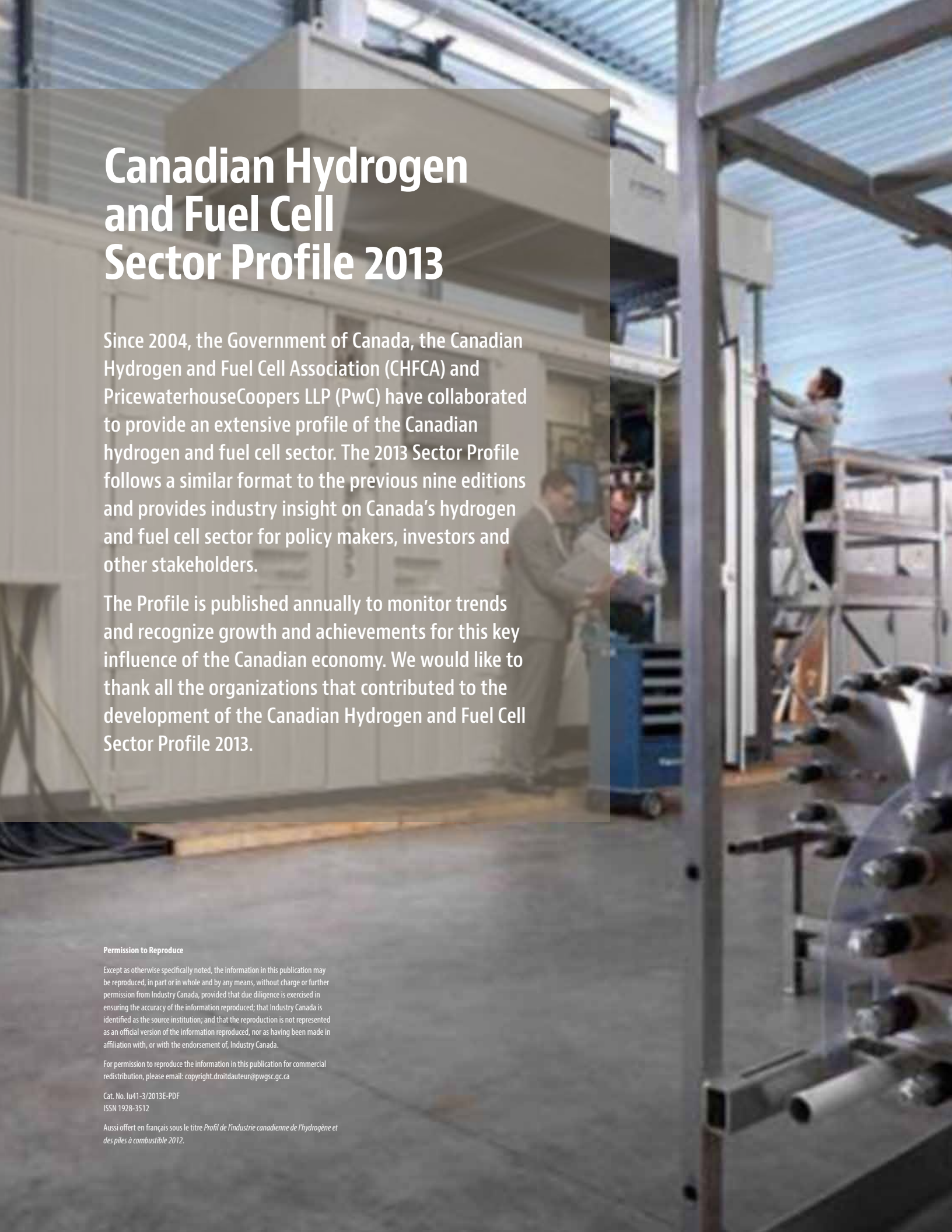


Canadian Hydrogen and Fuel Cell Sector Profile 2013





Canadian Hydrogen and Fuel Cell Sector Profile 2013

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 2013 Sector Profile follows a similar format to the previous nine editions and provides industry insight on Canada's hydrogen and fuel cell sector for policy makers, investors and other stakeholders.

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 2013.

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Cat. No. Iu41-3/2013E-PDF
ISSN 1928-3512

Aussi offert en français sous le titre *Profil de l'industrie canadienne de l'hydrogène et des piles à combustible 2012*.

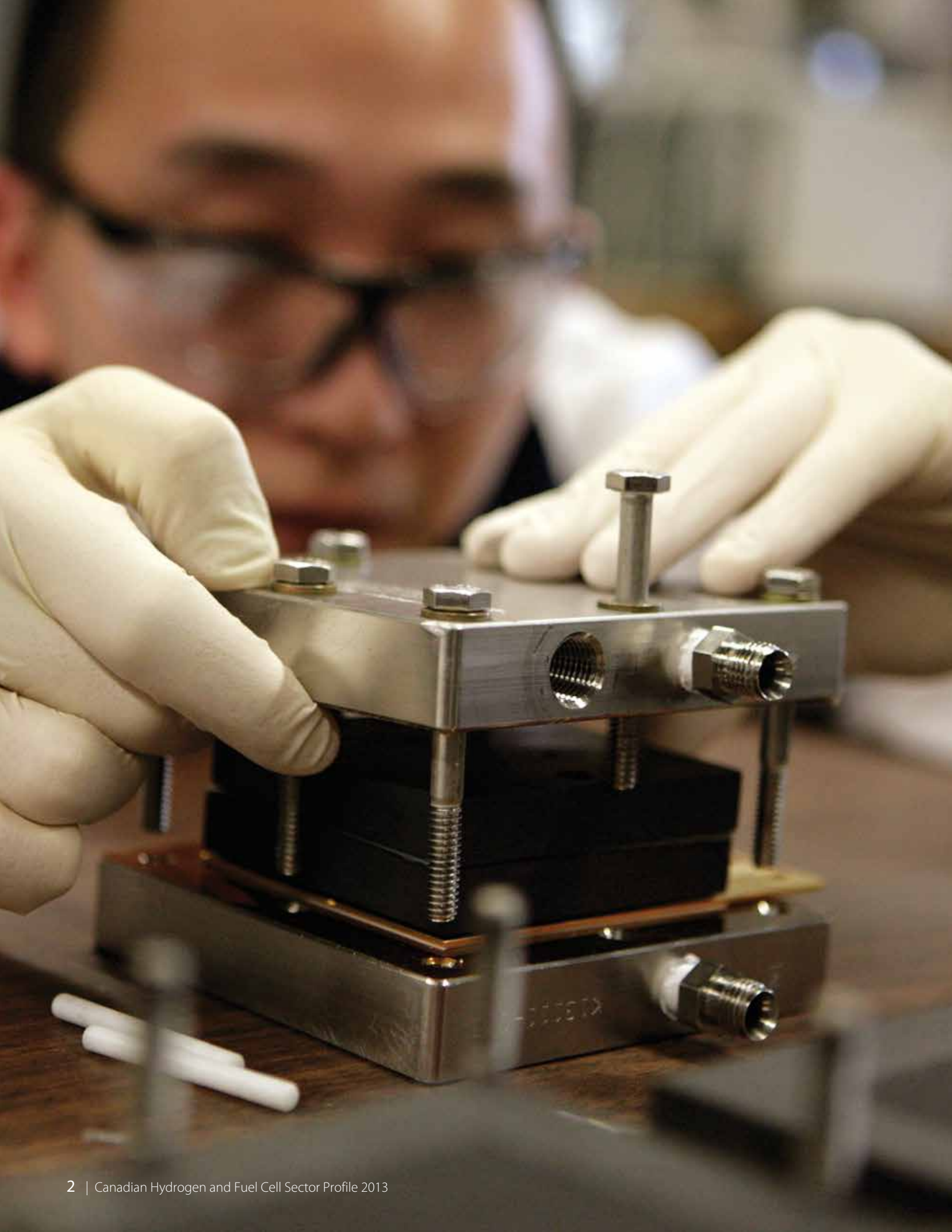
A photograph of industrial equipment, likely related to hydrogen or fuel cell technology, featuring various pipes, valves, and a yellow-handled valve.

Introduction

The Canadian Hydrogen and Fuel Cell Sector Profile 2013 measures performance indicators and provides industry insight to assess Canada's position within a competitive global industry. The Canadian sector has long been a 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 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 2012:

- Revenue was \$141 million.
- Product sales generated \$99 million of revenue.
- Research, development and demonstration expenditures were \$75 million.
- Employment was 1,582.
- 59 demonstration projects were reported.
- 71 strategic alliances were reported.
- 331 research partnerships were reported.



Methodology and Response Rate

The 2013 Sector Profile is the tenth 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, across sections relating to research, development and demonstration (RD&D) and funding, specific questions have been asked from 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, 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. In this study, additional data was requested from Corporates on new funding sources.

All monetary results are presented in Canadian dollars.

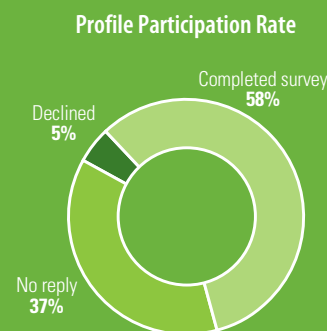
A total of 126 organizations associated with hydrogen and fuel cells in Canada were invited to participate in the development of this Sector Profile which is in line with the 2012 Sector Profile. Participation was also in line with that of the 2012 Sector Profile, with seventy-three completed responses received, representing an overall response rate of 58%.

Not all respondents provided information for every category requested. Some investigation was conducted as to the completeness of the data provided by respondents or reasons for non-provision, but in some cases no clarification was received.

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

Presentation of Data

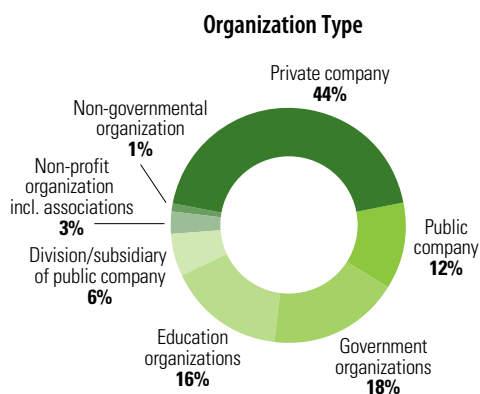
Figures presented for 2012 were collected by an online questionnaire in 2013. Figures presented for 2011 are as reported in the 2012 Sector Profile and, therefore, may not be fully comparable due to differing respondents and/or basis of individual responses.



Organization Profile

Organization Type

Corporate organizations, including public and private companies, and subsidiaries, represented 62% of total responses. Government organizations accounted for 18%, with education organizations, and non-profit organizations including associations representing the remaining 20% of respondents.

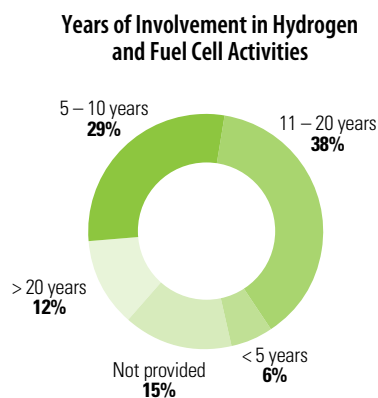


Headquarters

The majority of respondents (92%) reported headquarters of hydrogen and fuel cell activities in Canada. Others were headquartered in the United States and Europe.

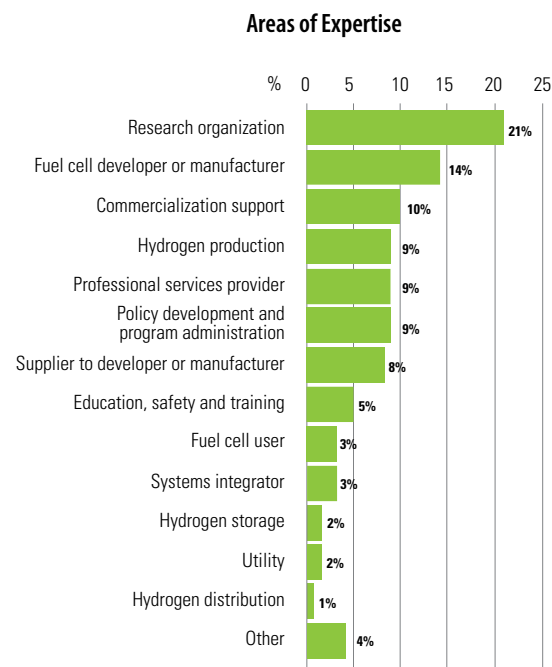
Years of Involvement in Hydrogen and Fuel Cell Activities

Fifty 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 (21%). Fuel cell development or manufacturing and hydrogen production represented 14%, followed by commercialization support at 10%. Hydrogen production, professional services and policy development/program administration each represented 9% while supply to developers or manufacturers represented 8%, followed by education, safety and training (5%). Fuel cell users and systems integrators each represented 3% while hydrogen storage accounted for 2%. Utility represented 2%, followed by hydrogen distribution (1%). The 'other' area of expertise category (4%) included hydrogen fueling infrastructure and purification.



Market Focus

Stationary applications, including both small (21%) and large (9%) subcategories, combined represented the largest area of market focus at 30%. Fueling infrastructure, which includes hydrogen production, distribution and storage, represented the second largest standalone area of market focus at 28%. In addition, the combined mobile application subcategories of portable (14%), primary power and drivetrain (22%) and auxiliary power (6%) represented 42% of the market focus. The results show that the market focus has remained stable from the 2012 Sector Profile.

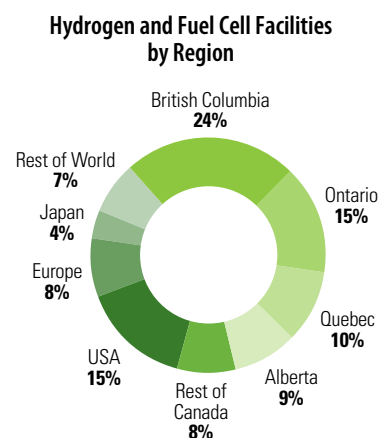
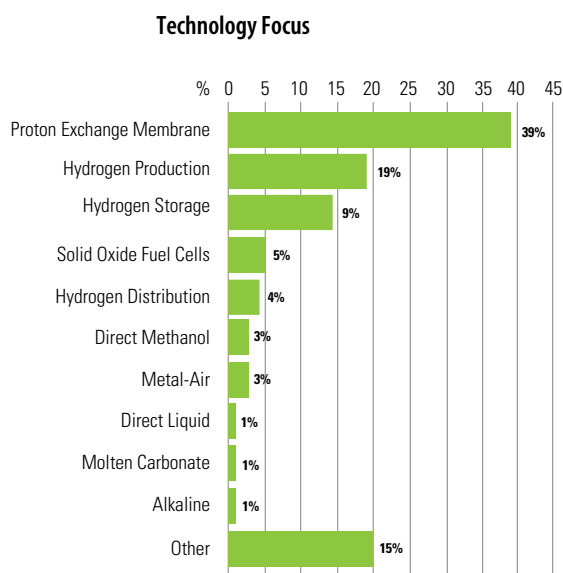
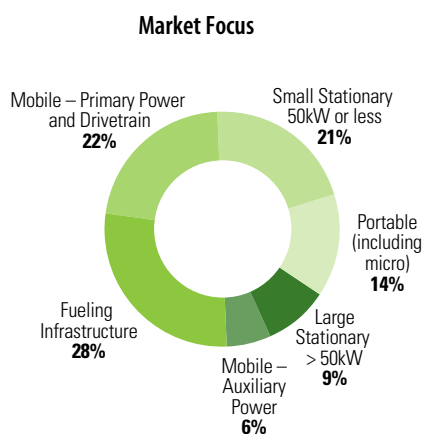
Technology Focus

Proton Exchange Membrane (PEM) fuel cells dominated the focus of technology activities at 39% with hydrogen production coming in second at 19%, followed by hydrogen storage at 9%. Solid oxide fuel cells represented 5%, hydrogen distribution represented 4% and the remaining categories represented 24% of the industry's technological focus. Some of the 'other' areas of technology focus (15%) include hydrogen infrastructure, testing, purification.

Hydrogen and Fuel Cell Facilities by Region

Survey participants reported 136 locations for hydrogen and fuel cell facilities and activities in 2012. In total, 66% of facilities were located in Canada, 15% in the United States, 8% in Europe and 4% in Japan. The remaining 7% were overseas in South Africa, Mexico, Russia, Indonesia, China, India, 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, Nova Scotia, and New Brunswick.



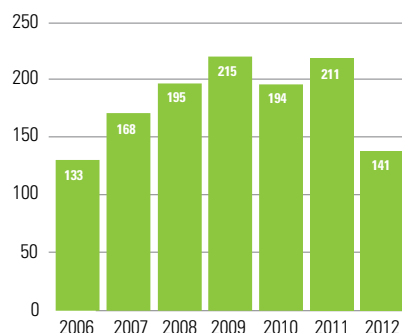
Revenue

In 2012, survey respondents reported revenue from hydrogen and fuel cell activities of \$141 million with 44% participating in revenue generating activities. 65% reported less than \$1 million in revenue, while 23% had more than \$5 million of revenue and 12% reported revenue between \$1 and \$5 million.

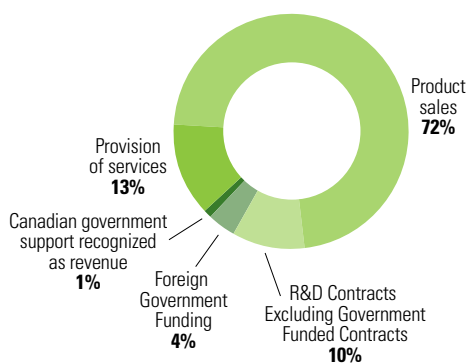
In 2012, the two categories that generated the most revenue were product sales with revenue of \$99 million, and provision of services producing revenue of \$18 million. R&D contracts (excluding government funded contracts) represented \$14 million or 10% of revenue, which is an increase since 2011 when there were no such contracts reported. Foreign government funding represented 4% of reported revenue. Where Canadian government support was recognized as revenue, it represented 1% of overall revenue in 2012. Additional details for government funding are provided in the research, development and demonstration and funding sections of this study.

The regions with the most hydrogen and fuel cell related sales were in Europe (36%) including Germany with 22%, Asia at 31% (including Japan at 24%) and USA at 12%. Sales in Canada represented 6% of total fuel cell related sales of survey respondents and were split approximately by thirds in each of British Columbia, Ontario and the rest of Canada.

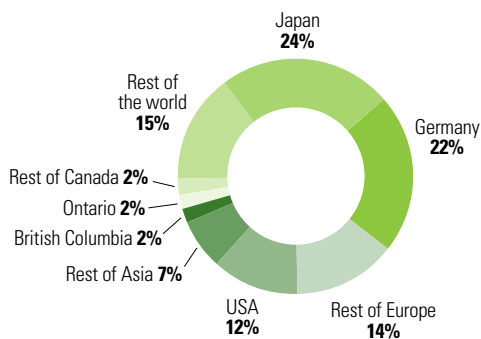
Total Revenue (\$ millions)



Revenue by Category



Revenue by Region

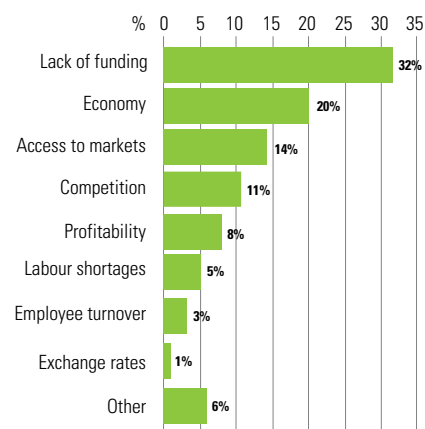


Competitive Performance and Challenges

The top three priorities identified by survey participants to enhance competitive performance were: collaboration and strategic alliances (22%), technology development (17%), and gain market share (14%).

Survey participants were asked to identify challenges faced by their organization in 2012. The main challenge faced by survey participants was lack of funding (32%). The economy (20%), access to market (14%) and competition (11%) were also identified. Profitability was a challenge for 8% of the population, while labour shortages represented 5% and employee turnover 3%, followed by exchange rates at 1%. Other challenges identified by companies included corporate reluctance to accept investment risk, fuel cell market decline, internal restructuring and the lack of a mature supply chain.

Challenges Faced in 2012



Research, Development and Demonstration (RD&D)

In 2012, 66% of respondents participated in RD&D activities, reporting total RD&D expenditure of approximately \$75 million. Total research and development (R&D) expenditure amounted to \$65 million or 87% of total RD&D spending. Demonstration expenditure for 2012 was \$10 million.

2012 Total RD&D Expenditure (\$ millions)			
	R&D	Demonstration	Total
Corporate	56.0	9.5	65.5
Government	2.0	0.2	2.2
Academic and non-profit	7.0	0.3	7.3
Total RD&D	65.0	10.0	75.0

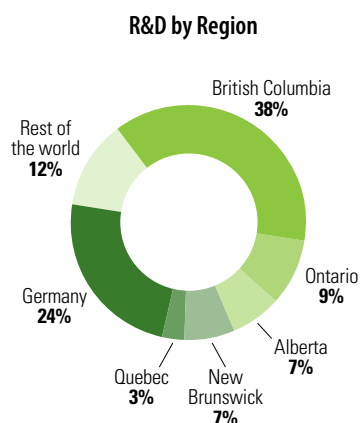
Sources of Funding for RD&D Expenditure

The table below provides a breakdown of funding for R&D and demonstration expenditures by source. Corporate operations together with parent, affiliated or subsidiary organizations funded 65% of total reported R&D expenditure. The Canadian government provided 12% and foreign governments provided 7% of R&D funding. For demonstration expenditure, corporate operations together with parent, affiliated or subsidiary organizations funded 59% while the Canadian government funded 13% and foreign governments 6%.

2012 Sources of Funding for RD&D Expenditure	R&D		Demonstration		Total	
	\$ millions	%	\$ millions	%	\$ millions	%
Corporate operations	22.3	34%	0.4	4%	22.7	30%
Parent, affiliated or subsidiary organization	20.1	31%	5.5	55%	25.6	34%
Canadian government (all levels)	8.1	12%	1.3	13%	9.4	13%
Foreign government	4.3	7%	0.6	6%	4.9	7%
University or academic institute	0.9	1%	0.1	1%	1.0	1%
Contract work conducted for another institute	0.5	1%	0.2	2%	0.7	1%
Other or not identified	8.8	14%	1.9	19%	10.7	14%
Total	65.0	100%	10.0	100%	75.0	100%

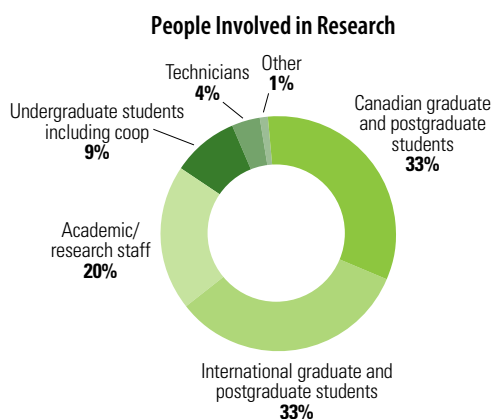
R&D by Region

Geographic data was provided for \$60 million of the \$65 million of R&D expenditure. British Columbia led all regions with 38% of R&D expenditure. Ontario had 9% of spending while each of Alberta and New Brunswick received 7% and Quebec 3%. Globally, R&D expenditure by participants was greatest in Germany at 24%. The most significant regions included in the Rest of the World category (12%) are Denmark and USA.



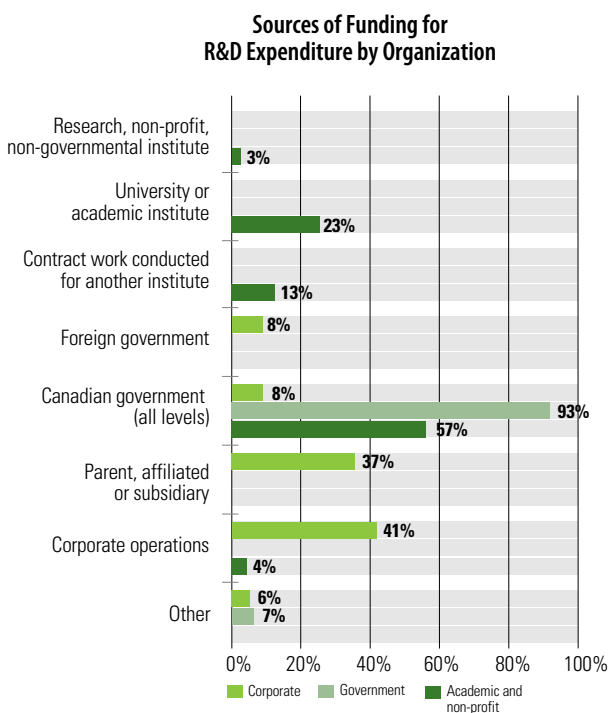
People Involved in Research

Participants reported that a total of 261 people were involved in hydrogen and fuel cell related research activity. Of the total people involved in research, 33% were Canadian graduate and post graduate students, and 33% were international graduate and post-graduate students. 20% were academic/research staff, 9% were undergraduate students including co-op, and 4% were technicians.



Sources of Funding For R&D Expenditure

The bar chart to the right represents sources of funding for R&D expenditure by type of organization. Corporate respondents received most of their funding from corporate operations (41%) and parent, affiliated or subsidiary sources (37%). Government organizations received the majority of their funding from Canadian government sources (93%). Academic and non-profit organizations also received most of their funding from Canadian government sources (57%).



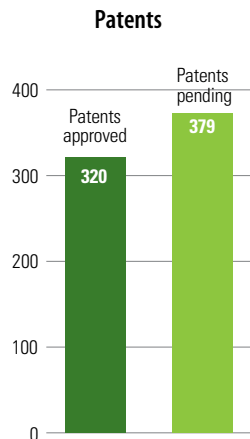
Demonstration Projects and Patents

Demonstration projects

In 2012, survey participants reported their participation in 59 demonstration projects around the world. Corporate organizations reported involvement in 56 demonstration projects, while academic respondents reported their involvement in 3 demonstrations.

Patents

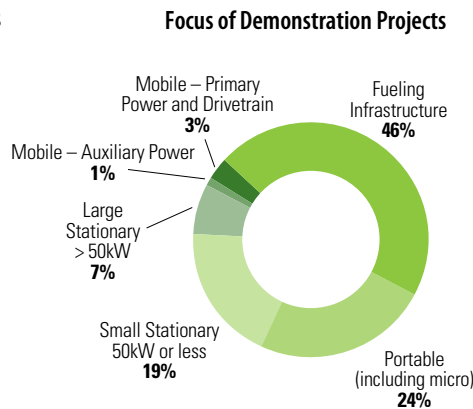
In 2012, corporate respondents reported 320 newly approved patents and 379 patents awaiting approval.



Sources of Funding for Demonstration

In 2012, Canadian governments funded 13% of the reported \$10 million demonstration expenditure and parent, affiliated or subsidiary organization funded 55%.

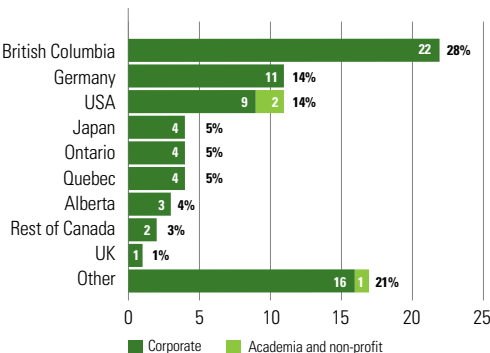
Fueling infrastructure was the main area of focus at 46% of overall demonstration projects. Corporate organizations focused most (46%) of their attention on fueling infrastructure with 24% of their efforts spent on mobile – portable power projects, a new focus in 2012.



Demonstration by Region

Canadian provinces hosted 45% of total demonstration projects. The majority of total demonstrations took place in British Columbia (28%), followed by Germany and USA (14%). Quebec and Ontario each hosted 5% of total demonstrations. Other Canadian provinces accounted for 7% of demonstrations. Japan hosted 5% of demonstration projects. The rest of the demonstrations (21%) took place in other regions including Prince Edward Island, Manitoba and outside of Canada.

Demonstration Projects by Region (Involvement in Projects)



Employment

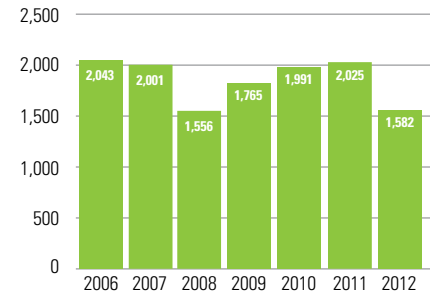
Survey participants reported a total of 1,582 employees involved in hydrogen and fuel cell activities in 2012.

Survey participants only provided a breakdown by region for 1,369 of the 1,582 employees. In 2012, the largest proportion of industry employees (approximately 79%) was located in Canada, 6% in the United States, and the remaining 15% overseas in the UK, France, Denmark, Belgium, Germany, China, Singapore, Indonesia, Russia, South Africa and Namibia. In Canada, most employees were located in British Columbia (752), followed by Ontario (174), Quebec (130) with the remaining 106 employees distributed across Canada.

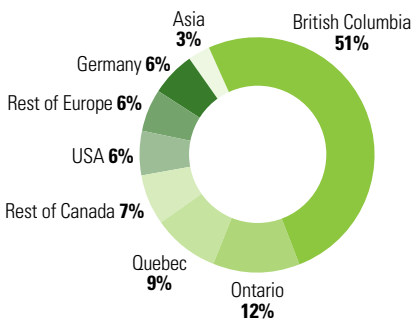
63% of companies surveyed had fewer than 10 employees, 19% had 10 to 25 employees, 6% had between 25 and 50, and 11% had more than 50 employees.

Based on the data provided for the number of employees and total salaries, the average annual salary paid to employees was \$58,178. Extrapolating the average salary for 2012 to the 1,162 employees in Canada, the sector contributed approximately \$67.6 million in salaries to the national economy.

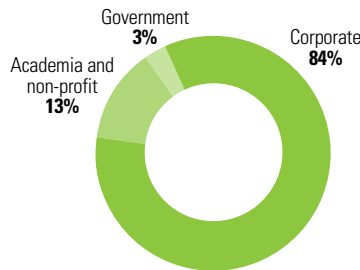
Employment



Employment by Region



Employment by Organization

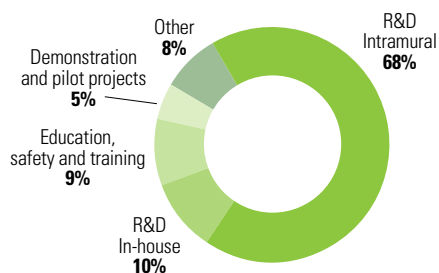


Funding Requirements

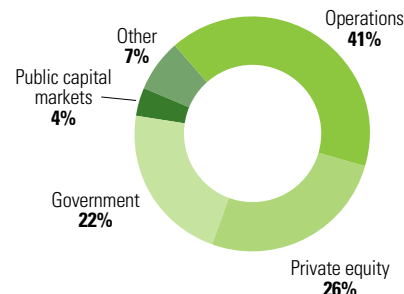
Continued education of governments and public capital markets on the benefits of investing in the hydrogen and fuel cell industry is an important part of the industry's efforts to secure funding. Given the industry's long development period and demanding RD&D requirements, adequate financing is necessary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

Funding was primarily allocated to R&D (both intramural and in-house). About 89% of government funding was allocated to R&D. Sixty-five percent of academic and non-profit organizations funding was allocated to R&D and 22% was allocated to education, safety and training. 49% of all funding for government and academic institutions came from the Natural Sciences and Engineering Council of Canada and was used for projects spread across Canada.

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

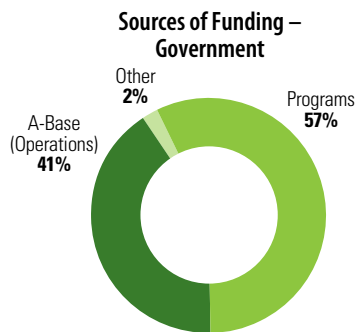


**Sources of Funding –
Corporate**



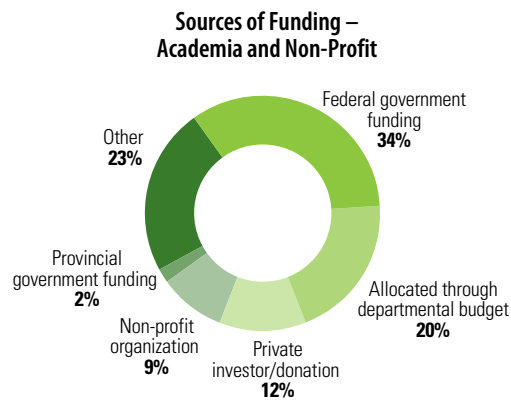
Corporate

Corporate participants reported the top three sources of funding for 2012 were operations (41%), private equity (26%) and government (22%). The financial requirements for the next five years are estimated to be \$467 million with funding expected to come from private equity (64%), operations (10%), government (5%) and the remainder from venture capital (3%), angel investors (1%) and other sources (17%). 41% of corporate respondents reported new investment in the sector, the majority of which was from British Columbia, followed by Ontario, then Alberta and Quebec. 26% of respondents indicated new investment in the sector coming from international sources. Most of the new foreign investment was from USA, followed by Germany, then China and South Africa.



Government

The total budget for hydrogen and fuel cell related activities reported for 2012 for which government was directly responsible; (including employee salaries and benefits) was \$14 million. Programs contributed 57% of funding requirements with A-base operations contributing 41%.



Academia and Non-Profit

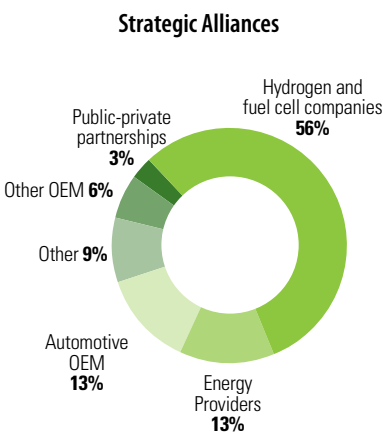
The total budget for hydrogen and fuel cell related activities reported for 2012, for which academic and non-profit was directly responsible, (including employee salaries and benefits) was \$10 million. The sources of funding for 2012 were from federal government funding (34%), departmental budgets (20%), private investor/donation (12%), non-profit organizations (9%), provincial funding (2%) and other sources without specification (23%).



Strategic Alliances and Research Partnerships

Strategic alliances

In 2012, respondents reported 71 strategic partnerships and alliances, demonstrating the value and importance of relationships and partnerships to the industry. Hydrogen and fuel cell companies represented 56% and energy providers represented 13% of strategic partnerships. Automotive original equipment manufacturer (OEM) represented 13% of partnerships, followed by other OEM with 6% and public-private partnerships representing 3%.



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 331 research partnerships in 2012. As survey respondents may report partnerships that they have with each other, there is a possibility that the number of research partnerships is overstated. However, research partnerships as a percentage of the total should be representative of actual partnerships. Partnerships with the Canadian Government represented 63% of all research partnerships. Partnerships with industry in Canada represented 15% of all research partnerships. Partnerships with academic/non-profit/associations represented 10% of total 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.

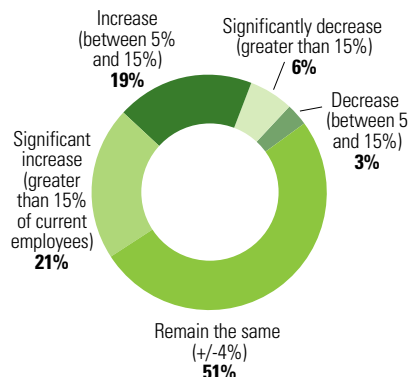
Number of Research Partnerships	
	Total
In partnership with Canadian government	210
In partnership with industry in Canada	50
In partnership with Canadian academia/non-profit/associations	33
In partnership with industry outside of Canada	19
In partnership with foreign governments	18
Other	1
Total	331

Outlook

Looking ahead to 2014, 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 22%, followed by technology development and gaining market share at 17% and at 14%. Improving processes and plans for expansion each represented 10%, while better targeting of customers and reducing cost of operations represented 8% and 7%. Better market or customer data, staff retention, outsourcing and other were identified as priorities for 12% of respondents.

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

Plans to Change Employment in the Next 18 Months



Priorities to Enhance Competitive Performance in 2013



Hydrogenics Facilities in Mississauga

Conclusion

The Canadian hydrogen and fuel cell sector is recognized for its role in the development of clean technology applications. In 2012, approximately 50% of respondents reported involvement in hydrogen and fuel cell activities for over 10 years suggesting a relatively stable industry. The industry also continues to be innovative with a 19% increase in the total number of approved and pending patents from 586 in 2011 to 699 in 2012.

In 2012, the Canadian hydrogen and fuel cell sector reported:

- revenue of \$141 million;
- continued commitment to RD&D with \$75 million of expenditures;
- employment at 1,582;
- 59 demonstration projects;
- 71 strategic alliances; and
- 331 research partnerships.

Industry 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 changes in the industry over time:

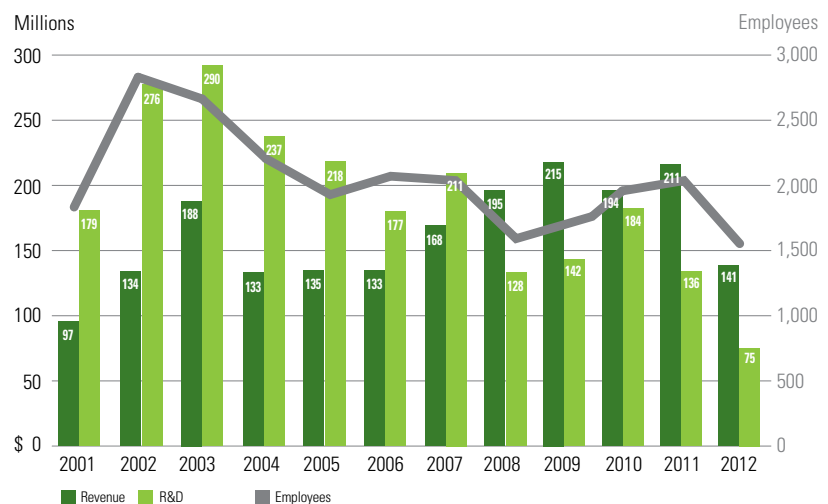


- Revenue growth in the industry of 45% from 2001 to 2012. The difference in revenue from 2011 to 2012 is largely explained by the reported 70% decrease in the provision of fuel cell and hydrogen related services;
- R&D expenditure has decreased by 58% since 2001 and 45% since 2011. Participants reported a significant decrease in all funding sources for R&D and demonstrations other than foreign government support. Participants report greater R&D expenditure in Germany and a significant reduction in investment in British Columbia; and

- Employment in the industry is 11% lower than it was in 2001 and 22% lower than in 2011. Some organizations have reported closing their Canadian facilities and are therefore not reporting any statistics for the sector. This would include Canadian based as well as foreign based employees.

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 organizations 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.

Industry Since 2001



Ballard powered zero-emission fuel cell-powered buses deliver economic, operational as well as environmental benefit

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.

For more information on the Canadian hydrogen and fuel cell Sector Profile please contact:

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Mike Pacholek
Partner
PwC

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michael.j.pacholek@ca.pwc.com

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.



2013 Participants

A.V. Tchouvelev & Associates Inc.

AECL, Chalk River Laboratories

Air Liquide Canada

Alternative Energy Development Corporation (AEDC)

Angstrom Power Inc.

Associated Plastics

Automotive Fuel Cell Cooperation.

Ballard Power Systems Inc.

BC Hydro

Blue O Technology

Blueprime Technology Management

Canadian Hydrogen and Fuel Cells Association

Canetique Electrocatalyst Inc.

Change Energy

Dana Canada Corporation

Department of National Defense

Dpoint Technologies

Enbridge Gas Distribution

Evergreen Energy

Government of BC, Ministry of Energy and Mines

Government of Manitoba

Greenlight Innovation

HRH Consulting

HTEC Hydrogen Technology & Energy Corp.

Hydrogen Research Institute

Hydrogenics Corporation

Hyteon Inc.

Industry Canada – MRPIB

Isowater Corporation

Lambton College

McMaster University
Mercedes-Benz Canada
National Research Council – IRAP
National Research Council of Canada
(Aluminum Technology Centre)
Natural Resources Canada, CANMET
Natural Sciences and Engineering
Council of Canada
NORAM Engineering & Constructors Ltd.
Palcan Fuel Cells Ltd.
Phoenix Canada
PowerDisc Development
Corporation Ltd.
Profile Composites
Quadrogen Power Systems Inc.

Quantum Technology Corp
Queen's RMC Fuel Cell Research Centre
Royal Military College of Canada
Sarnia-Lambton Economic Partnership
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Terrella Energy Systems Ltd.
Thumbprint Solutions
TISEC Inc.
Universite de Quebec a Trois-Rivieres,
Hydrogen Research Institute
University of Alberta
University of British Columbia –
Clean Energy Research Centre
University of Ottawa

University of Toronto, Mechanical &
Industrial Engineering Department
University of Victoria
University of Waterloo, Department of
Mechanical & Mechatronics Engineering
University of Windsor
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