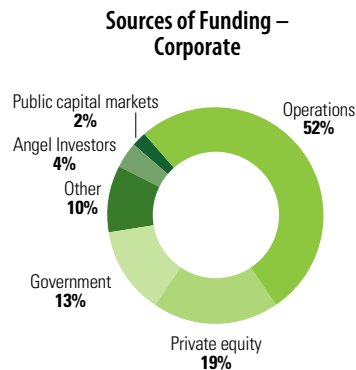
# Funding Requirements

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 84% 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 (75%). British Columbia received 69% of the funding allocation, 26% went to Ontario, 4% went to Quebec and the remaining 1% went to Saskatchewan.

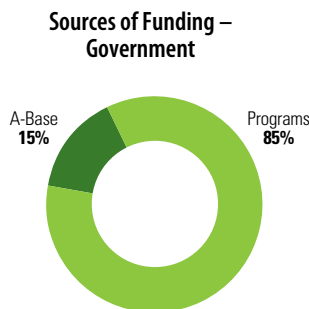
## CORPORATE

Corporate participants report the top three sources of funding for 2011 from operations (52%), private equity (19%) and government (13%). The financial requirements for the next five years are estimated to be \$544.9 million with funding expected to come from private equity (43%), public capital markets (16%), operations (14%), and government (5%) and 22% from other sources.



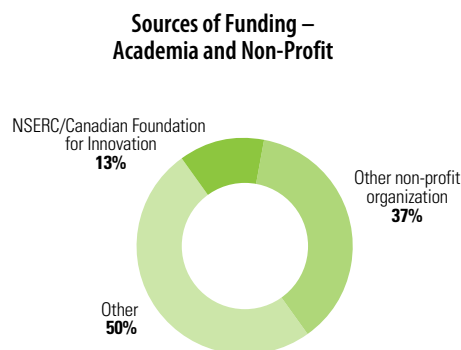
## GOVERNMENT

The total budget for hydrogen and fuel cell related activities reported for 2011 for which government was directly responsible, (including employee salaries and benefits) was \$29 million. Programs contributed 85% of funding requirements with A-base operations contributing 15%.

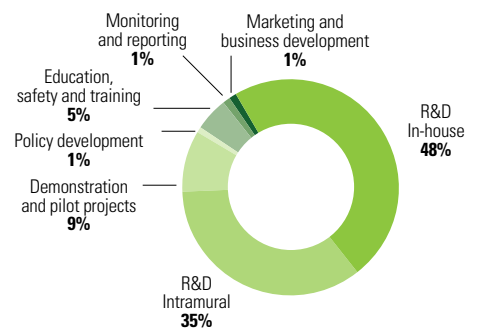


## ACADEMIA AND NON-PROFIT

The total budget for hydrogen and fuel cell related activities reported for 2011, for which academic and non-profit was directly responsible, (including employee salaries and benefits) was \$6 million. The sources of funding for 2011 were from Natural Science and Engineering Research Council of Canada (NSERC)/Canadian Foundation for Innovation (13%), other non-profit organization (37%), and other sources without specification (50%).

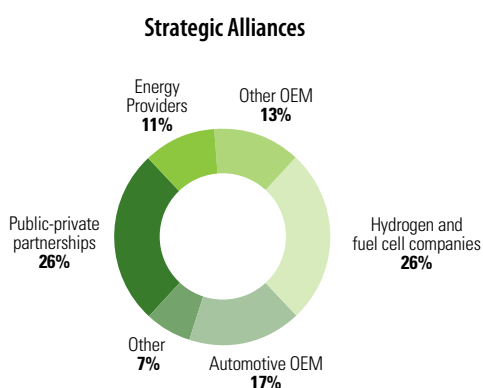


## Funding Allocation by Area – Government & Academia & Non-profit



## Strategic Alliances

In 2011, respondents reported 142 strategic partnerships and alliances, up from 118 reported in 2010, demonstrating the value and importance of relationships and partnerships to the industry. Hydrogen and fuel cell companies represented 26% and public/private partnerships represented 26% of strategic partnerships. Automotive original equipment manufacturer (OEM) represented 17% of partnerships, followed by other OEM and energy providers with 13% and 11% 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 582 research partnerships in 2011. 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 represent 42% of total research partnerships. Partnerships with industry in Canada represented 37% 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	243
In partnership with industry in Canada	214
In partnership with Canadian government	52
In partnership with industry outside of Canada	40
In partnership with foreign government	23
Other	10
<b>Total</b>	<b>582</b>

# Outlook

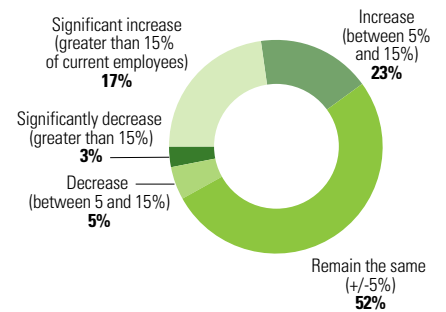
Looking ahead to 2013, participants were asked to identify the top three priorities to enhance competitive performance. Responses varied with collaboration/strategic alliances identified as the top priority at 21%, followed by technology development and gain market share at 19% and at 12%. Better targeting of customers represented 10% while improving processes and plans for expansion each represented 8%. Reduced costs of operations, better market or customer data and outsourcing were identified as priorities for 14% of respondents.

40% of organizations surveyed indicate plans to increase employment within the next 18 months. Eight percent of organizations plan to reduce employment, while over half anticipate that employment will remain the same.

### Priorities to Enhance Competitive Performance in 2013



### Plans to change employment in the next 18 months



# Methodology and Response Rates

The 2012 Sector Profile is the ninth 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.

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-three 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.

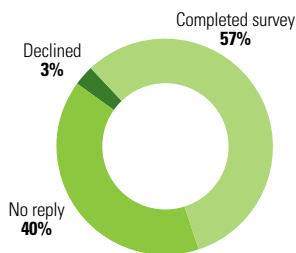
In order to capture more information, the 2012 Sector Profile is also supplemented by publicly available information.

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

## PRESENTATION OF DATA

Figures presented for 2011 were collected by an online questionnaire in 2012. Figures presented for years prior to 2011 are as reported in previous sector profiles, therefore, may not be fully comparable due to differing respondents and/or basis of individual responses.

Profile participation rate



# Conclusion

The Canadian hydrogen and fuel cell sector is recognized for its role in the development of clean technology applications. In 2011, approximately 51% 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 an 11% increase in the total number of

approved and pending patents from 527 in 2009 to 586 in 2011.

In 2011, the Canadian hydrogen and fuel cell sector reported:

- employment at 2,025;
- revenue of \$211 million, with British Columbia representing the largest revenue region in Canada;
- continued commitment to RD&D with \$136.6 million of expenditures;
- a stable number of demonstration projects (123) compared to 128 in 2010 and an increase compared to 86 in 2009;

- a considerable increase both in the number of strategic alliances 142 and research partnerships 582 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 rate, we can see significant growth in the industry between 2001 to 2011:

- Revenue has grown 118% from \$97 million in 2001 to \$211 million in 2011
- R&D expenditures have decreased by 24% from \$179 million in 2001 to \$136 million in 2011.
- Employment in the industry has increased by 14% from 1,772 in 2001 to 2,025 in 2011.

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



## 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 Clean Technology 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.

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

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# 2012 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

Dana Canada Corporation

dPoint Technologies

Enbridge Gas Distribution

FCTEK Holdings Ltd.,

Greenlight Innovation

HRH Consulting

HTEC Hydrogen Technology & Energy Corp.

Hummingbird Hydrogen Corporation

Hydrogen Link

Hydrogen Research Institute

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



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|--|---|
| NORAM Engineering & Constructors Ltd.  | Tekion  |
| Palcan Fuel Cells Ltd.                 | TISEC Inc   |
| Phoenix Canada                         | Transport Canada  |
| PowerDisc Development Corporation Ltd. | Université du Québec à Trois-Rivières                                 |
| PowerTech Labs                         | University of Alberta   |
| Profile Composites                     | University of British Columbia – CERC                                 |
| Queen's RMC Fuel Cell Research Centre  | University of Ottawa  |
| Ryerson University                     | University of Toronto, Mechanical & Industrial Engineering Department |
| Sacre-Davey Engineering                | Walmart Canada  |
| Saskatchewan Research Council          |   |
| Simon Fraser University                |   |

