Canadian Hydrogen and Fuel Cell Sector Profile 2015

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CHFCA clean energy now™ Canada MNP LLP

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Canadian Hydrogen and Fuel Cell Sector Profile 2015

For more than a decade, the Government of Canada and the Canadian Hydrogen and Fuel Cell Association (CHFCA) have collaborated to develop an industry profile of the Canadian hydrogen and fuel cell sector. The profile is published annually in order to:

- Capture trends, growth and achievements for the Canadian sector.
- Offer insights into the current state of the sector.
- Provide valuable information for policy makers, investors and other stakeholders.

The 2015 profile was commissioned by Innovation, Science & Economic Development Canada (ISED) and the CHFCA and conducted by MNP LLP. The information presented in the profile was collected through a survey of Canadian companies, educational institutes and government agencies that were directly involved in hydrogen and fuel cell-related activities in 2014. All monetary results are presented in Canadian dollars.

Our thanks to all the organisations that contributed to the development of the Canadian Hydrogen and Fuel Cell Sector Profile 2015.

Introduction

The Canadian hydrogen and fuel cell sector is recognised as a leader in the global industry for pioneering new technologies and industry expertise. Increasing demand for clean energy products and solutions domestically and worldwide is generating opportunities and investments in a broad range of applications, including passenger vehicles, buses, stationary and back-up power and materials handling. Fuel cell technologies are being used to enhance the performance of clean energy systems by helping to balance fluctuations in energy loads. These technologies also play an important role in helping to grow the renewable energy sector in Canada and around the world. The sector is an important contributor to the Canadian economy and the development of clean, efficient and reliable energy alternatives.

The Industry at a Glance in 2014

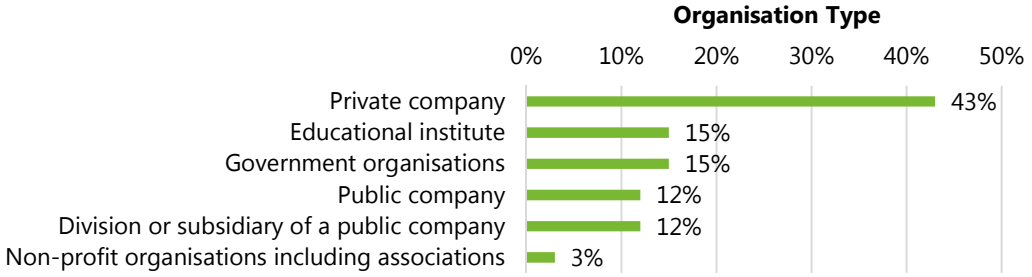
In 2014 survey respondents from the Canadian hydrogen and fuel cell sector reported:

- Revenue of $199 million.
- $119 million of revenue from product sales.
- $70 million of revenue from the provision of services.
- Research, development and demonstration expenditures of $158 million.
- Employment of 1,662 jobs.
- 15 demonstration projects.
- 79 strategic alliances.
- 191 research partnerships.

Organisation Profile

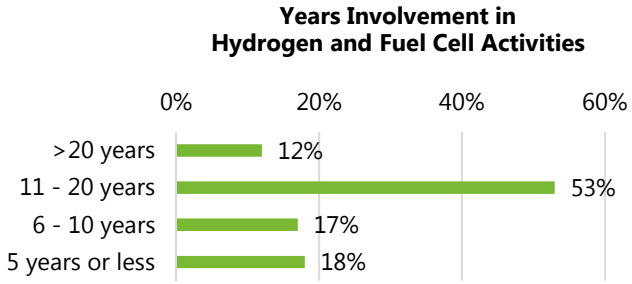
Organisation Type

Corporate organisations, including private companies, public companies and subsidiaries, represented 67% of total survey respondents. Government organisations accounted for 15%, and educational institutes and non-profit organisations, including associations, represented the remaining 18% of respondents.



Years of Involvement in Hydrogen and Fuel Cell Activities

The majority of survey respondents (65%) reported involvement in hydrogen and fuel cell activities for more than ten years.



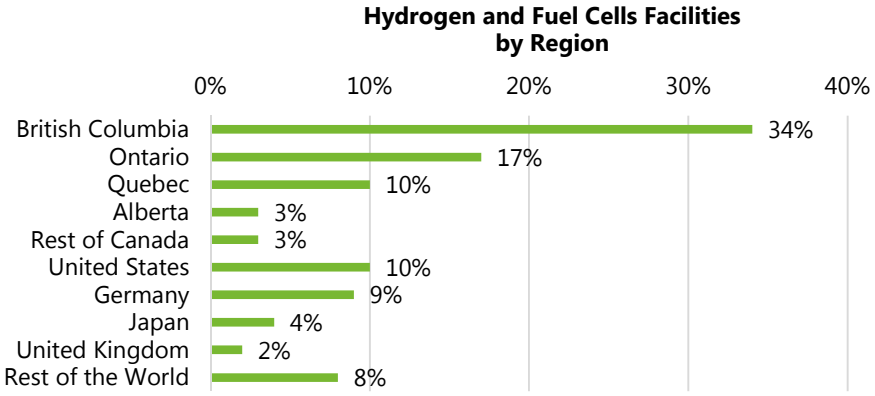
Headquarters

The companies surveyed were those operating in Canada. The majority of survey respondents (91%) reported headquarters for hydrogen and fuel cell activities located in Canada. Others survey respondents had headquarters in Germany, Japan, South Korea, the United States and the United Kingdom.

Hydrogen and Fuel Cell Facilities by Region

Survey respondents reported 93 locations for hydrogen and fuel cell facilities and activities in 2014. In total, 67% of facilities were located in Canada, 10% in the United States, 9% in Germany, 4% in Japan and 2% in the United Kingdom. The remaining 8% were in China, South Korea, Denmark, Belgium, France, India and South Africa.

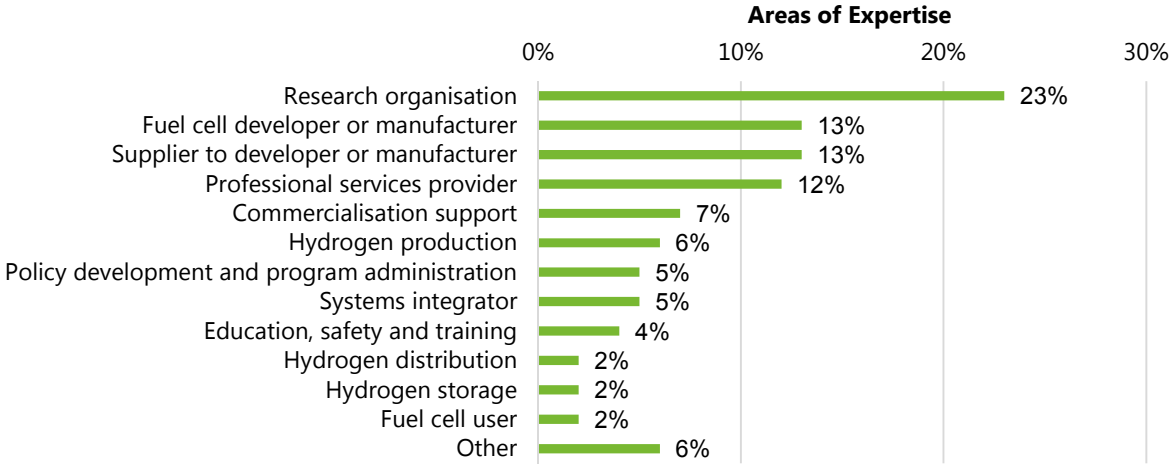
In 2014, hydrogen and fuel cell activities took place in most provinces within Canada. The majority of facilities and activities were in British Columbia (34%) and Ontario (17%), followed by Quebec (10%) and Alberta (3%). The rest of Canada (3%) included facilities located in Manitoba and Newfoundland.



Areas of Expertise

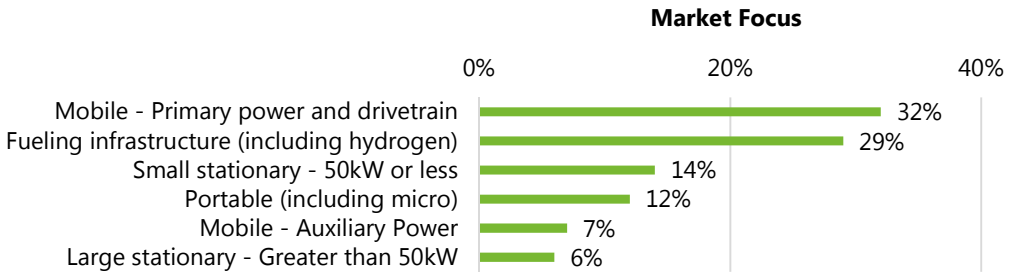
Survey respondents' main area of expertise in 2014 was research (23%). Other areas of expertise included fuel cell development or manufacturing and supplying to developers or manufacturers (13% each), professional services (12%), commercialisation support (7%) and hydrogen production (6%).

Policy development and program administration, systems integration, education, safety and training, hydrogen distribution, hydrogen storage, and fuel cell usage each represented 5% or less of the survey respondents' expertise.



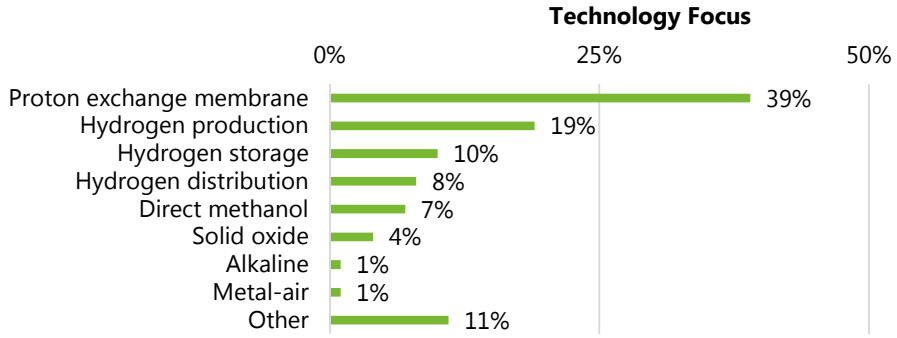
Market Focus

In 2014, the combined mobile applications of primary power and drivetrain (32%), portable (12%) and auxiliary power (7%), represented 51% of survey respondents' market focus. Fueling infrastructure, which includes hydrogen production, distribution and storage, represented the second largest single area of market focus (29%), while stationary applications accounted for the remaining 20% of market focus.



Technology Focus

Proton Exchange Membrane (PEM) fuel cells dominated the focus of survey respondents' technology activities in 2014 (39%). Hydrogen production, storage and distribution accounted for 37% of survey respondents' technology focus. Direct methanol represented 7%, solid oxide 4%, alkaline and metal-air each represented 1%, and other categories represented 11% of survey respondents' technology focus.



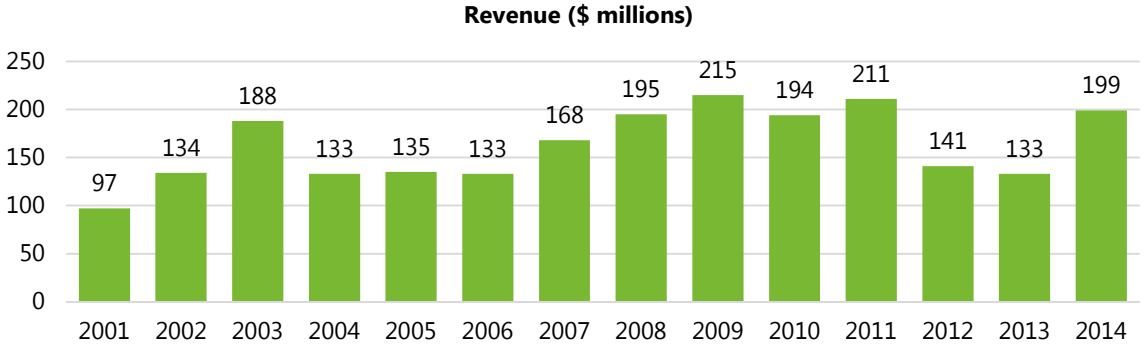
Revenue

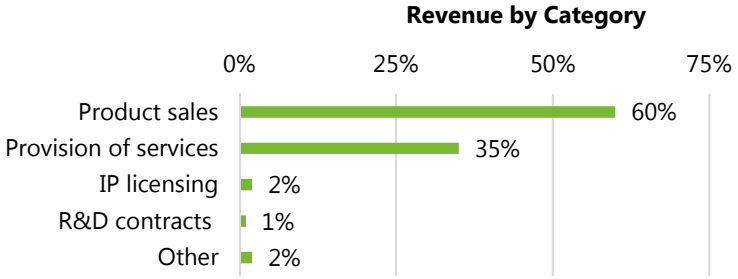
In 2014, 46% of survey respondents generated revenue from hydrogen and fuel cell activities. This revenue generated by survey respondents was approximately $199 million. Year-over-year revenue is not directly comparable due to variations in survey respondents and participation rates.

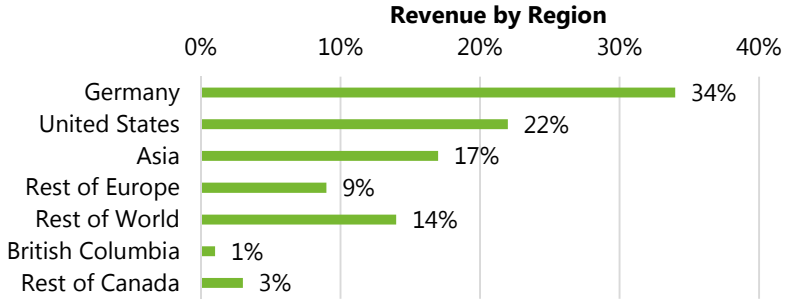
Of the survey respondents that provided their revenue in 2014, 22% reported more than $5 million in revenue with over half of those respondents reporting revenue of more than $25 million, 13% reported revenue between $1 and $5 million, and 65% reported less than $1 million in revenue.

In 2014, survey respondents generated the most revenue from product sales and provision of services, which generated 60% or $119 million and 35% or $70 million in revenue respectively.

The regions in which survey respondents generated the most hydrogen and fuel cell-related revenue in 2014 were Germany (34%), United States (22%) and Asia (17%). Overall, 4% of revenues were generated in Canada. Note: some respondents that selected the "Rest of World" category did not indicate the specific country.



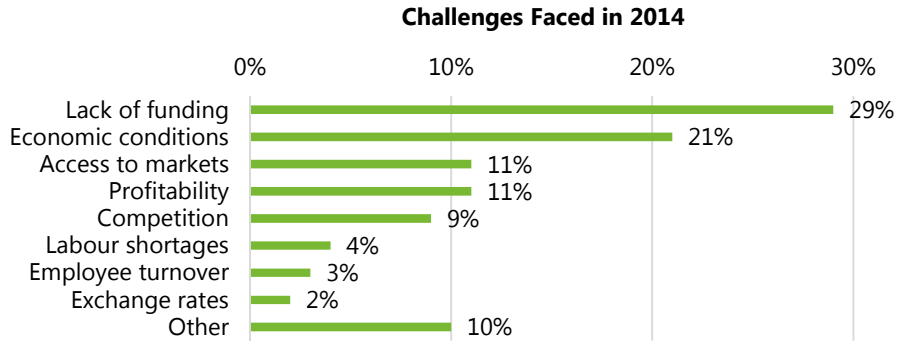




Competitive Performance and Challenges

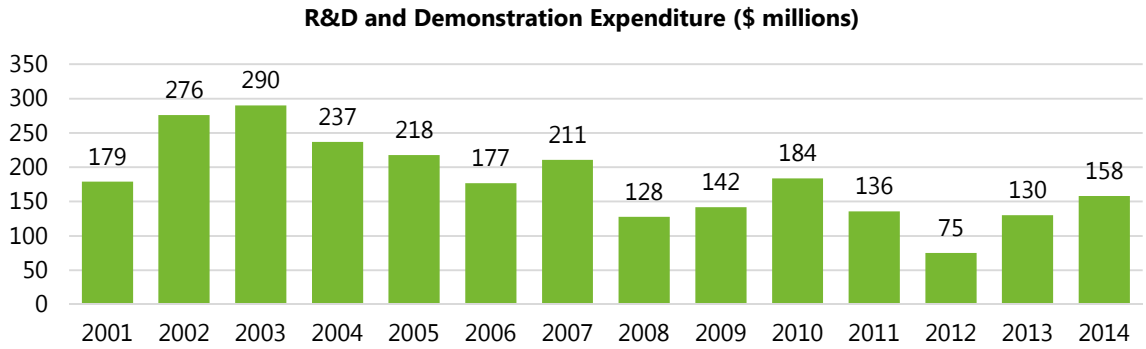
Survey respondents were asked to identify challenges faced by their organisations in 2014. The main challenges faced by survey respondents were lack of funding (29%) and economic conditions (21%), followed by access to markets and profitability (11% each).

Respondents also reported competition (9%), labour shortages (4%) and employee turnover (3%) as challenges faced in 2014. Other challenges identified by respondents were mostly related to a lack of market opportunities in Canada.



Research and Development (R&D) and Demonstration

In 2014, 69% of survey respondents participated in research and development (R&D) and demonstration activities and reported total expenditures of approximately $158 million. Total R&D expenditure was $156 million and demonstration expenditure was $2 million.



2014 Total R&D and Demonstration Expenditure ($ millions)	R&D	Demonstration	Total
Corporate	139.8	0.9	140.7
Government, Academic and Non-Profit	16.2	1.1	17.3
Total	**156.0**	**2.0**	**158.0**

Sources of Funding for R&D and Demonstration Expenditure

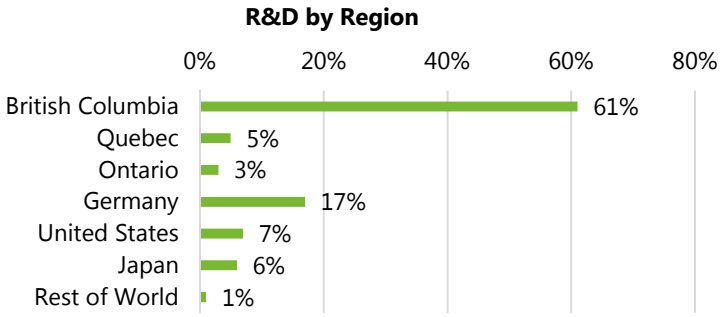
The table below provides a breakdown of survey respondents' funding for R&D and demonstration expenditures, by source. Corporate operations together with parent, affiliated or subsidiary organisations funded 79% of total reported R&D expenditure and 38% of reported demonstration expenditures.

Canadian governments funded $15.7 million or 10% of R&D expenditures and $1.2 million or 61% of demonstration expenditures.

2014 Total R&D and Demonstration Expenditure	R&D		Demonstration		Total
	$ millions	%	$ millions	%	$ millions
Parent, affiliated or subsidiary organisation	89.5	57%	0.1	4%	89.6
Corporate operations	33.6	22%	0.7	34%	34.3
Canadian government (all levels)	15.7	10%	1.2	61%	16.9
Foreign government	2.0	1%	0.0	1%	2.0
University or academic institute	1.8	1%	-	-	1.8
Other	13.4	9%	-	-	13.4
Total	**156.0**	**100%**	**2.0**	**100%**	**158.0**

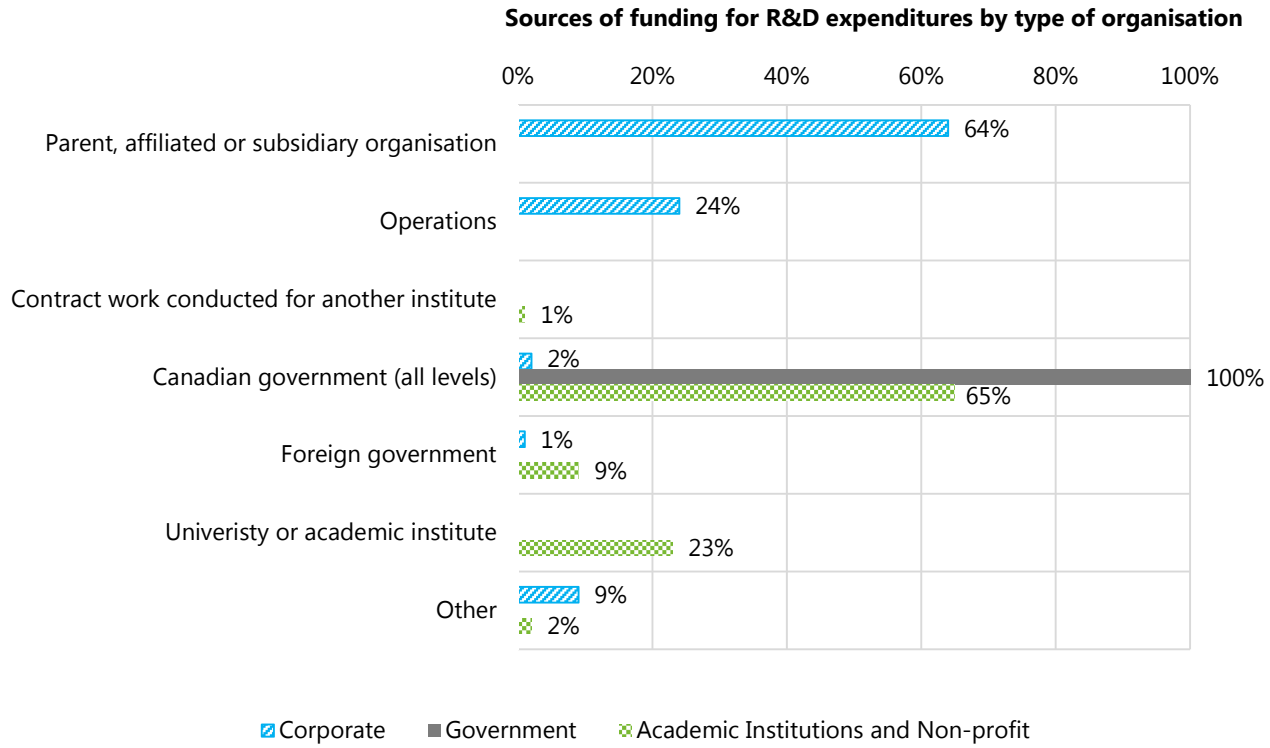
R&D by Region

Sixty-one percent of survey respondents' R&D expenditures took place in British Columbia, followed by Germany (17%). Five percent of R&D expenditures by respondents took place in Quebec and 3% in Ontario. The remaining R&D expenditure took place in the United States (7%), Japan (6%) and the rest of world (1%).



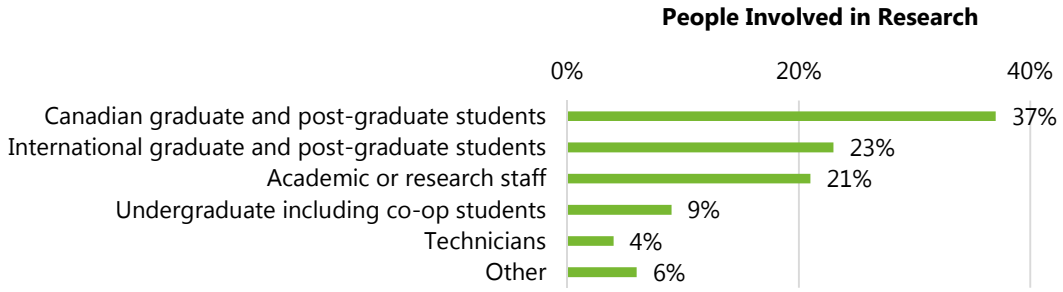
Sources of Funding for R&D Expenditure

In 2014, corporate survey respondents received the majority of their funding for R&D expenditure from parent, affiliated or subsidiary organisation (64%) and operations (24%). Government survey respondents received funding for R&D expenditure exclusively from Canadian government sources. Educational and non-profit survey respondents received most of their funding from Canadian government sources (65%) and universities or academic institutes (23%).



People Involved in Research

Survey respondents reported that a total of 312 people were involved in hydrogen and fuel cell-related research activity in 2014. Of the total reported number of people involved in research, 37% were Canadian graduate and post graduate students, 23% were international graduate and postgraduate students, 21% were academic or research staff, 9% were undergraduate students, including co-op, and 4% were technicians.



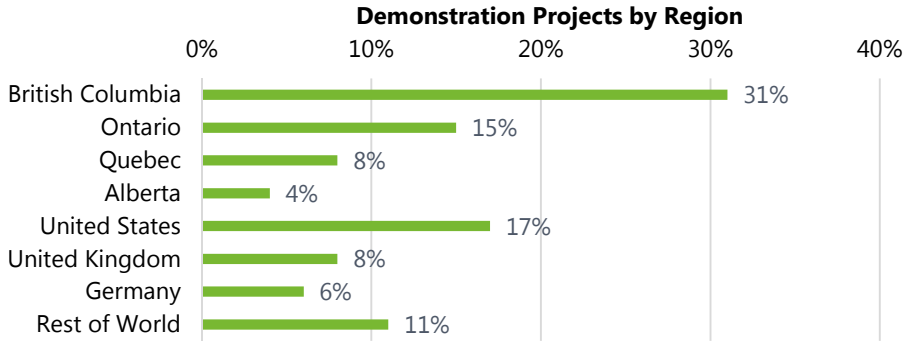
Demonstration Projects and Patents

Demonstration Projects

In 2014, survey respondents reported their participation in over 15 demonstration projects around the world.

Demonstration by Region

Canadian provinces hosted 58% of total demonstration projects by survey respondents in 2014. The majority of demonstrations took place in British Columbia (31%). Other Canadian provinces accounted for 27% of demonstrations which were hosted in Ontario (15%), Quebec (8%) and Alberta (4%). The remainder took place in the United States (17%), United Kingdom (8%), Germany (6%) and in other countries (11%).

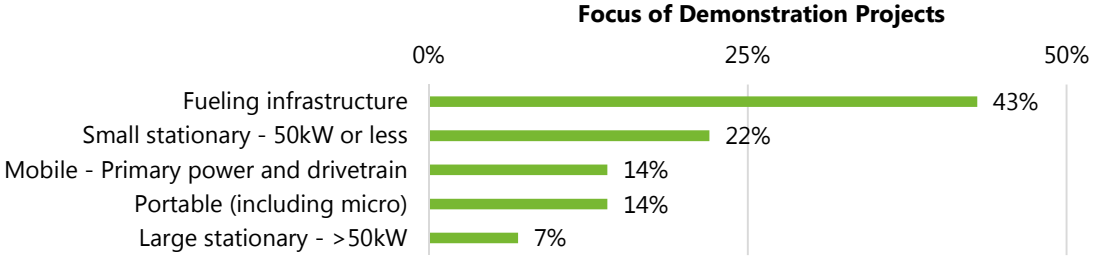


Sources of Funding for Demonstration

In 2014, Canadian governments funded 58% of the $2 million in demonstration expenditure reported by survey respondents and corporate operations funded 34%.

Focus of Demonstration Projects

Survey respondents' main areas of focus for demonstration projects was fueling infrastructure (43%) followed by stationary applications (29%) and mobile applications (28%).



Patents and Licenses

In 2014, survey respondents had access to over 2,000 approved patents and licenses and had 126 patents pending.

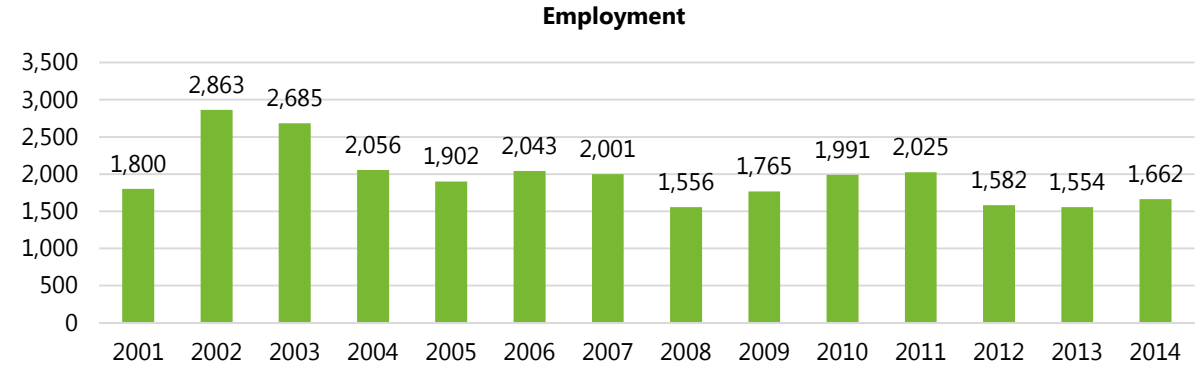
Employment

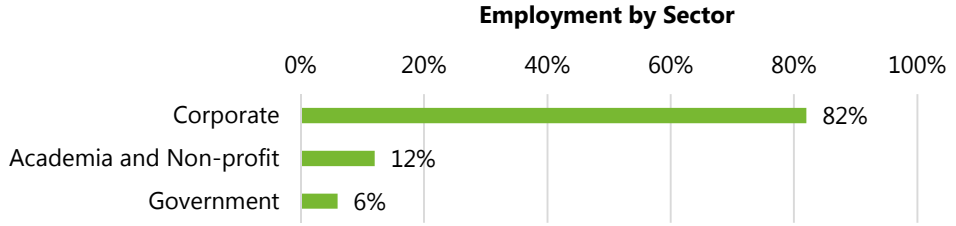
Survey respondents reported a total of 1,662 employees involved in hydrogen and fuel cell activities in 2014. Corporate organisations employed the majority of these employees (82%).

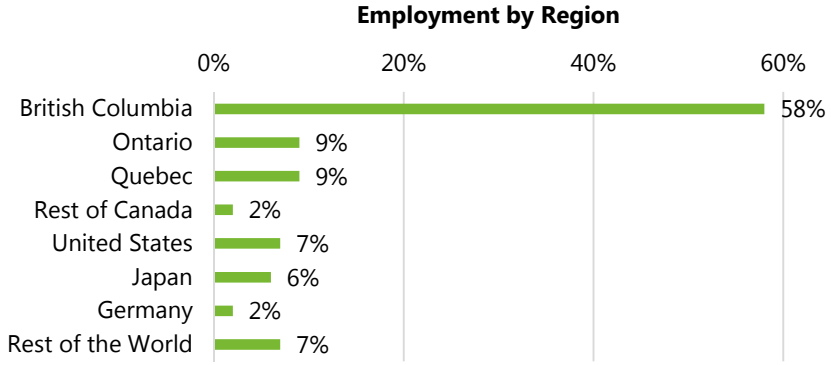
In 2014, the largest proportion of survey respondents' employees (approximately 78%) were located in Canada. Within Canada, most employees were located in British Columbia, followed by Ontario and Quebec. Other employees were in the United States (7%), Japan (6%) and Germany (2%). The remaining 7% were in other countries including, China, India, Thailand, Belgium and Denmark.

Most of survey respondents (62%) employed fewer than 10 employees. Fourteen percent had between 10 and 25 employees, 9% had between 25 and 50 employees and 16% had more than 50 employees.

Based on the data provided by survey respondents for the number of employees and total salaries, the average annual salary paid to employees was $66,369 in 2014. Extrapolating the average salary to the 1,296 employees reported in Canada, survey respondents contributed approximately $86 million in salaries to the national economy.







Research Partnerships and Strategic Alliances

Research Partnerships

Research partnerships promote closer collaboration between the university research community, government and industry. Survey respondents reported 191 research partnerships in 2014. Since survey respondents may report partnerships that they have with each other, there is a possibility that the number of research partnerships is overstated. However, the distribution of research partnerships by type is expected to be representative of actual partnerships.

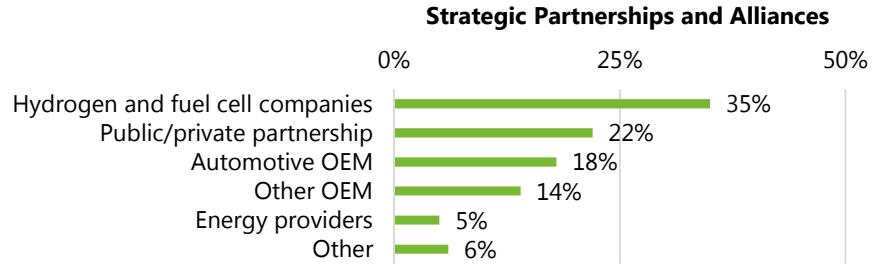
In 2014, partnerships with Canadian academia/non-profit/associations represented 27% of all reported research partnerships. Partnerships with industry in Canada represented 26%, and with Canadian government represented 11%. Partnerships outside of Canada, including partnerships with industry outside of Canada and with foreign government, represented 28% of reported research partnerships in 2014.

The number of research partnerships signifies the necessity of pre-commercial collaboration in order to address common technical challenges. The table below illustrates the various types of partnerships and collaborations in the hydrogen and fuel cell sector within Canada and abroad.

Number of Research Partnerships	
Partnerships with Canadian academia/non-profit/associations	51
Partnerships with industry in Canada	50
Partnerships with industry outside of Canada	31
Partnerships with foreign governments	23
Partnerships with Canadian government	21
Other	15
Total	**191**

Strategic Partnerships and Alliances

In 2014, survey respondents reported 79 strategic partnerships and alliances. Hydrogen and fuel cell companies represented 35% of these and public/private partnerships represented 22%. Automotive OEM represented 18%, followed by other OEM (14%) and energy providers (5%).



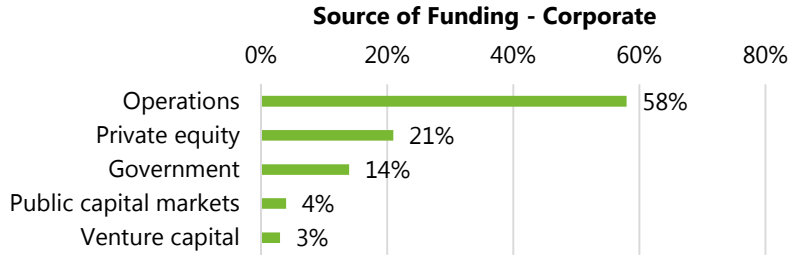
Funding Requirements

Given the hydrogen and fuel cell sector's long development period and demanding R&D and demonstration requirements, adequate funding is necessary to bring commercial products to market.

Corporate

Corporate survey respondents reported the top three sources of funding for 2014 were from operations (58%), private equity (21%) and government (14%).

Corporate survey respondents estimated their financial requirements for the next five years to be $813 million.

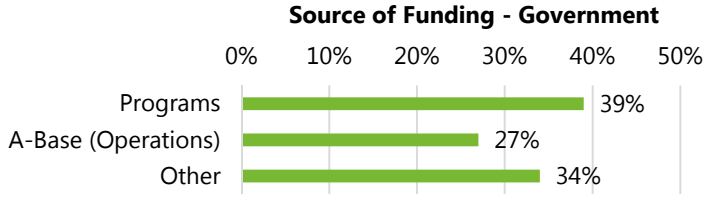


Twenty-one percent of corporate survey respondents reported new investment in the sector in 2014. The majority of new investments in 2014 originated from the United States (34%), followed by Canada (29%), with British Columbia and Quebec each accounting for 13% of new investments and Alberta for 3%. The remaining new investment in the sector was from the United Kingdom (13%), and the rest from other international sources (25%).

Corporate survey respondents' main targets for new investment in 2014 were mobile applications including primary power and drivetrain (29%), auxiliary power (14%) and portable applications (14%), followed by fueling infrastructure (14%) and stationary applications (29%).

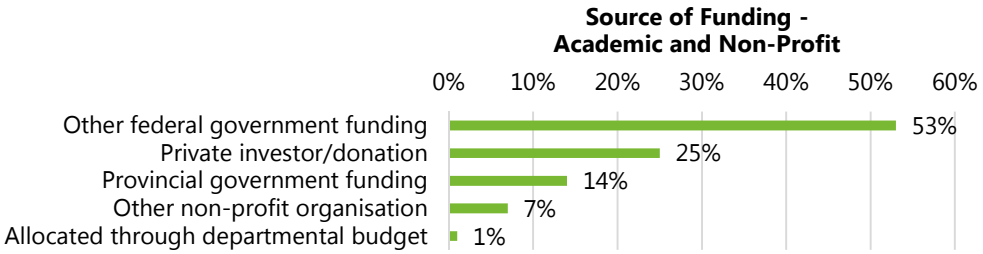
Government

The total budget for hydrogen and fuel cell related activities reported by government survey respondents in 2014, for which they were directly responsible, was $3 million (including employee salaries and benefits). Programs contributed 39% of the funding and A-base operations contributed 27%.



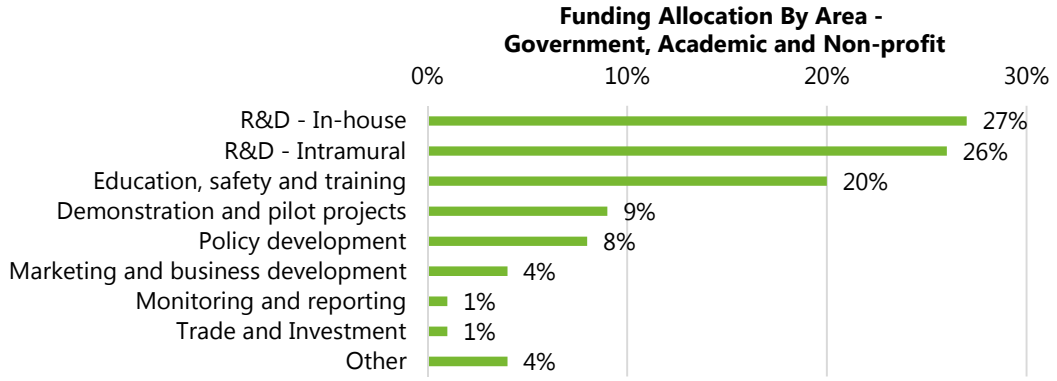
Academic and Non-Profit

The total budget for hydrogen and fuel cell related activities reported by academic and non-profit survey respondents in 2014, for which they were directly responsible, was $8.4 million (including employee salaries and benefits). Federal government funding contributed 53% of the funding, followed by private investors/donations (25%), provincial government funding (14%), non-profit organisations (7%) and allocation through departmental budgets (1%).



Funding Allocation for Government, Academic and Non-Profit

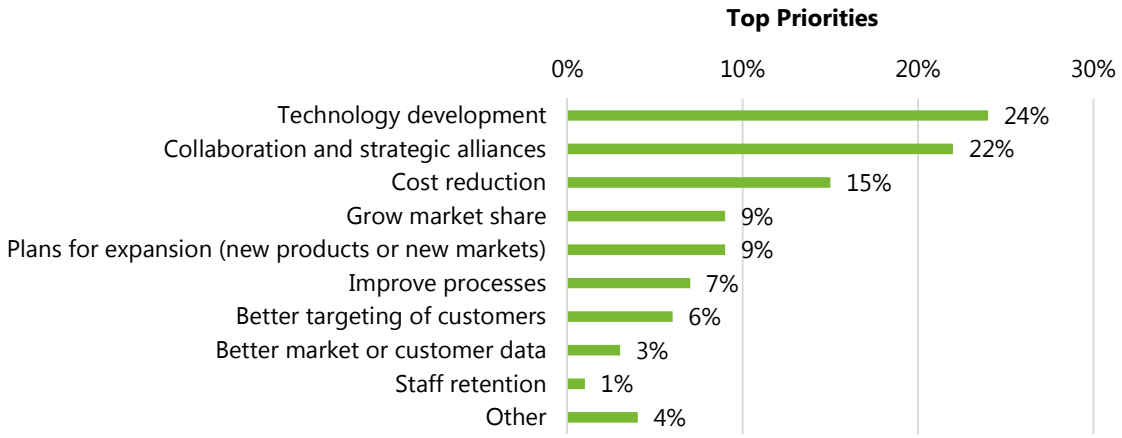
In 2014, government, academic and non-profit survey respondents collectively allocated over half of their funding (53%) to R&D (both intramural and in-house). Twenty percent of funding was allocated to education, safety and training. Separately, educational institutes and non-profit respondents allocated 65% of funding to R&D and 27% to education, safety and training, while government respondents allocated 33% of funding to demonstrations projects, followed by policy development (25%), and in-house R&D (20%).



Outlook

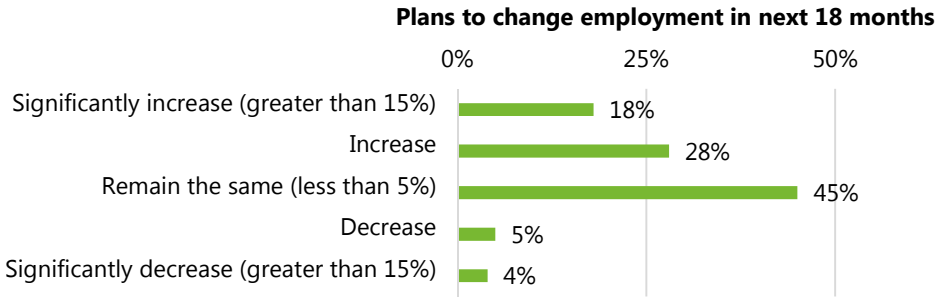
Looking ahead to 2015, survey respondents were asked to identify the top three priorities to enhance competitive performance. Survey respondents' top priorities were technology development (24%) and collaboration and strategic alliances (22%). This was followed by cost reduction (15%) and growing the market share and plans for expansion (9% each).

Improving processes, better targeting of customers, better market or customer data and staff reduction were also identified as priorities for some respondents. Other priorities identified by respondents included the recruitment of specialized staff, financing, infrastructure investment and new knowledge generation.



Employment Outlook

Forty-six percent of survey respondents planned to increase or significantly increase employment within 18 months, 45% planned to keep employment the same over the next 18 months and 9% planned to reduce employment.



Conclusion

The Canadian hydrogen and fuel cell sector is recognized for its role in the development of clean technology applications. In 2014, approximately 65% of survey respondents reported involvement in hydrogen and fuel cells activities for more than 10 years, which suggests a sector with a stable base of organisations. Research was the largest area of focus and expertise of most survey participants in 2014, and their top priorities for 2015 were technology development and collaboration and strategic alliances.

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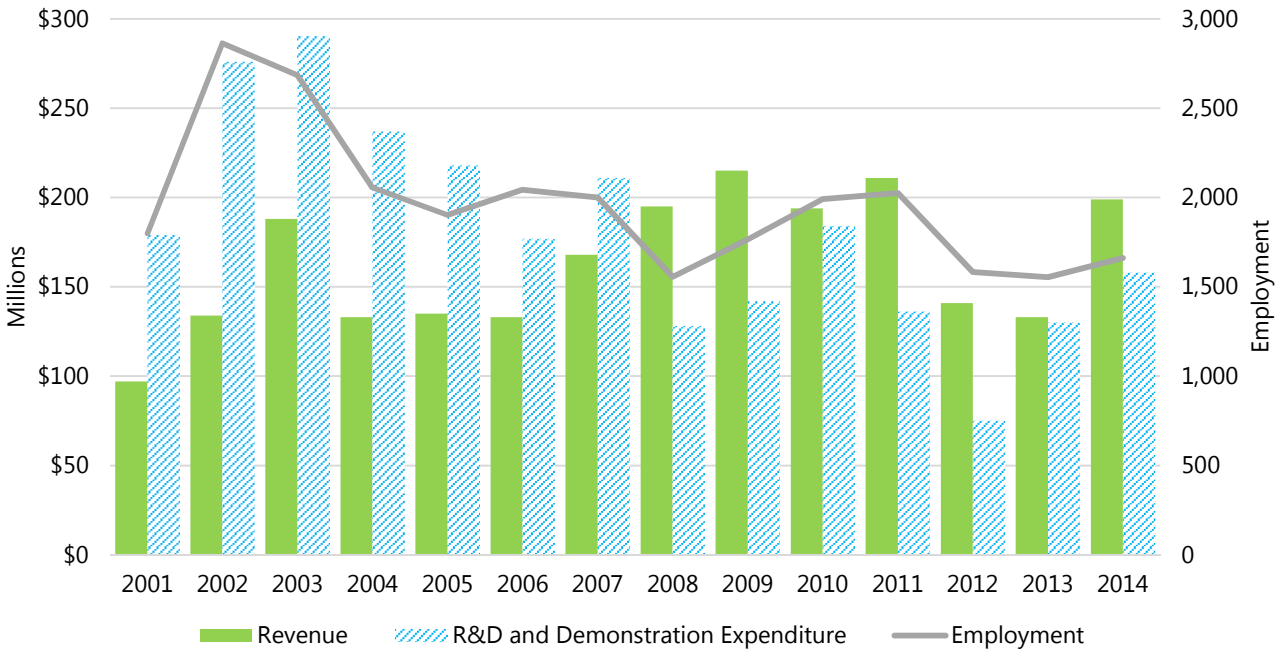
Revenue, R&D and Demonstration Expenditure, and Employment since 2001



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.

Innovation, Science & Economic Development Canada (ISED)

Innovation, Science & Economic Development Canada's goal is to enhance the competitiveness of Canadian industry. This federal government department 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.

MNP LLP

MNP is the fastest growing major accountancy and business consulting firm in Canada, with more than 70 locations and 3,000 team members across the country. Economic and industry studies are carried out by MNP's Economics and Research practice. Based in Vancouver, the Economics and Research practice consists of a team of dedicated professionals that have a successful track record of assisting clients with a wide variety of financial and economic studies. Its work has encompassed a wide range of programs, industries, company operations and policy initiatives, and has helped clients with decision-making, communication of economic and financial contributions, documentation of the value of initiatives and activities and development of public policy.

Methodology

The 2015 Sector Profile is the twelfth 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, educational institutes, 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, organizers have refined the questions to gather more detailed information to better reflect the sector and its trends. Since the 2004 survey, specific questions have been asked from three types of stakeholders:

- Corporate (public and private organisations);
- Government (government and government agencies); and
- Educational institutes and non-profit (educational, non-profit, and non-governmental organisations (NGOs)).

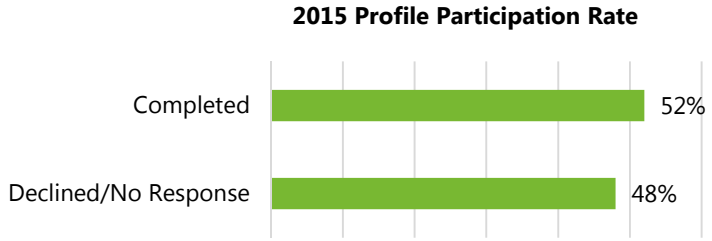
All monetary results are presented in Canadian dollars.

A total of 114 organisations associated with hydrogen and fuel cells in Canada were invited to participate in the development of this Sector Profile.

In total 60 completed responses were received, representing an overall response rate of 52%. 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 clarification was not received.

R&D expenditures provided by respondents were supplemented with awards for hydrogen and fuel-cell related R&D projects by Natural Sciences and Engineering Research Council of Canada (NSERC).

Note that industrial hydrogen production represents a large segment of the sector, but participation in the survey is likely low due to concerns about inferring financial information from the survey data.



A list of survey respondents is included at the end of the report. Note: some respondents did not consent to have their organisation's name publish in the sector profile.

Figures presented for 2014 were collected by an online questionnaire in early 2016. Figures presented for 2013 are as reported in the 2014 Sector Profile and, therefore, may not be fully comparable due to differing respondents and/or participation rate.

2015 Participants

A.V.Tchouvelev & Associates Inc.

Associated Plastics & Supply Corp

Automotive Fuel Cell Cooperation

Ballard Power Systems Inc.

BioGenerator Energy Solutions Inc.

British Columbia Ministry of Energy and Mines

Canadian Hydrogen and fuel Cell Association

Canadian Nuclear Laboratories

Carleton University (Department of Mechanical and Aerospace Engineering)

Catalysis Research for Polymer Electrolyte Fuel Cells

Change Energy Services Inc.

CSA Group

Dana Canada Corporation

dPoint Technologies Inc

Global Affairs Canada

Greenlight Innovation Corp.

HTEC Hydrogen Technology & Energy Corporation

Hydra-Energy Corporation

Hydrogen In Motion Inc. (H2M)

Hydrogen Research Institute

Hydrogenics Corporation

Hyteon Inc.

Hyundai Auto Canada Corp.

Innovation, Science & Economic Development Canada (ISED)

Institut National de la Recherche Scientifique (INRS)

Institute for Sustainable Energy, University of Toronto

IRDI System

ITM-Power Plc

Lambton College

Linde LLC

Loop Energy Inc.

Mercedes-Benz Canada, Fuel Cell Division

National Research Council Canada

Natural Resources Canada

New Flyer Industries Inc.

NORAM Engineering & Constructors Ltd

Palcan Energy Corporation

Pathway Industries Inc.

Powertech Labs

Quadrogen Power Systems, Inc.

Sacré-Davey Engineering Inc.

Simulent Inc

Sustainable Development Technology Canada

Terrella Energy Systems

The CCS Global Group

The University of British Columbia

Truckenbrodt Clean Energy Consulting Inc.

UOIT University of Ontario Institute of Technology

Whitefox Technologies Canada Ltd

Xebec Adsorption Inc.

XRG Energytech Solutions Inc.

Zolair Energy Ltd

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