

# Canadian Hydrogen and Fuel Cell Sector Profile

# 2006



## This profile of the Canadian hydrogen and fuel cell sector provides an objective assessment of Canada's position within the increasingly competitive global industry.

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Cat. No. Iu41-3/2006E-PDF  
ISBN 978-0-662-44678-1  
60147E

Aussi offert en français sous le titre *Profil 2006 du secteur canadienne de l'hydrogène et des piles à combustible*.

In 2004, the Government of Canada, Hydrogen & Fuel Cells Canada and PricewaterhouseCoopers partnered to develop a comprehensive profile of the Canadian hydrogen and fuel cell sector. Following on the success of its previous two editions, the *Canadian Hydrogen and Fuel Cell Sector Profile* has been updated for 2006. The 2006 Sector Profile responds to the needs of stakeholders—companies, governments, academia and investors—to obtain the current economic and corporate information required to assess and benchmark the progress of the industry. The Profile describes the sector in terms of revenue, research, development and demonstration activity, and employment. These statistics are needed to keep policy makers, investors and other stakeholders informed and assess Canada's competitive position within the international hydrogen and fuel cell community.

The Profile is published annually to ensure that this important sector of the Canadian economy is consistently measured, its trends tracked and its achievements and growth recognized. We thank all the companies and organizations that contributed to the development of the *Canadian Hydrogen and Fuel Cell Sector Profile 2006*.



Cover 10%  
Inside pages 10%

# Canadian Hydrogen and Fuel Cell Sector Profile

# 2006

## Introduction

The *Canadian Hydrogen and Fuel Cell Sector Profile 2006* measures several key performance indicators and provides an objective assessment of Canada's position within the increasingly competitive global industry. As it moves towards commercialization, the Canadian sector continues to mature and build its reputation globally.

This year's Profile reveals a strong performing Canadian sector. The core metrics of revenue, research, development and demonstration (RD&D) expenditures, and employment show slight changes to the previous year. Revenue for 2005 was reported at \$135 million, on par with \$133 million reported in 2004. RD&D expenditures decreased slightly to \$218 million in 2005 versus \$237 million in 2004. Employment numbers for 2005 were reported at 1,902 compared to 2,056 in 2004. While the number of demonstration projects decreased, with 142 reported in 2005 versus 215 in 2004, strategic alliances remained stable in both 2004 and 2005, 270 compared to 271.

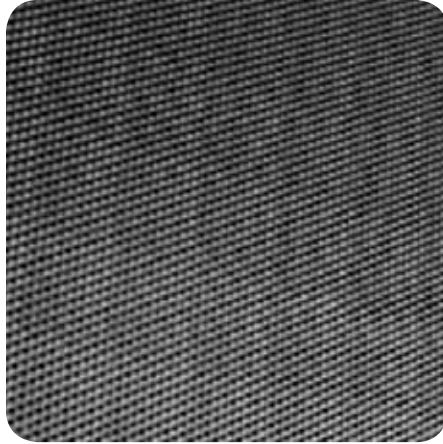
These results are representative of a transformative technology industry with a longer commercialization period, competing with incumbent technologies that continue to evolve. The sector continues to focus on R&D efforts, adjusting market strategies appropriately as products are developed for near term markets.

## The sector at a glance

- o Revenue stood at \$135 million in 2005, compared to \$133 million in 2004.
- o Research, development and demonstration expenditures decreased 8% to \$218 million in 2005 from \$237 million in 2004.
- o Employment numbers were reported as 1,902 in 2005 versus 2,056 in 2004.
- o The number of demonstration projects declined 34% to 142 in 2005 from 215 in 2004.

## Growth since 2001

The 2006 Sector Profile provides important updates to the information reported in *Economic Impact of Industrial Hydrogen Activity in Canada*—an initial sector profile conducted by Sypher Mueller and Natural Resources Canada in 2001. Over the five year period between 2001 and 2005, the sector shows growth in all key indicators. For details please see the discussion at the end of this report.

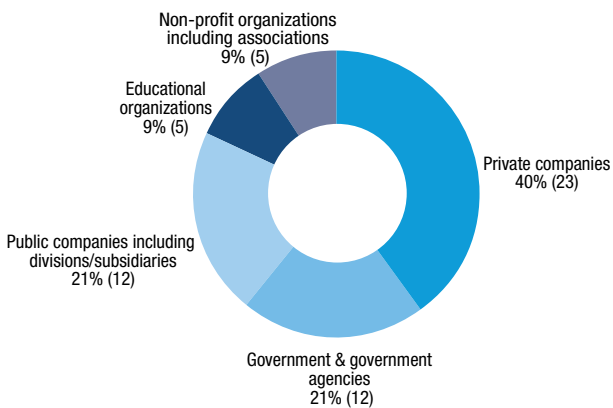


## Corporate profile

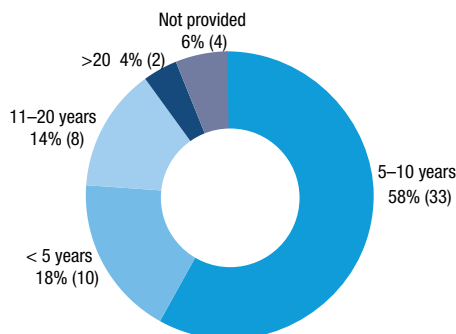
Corporate organizations represented nearly two-thirds of the total response, with private companies alone accounting for 40%. As private companies are not obliged to provide financial or other data to the market, their voluntary participation in this year's profile provides a more thorough appreciation of the size and activities of the hydrogen and fuel cell industry in Canada. Government and government agencies accounted for close to one quarter of respondents (21%), with educational organizations and non-profit organizations each representing almost 10%.

The vast majority of organizations (76%) reported ten years or less involvement in hydrogen and fuel cell activities, with 58% of respondents reporting between five and ten years of activity. This indicates a maturing Canadian hydrogen and fuel cell industry.

Organization type  
(Number of respondents)



Number of years involved in hydrogen/fuel cell activities  
(Number of respondents)



Areas of expertise  
(Respondents may be included in several categories) %

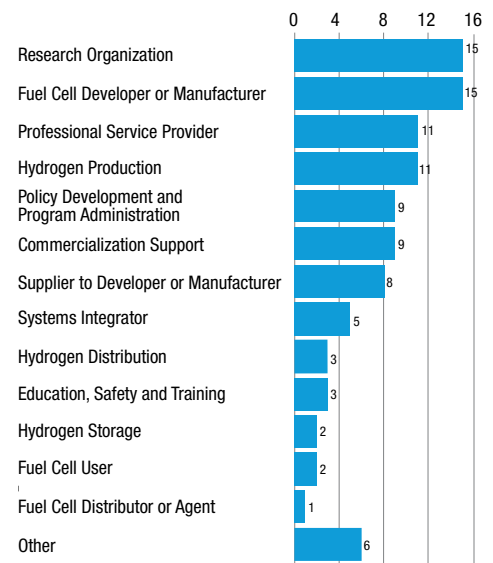




Photo courtesy of Hydrogenics Corporation

The Canadian hydrogen and fuel cell industry has a broad foundation of expertise. Although research organization and fuel cell developer or manufacturer were identified as the top two areas of expertise, the results clearly indicate that the Canadian industry is active in a wide range of areas across both hydrogen and fuel cells sectors, with activities ranging from manufacturing through to sales.

While mobile applications represented the largest market focus at 35%, stationary and fueling infrastructure were also well represented. Reflective of the results of the 2005 Profile, technology activities were primarily focused on proton exchange membrane (PEM) (34%). These results are consistent with the fact that Canada is a recognized leader in the development of PEM technology for mobile, small stationary and portable applications.

Respondents reported the bulk of hydrogen and fuel cell-related activity as occurring in Western Canada (65%) and secondarily in Eastern Canada (24%). Additional activity took place in the United States, Germany, Japan and other countries not specified by respondents.

**\* DEFINITIONS**

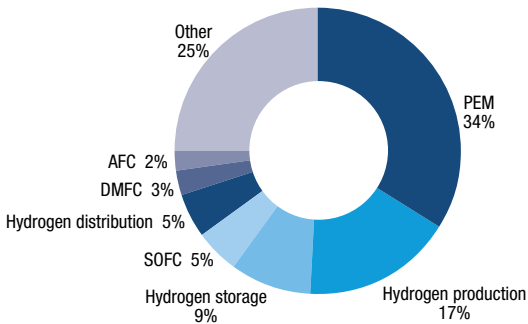
**AFC** = Alkaline fuel cell

**DMFC** = Direct methanol fuel cell

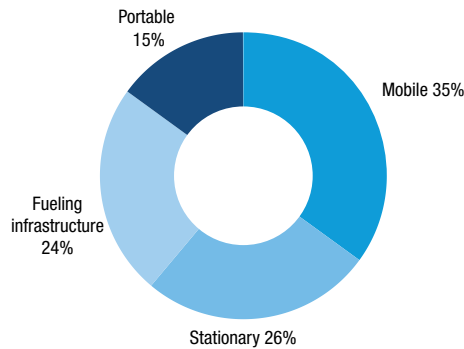
**SOFC** = Solid oxide fuel cell

**PEM** = Proton exchange membrane

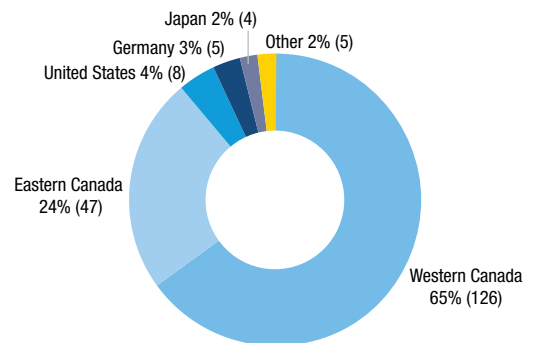
Technology focus\*

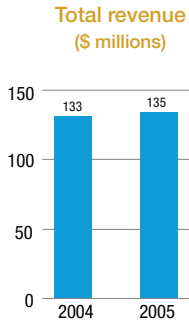


Market focus

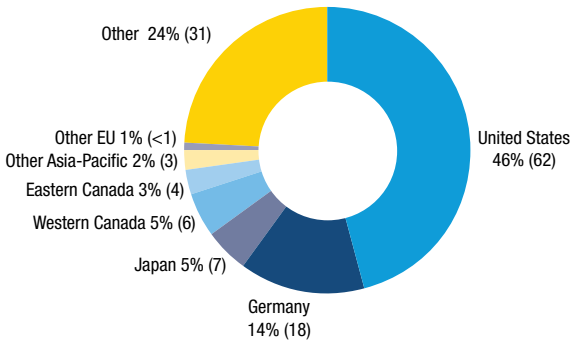


Location of hydrogen/fuel cell related facilities (Number of facilities)

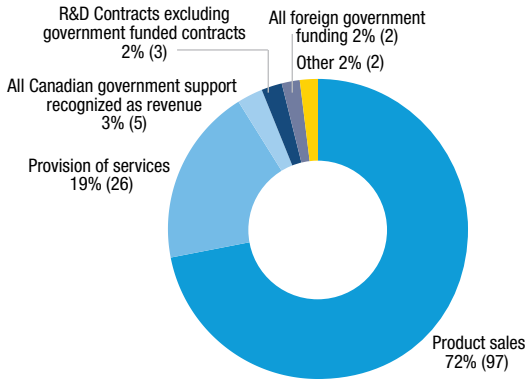




**Revenue by region (\$ millions)**



**Revenue by type (\$ millions)**



## Revenue

Total revenue from hydrogen and fuel cell activities reported by respondents remained flat, at \$135 million in 2005 versus \$133 million in 2004. Of the total revenue reported in 2005, a geographic breakdown of sales was provided for \$132 million. Sales in the United States accounted for 46% of revenue, followed by sales in Germany at 14%. Sales to other countries, including Australia, Czech Republic, Denmark, France, Italy, Korea and Spain, as well as unspecified locations, were also noted.

Product sales comprised the largest revenue stream for 2005 at \$97 million, a 9% jump from 2004 results of \$89 million, demonstrating that the sector is delivering products to near-term markets and moving towards commercialization. Provision of services came in a distant second at \$26 million. It is important to note that although some organizations recognize Canadian government support as revenue, the bulk of government support is provided for pre-commercial activities, as outlined below in the Research, Development and Demonstration sections that follow.

## Research, development and demonstration expenditures

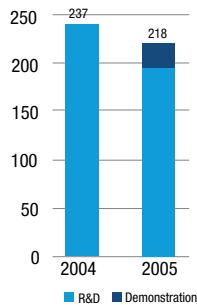
This year's survey asked respondents to supply information on research, development and demonstration (RD&D) expenditures for hydrogen and fuel cell activities rather than just research and development (R&D) expenditures as in previous years. Total RD&D expenditures were reported at \$218 million in 2005 versus \$237 million for R&D in 2004. Of the \$218 million in 2005, \$193 million was reported for R&D and \$25 million for demonstration projects.

Geographic data was provided for \$215 million of the total RD&D dollars. The majority of RD&D was conducted in Eastern and Western Canada.

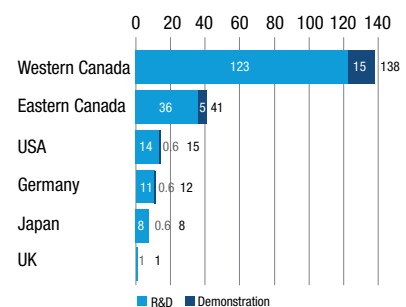
Operations and the Canadian federal government tied for the top source of RD&D funding with 31% each. Corporate respondents reported that operations served as the primary source of funding for their RD&D expenditures, followed by the Canadian federal government. Academic and Non-profit respondents overwhelmingly cited the Canadian federal government as their top source of RD&D funding, as government respondents also, unsurprisingly, did.

Corporate respondents reported 64 patents approved in 2005, demonstrating an ongoing commitment to innovation within the Canadian sector.

**Total research, development and demonstration (\$ millions)**



**Research, development and demonstration by region (\$ millions)**





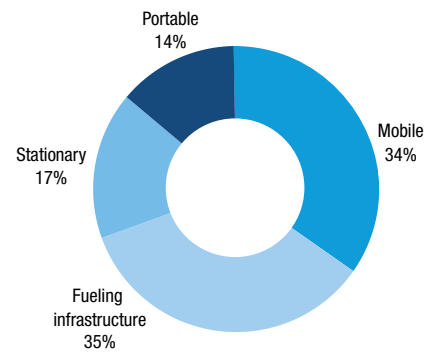
## Demonstration projects

A reduction in the number of demonstration projects was reported by respondents—from 215 in 2004 to 142 in 2005. This may be partially attributable to a re-focusing of R&D efforts as a result of learnings from demonstration projects. Demonstration projects were mostly focused on fueling infrastructure and mobile sectors. Demonstrations represent a valuable opportunity to engage the end-user and to increase public and investor knowledge, and must therefore continue to be treated as a priority by the sector.

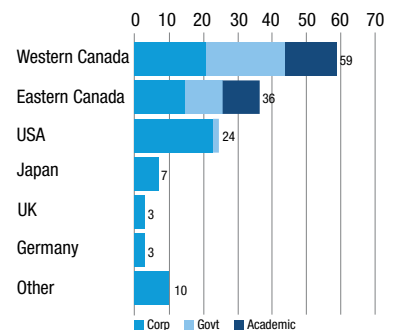
This year's Profile sees proportionately more Canadian-based demonstration projects compared to the 2005 Profile. Western Canada is the top location for demonstration projects, although non-profit and academic respondents' demonstration projects were split evenly between Eastern and Western Canada.

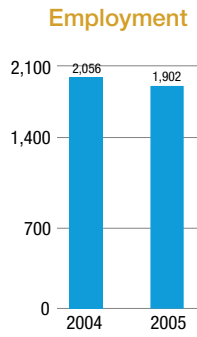
Corporate respondents were primarily involved in mobile demonstration projects, whereas Government respondents were primarily involved in fueling infrastructure projects. Non-profit, and academic respondents were split almost evenly among stationary, mobile, portable and fueling infrastructure projects.

Demonstration focus



Location of demonstration projects (Number)





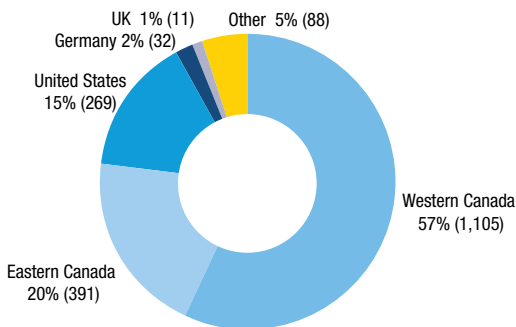
## Employees

Respondents reported a total of 1,902 employees focused on hydrogen and fuel cell activities in 2005, slightly down from 2,056 employees reported in 2004. A geographic breakdown was provided for 1,896 employees. Throughout the year, the industry continued to consolidate its activities and focus on core competencies. Employment numbers continue to indicate the existence of a vibrant sector.

The largest employment cluster reported was in Western Canada (57%), followed by Eastern Canada (20%), with the United States in third position (15%). Other countries such as Germany, the United Kingdom and Japan, as well as several Asian and European countries, were also represented in the results.

The average annual salary paid to hydrogen and fuel cell employees in Canada changed from \$66,798 in 2004 to \$55,262 in 2005. Extrapolating the average salary for 2005 to the 1,496 employees in Canada, the sector contributes \$83 million in salaries to the national economy.

### Employees by region (Number)





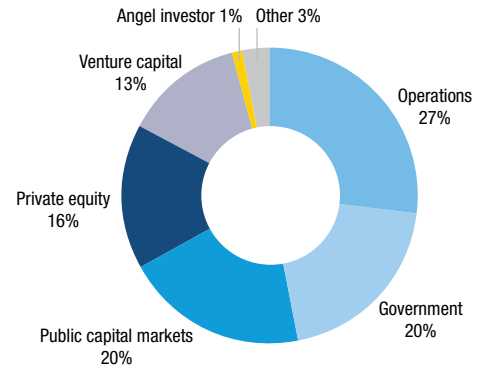
## Funding requirements

Continued education of governments and public capital markets of the benefits of investing in the hydrogen and fuel cell sector is an important part of its efforts to secure funding. Given the technology's longer development period and demanding RD&D requirements, adequate financing is necessary if full-scale commercialization is to be achieved.

### Corporate

Corporate respondents were asked to identify their capital requirements for the period 2007 to 2012, and, if possible, to break down their requirements by year and expected funding source. Respondents estimated total capital requirements for this period at \$842 million with operations, domestic and foreign capital markets, and private equity identified as the largest expected sources of this funding. This closely mirrors the actual breakdown for 2005 funding as reported by respondents, lead by operations (27%), private equity (22%), and public capital markets (19%).

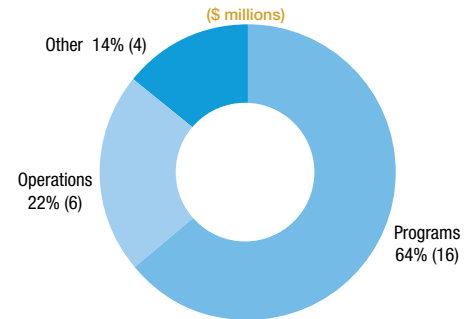
Expected source of domestic funding 2007-2012 – Corporate



### Government

Government respondents indicated that their total budget for hydrogen and fuel cell related activities, excluding employee salaries and benefits, in 2005 was \$26 million. Sources of this funding were programs (64%), operations (22%) and other (14%). The bulk of funding (68%) was expected to be allocated to Western Canada, with demonstration and pilot projects (45%), intramural R&D (34%), and in-house R&D (17%) identified as the primary targets for funding.

Current sources of funding – Government

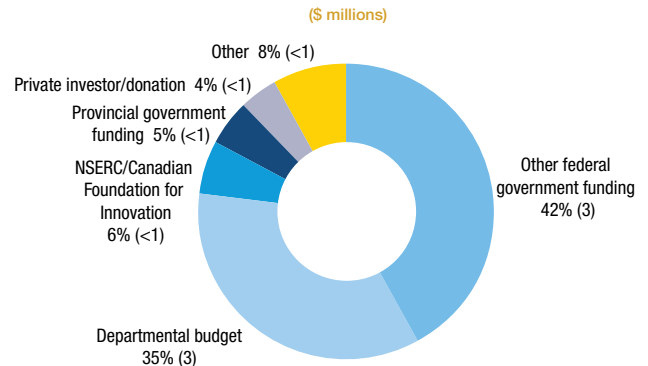


Government agencies spent or committed to procure slightly over \$3 million on hydrogen and fuel cell products in 2005.

### Non-profit and Academic

Non-profit and academic respondents indicated that their total budget for hydrogen and fuel cell related activities, excluding employee salaries and benefits, in 2005 was \$8.6 million. Other federal government funding (42%) and departmental budgetary allocations (35%) constituted the top two funding sources. Demonstration and pilot projects (57%) and in-house R&D (25%) were identified as the top two areas for funding allocation.

Current sources of funding – Academic and Non-profit

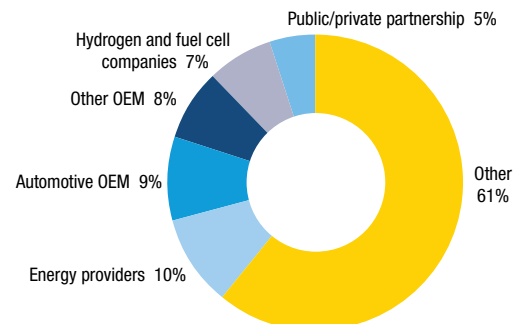


## Strategic alliances

The number of strategic alliances reported in 2005 at 271 is level with 2004 results of 270. The number of strategic alliances confirms the continued value and importance of key relationships and partnerships for the industry.

The 'other' category represented the largest single choice for strategic alliance partner. Energy provider, automotive original equipment manufacturer (OEM), and other OEM each garnered approximately 10% of responses, with hydrogen and fuel cell companies and public private partnerships each accounting for less than 10%.

Strategic alliances



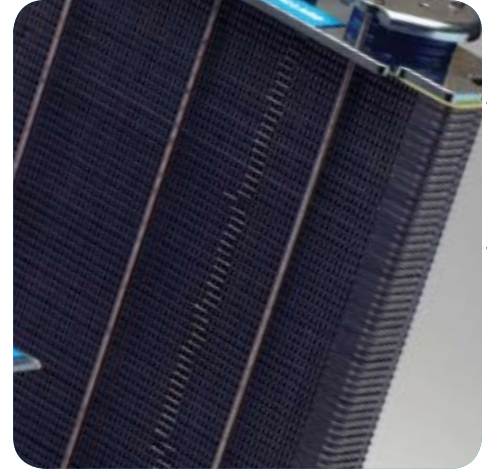
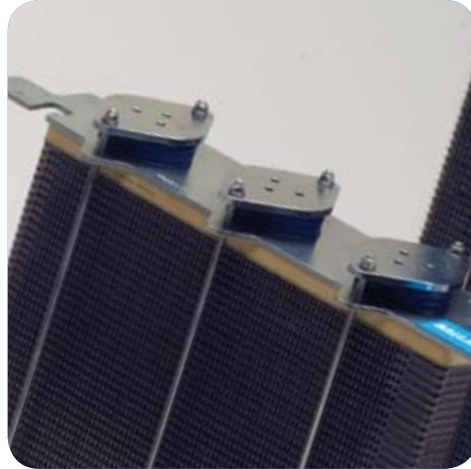
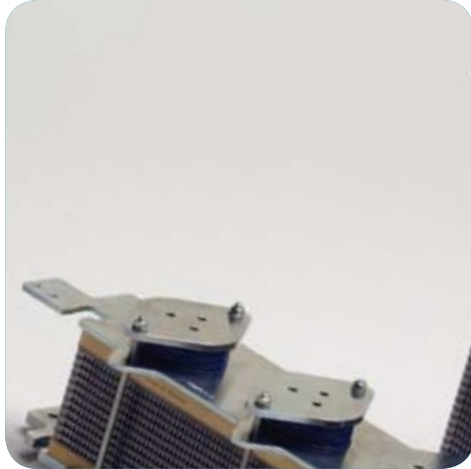


Photo courtesy of Ballard Power Systems

**For more information on the Canadian hydrogen and fuel cell industry please contact:**

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## Conclusion

The Canadian hydrogen and fuel cell sector continued its track record of solid performance:

- o Revenue stood at \$135 million in 2005, compared to \$133 million in 2004, with significant growth in the product sales category.
- o Research, development and demonstration projects were reported at \$218 million in 2005 versus \$237 million in 2004.
- o Employment numbers were reported as 1,902 in 2005 versus 2,056 in 2004, with Western Canada accounting for the largest employment cluster.
- o The number of demonstration projects reported declined 34% to 142 in 2005 from 215 in 2004.
- o The number of strategic alliances reported remained steady at 271 compared to 270 in 2004.

Canada continues to be a leader in providing alternative energy technology as the world moves towards a cleaner, more sustainable energy economy. With a steady employment base, a solid export framework, and an ongoing commitment to R&D expenditures, Canada's hydrogen and fuel cell industry continues to innovate.

The Government of Canada, Hydrogen & Fuel Cells Canada and PricewaterhouseCoopers would like to thank the organizations that took part in this survey. By participating, stakeholders from private industry, government and academia showed their support for improving publicly available industry intelligence. This information will be used to support funding decisions, influence alliance partnerships, and strengthen the overall competitive position of the Canadian hydrogen and fuel cell sector.

## Methodology and response rates

As in previous years, existing and potential members of Hydrogen & Fuel Cells Canada, academic institutions, government stakeholders and partners in current hydrogen and fuel cell demonstration activities were asked to voluntarily complete the survey.

The survey questionnaire was revised for the 2006 Profile. Sections relating to RD&D and Funding were broken out for three types of stakeholders: corporate; government; and non-profit, academic and non-governmental organizations. Revised response options were also introduced in the Corporate Profile and Revenue sections.

Not all respondents provided information for every category requested. No investigation was conducted as to the completeness of data provided by respondents or reasons for non-provision.

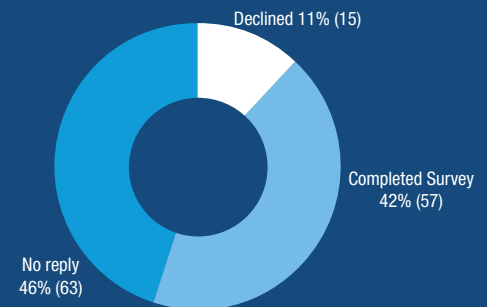
Responses to this profile are also included in the *Worldwide Fuel Cell Industry Survey*, published by the United States Fuel Cell Council and PricewaterhouseCoopers.

All monetary results are presented in Canadian dollars.

A total of 135 organizations associated with the hydrogen and fuel cell sector in Canada were invited to participate. 57 completed responses were received, representing an overall response rate of 42%. A complete distribution list is included on the back cover.

Figures presented for 2005 were collected by survey questionnaire in 2006. Figures presented for 2004 are as reported in the 2005 Sector Profile and therefore may not be fully comparable due to differing respondents and/or basis of individual responses.

**Profile response rate**  
(Number of respondents)

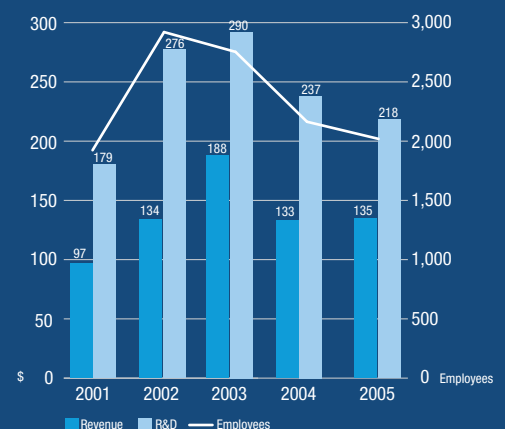


## Growth since 2001

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, Hydrogen & Fuel Cells Canada and PricewaterhouseCoopers Sector Profiles have updated the original industry benchmark study to demonstrate an active hydrogen and fuel cell sector within Canada. Although some data may not be fully comparable due to differing methodology, we can see significant growth over in the industry over the five-year period:

- Revenue has grown 39%—from \$97 million in 2001 to \$135 million in 2005.
- R&D expenditures have increased 22% to \$218 million.
- Employment in the industry has seen an increase of 6%.

**Comparative Sector Statistics: 2001 to 2005**



Sources: 2001 – *The Economic Impact of Industrial Hydrogen Activity in Canada*, Sypher Mueller and Natural Resources Canada

2002 & 2003 – *Canadian Hydrogen and Fuel Cell Sector Profile 2004*, Government of Canada, Hydrogen & Fuel Cells Canada and PricewaterhouseCoopers

2004 – *Canadian Hydrogen and Fuel Cell Sector Profile 2005*, Government of Canada, Hydrogen & Fuel Cells Canada and PricewaterhouseCoopers

2005 – *Canadian Hydrogen and Fuel Cell Sector Profile 2006*, Government of Canada, Hydrogen & Fuel Cells Canada and PricewaterhouseCoopers

## Invited to participate

Advanced Measurements Inc.  
Agile Systems Inc.  
Air Liquide Canada  
Alberta Research Council Inc.  
Analytic Systems  
Angstrom Power Inc.  
Armstrong Monitoring Corporation  
Astris Energi Inc.  
Atlantic Hydrogen Inc.  
Atomic Energy of Canada Ltd.  
Azure Dynamics Corporation  
Ballard Power Systems Inc.  
BC Hydro  
BC Transit  
British Columbia Institute of Technology  
BET Services Inc.  
BOC Gases  
Business Development Bank of Canada  
Canadian Hydrogen Association  
Canadian Hydrogen Energy Corporation Ltd.  
Cellex Power Products Inc.  
Centre for Automotive  
Materials & Manufacturing  
Chevron Technology Ventures LLC  
Chrysalix Energy Management Inc.  
Cimtex Industries Ltd.  
Clean Energy Canada  
Clean Energy Research Centre (CERC),  
University of British Columbia  
Conduit Ventures Limited  
Dana Canada Corporation  
Deere & Co.  
Deloitte & Touche  
Department of National Defence  
Direct Carbon & Fuel Cells Canada  
Dpoint Technologies

DuPont  
Dynetek Industries Ltd.  
Enbridge Gas Distribution  
EnergiX Research Inc.  
Energy iNET  
Energy Visions Inc.  
EnergyQBD Inc.  
Environment Canada  
ESTCO Battery Management Inc.  
Ford Motor Company  
Foreign Affairs and International Trade Canada  
Fuel Cell Technologies Ltd.  
FuelCon Systems Inc.  
Fueling Technologies Inc.  
General Hydrogen Corporation  
General Motors of Canada  
Government of Alberta  
Government of British Columbia  
Government of Manitoba  
Government of Prince Edward Island  
Government of Saskatchewan  
Gowling Lafleur Henderson LLP  
GrowthWorks Ltd.  
H3 Energy Ltd.  
Heliocentris Energy Systems  
HTC Hydrogen Technologies Corp.  
Hybrid Energy Inc.  
Hydrogen & Fuel Cells Canada  
Hydrogen Research Institute  
Hydrogen Systems Inc.  
Hydrogenics Corporation  
Hyteon Inc.  
IMW Industries Ltd.  
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Palcan Power Systems  
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PEI Energy Corporation  
PEM Engineers  
PolyFuel Inc.  
Power Air Corporation  
PowerDisc Development Corporation Ltd.  
PowerNova Technologies Corporation  
Powertech Labs  
Praxair, Inc.  
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Queens Royal Military College Fuel Cell  
Research Centre  
QuestAir Technologies Inc.  
Reknewco  
Sacre-Davey Engineering  
Sarnia-Lambton Economic Partnership  
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