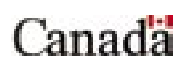




Canadian Hydrogen and Fuel Cell Sector Profile 2004



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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The Government of Canada, Fuel Cells Canada and PricewaterhouseCoopers have partnered to develop a comprehensive, up-to-date profile of the Canadian hydrogen and fuel cell sector. The 2004 Sector Profile responds to the needs of stakeholders—companies, governments and investors—to obtain current economic and corporate information required to assess and benchmark the progress of the industry. It describes the sector in terms of revenue, research and development activity and employment. These statistics are urgently needed to keep policy makers, investors and other stakeholders informed and to assess Canada's competitive position within the international hydrogen community.

The full-scale commercialization of hydrogen and fuel cell technologies represents tremendous environmental and economic opportunities for Canada. Canada's current position as a global industry leader has been achieved, in a large part, through the high level of collaboration between government and industry. This longstanding partnership combines the technological breakthroughs achieved by Canadian companies and research facilities with the support of forward-looking government policies and programs. The 2004 Sector Profile is another example of the value of cooperation between the Government of Canada, Fuel Cells Canada and the Canadian hydrogen and fuel cell industry. This relationship will continue to be crucial for the demonstration, deployment and commercialization of new products as Canada makes the transition to a hydrogen economy.

We anticipate that this profile will be the beginning of a regular tracking of trends that will allow consistent measurement of this growing sector of the Canadian economy. We thank all the companies and organizations that contributed to the development of The Canadian Hydrogen and Fuel Cell Sector Profile 2004.



Canadian Hydrogen and Fuel Cell Sector Profile 2004

Introduction

Canadian hydrogen and fuel cell leadership covers most types of fuel cell technologies, components, systems supply and integration, fuelling systems, fuel storage, and engineering and financial services. Our industry expertise and products play a major role in the pre-commercial activities in countries around the world. However, international competition is growing as industry and governments in other jurisdictions become increasingly involved in focused demonstration projects.

Domestic support for the sector is growing. Government, industry and academia understand that Canada's leadership position cannot be taken for granted. As wide-spread commercialization approaches, it becomes important to assess and communicate the performance of the Canadian hydrogen and fuel cell sector.

The 2004 Sector Profile measures several key performance indicators and provides an objective assessment of the growth and development of the Canadian hydrogen and fuel cell sector between 2002 and 2003.

Respondents reported hydrogen and fuel cell-related revenues of \$188 million, a 40 percent increase over 2002. Patent holdings grew by 34 percent to 581. Participation in demonstration projects increased by 232 percent and research and development (R&D) expenditures remained relatively level, increasing only 5 percent to \$290 million. Employment within the sector decreased modestly to 2,685 from 2,863 in 2002.

Respondents also stated that a significant portion of their funding for the next 5 years is expected to come from the Canadian federal government, foreign capital markets and private equity firms. Government, public-private partnerships (P3s) and other fuel cell and hydrogen developers were identified as key strategic partners, critical to the future success of the sector.

Methodology and response rates

A total of 112 organizations associated with the hydrogen and fuel cell sector in Canada were invited to participate in the development of this profile. The complete distribution list is included at the end of this report. It comprises existing and potential members of Fuel Cells Canada, academic institutions, government stakeholders and partners in current hydrogen and fuel cell demonstration activities.

A total of 98 organizations responded—representing an overall response rate of 88 percent. Of the 98 respondents, 83 provided data.¹

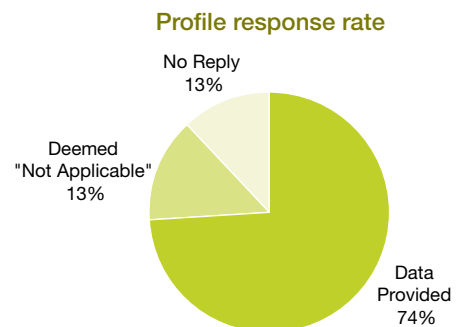
The industry at a glance

The 2004 Sector Profile shows strong growth in many key indicators for the period 2002–2003.

- **Revenue** has grown 40 percent from \$134 million in 2002 to \$188 million in 2003.
- **R&D expenditures** have increased 5 percent from \$276 million in 2002 to \$290 million in 2003.
- **Employment** stands at 2,685, a modest decrease from 2002 levels.
- **Participation in demonstration projects** has increased by 232 percent to 262 in 2003 from 79 in 2002.
- **Patent holdings** are up by 34 percent to 581 in 2003.

Growth since 2001

The 2004 Sector Profile provides important updates to the information reported in *Economic Impact of Industrial Hydrogen Activity in Canada*—the initial sector profile conducted by Sypher Mueller and Natural Resources Canada in 2001. The sector shows considerable growth in all key indicators since 2001. For details please see the discussion at the end of this report.



1. Responses have not been challenged, tested or audited. No investigation has been conducted to determine the completeness of data or reasons for non-provision. To protect the confidentiality of respondents, only summarized data has been reported.

Over the past five years, the number of Canadian companies associated with the hydrogen and fuel cell industry has doubled.



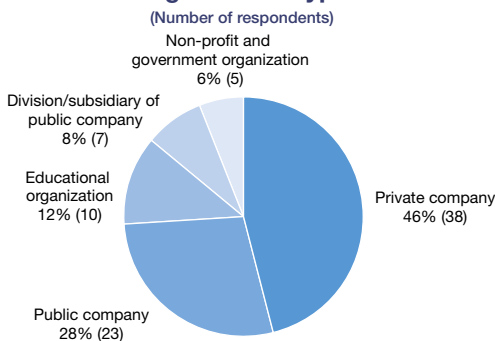
Corporate profile

Almost half of the companies included in this profile are private and, as such, are not obliged to provide financial or other data to the market. Their voluntary participation in this year's profile has helped develop a clear understanding of the size and activities of the hydrogen and fuel cell industry. Another one third are public organizations, and 8 percent stated they were divisions or subsidiaries of public companies, the parent companies of which may or may not be based in Canada.

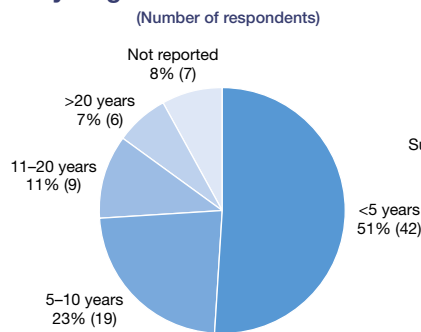
The number of companies involved in the sector has doubled within the past five years, with 42 organizations, or 51 percent of respondents, reporting less than five years of hydrogen and fuel cell-related activities. Professional services firms, suppliers and research organizations make up a large portion of the industry. 17 organizations, or 13 percent of respondents, are focused on fuel cell development and/or systems integration.

Half of the Canadian hydrogen and fuel cell sector is focused on proton exchange membrane (PEM) technology. PEM is considered one of the most versatile fuel cell technologies, with uses in both mobile and stationary applications. Solid oxide fuel cell (SOFC) technology, which is used mainly in stationary applications, was identified as the next most prominent area of technological focus.

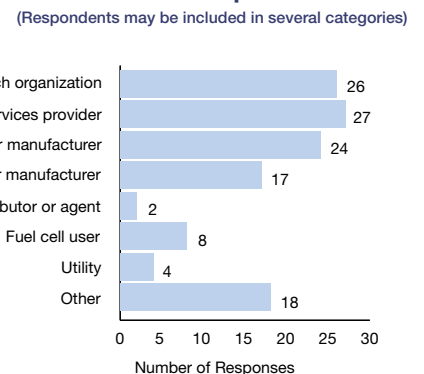
Organization type



Number of years involved in hydrogen and fuel cell activities



Area of expertise



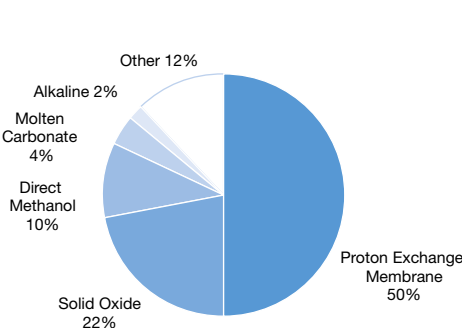


Public and private companies, government agencies and academic institutions provided information on which to base this updated sector profile.

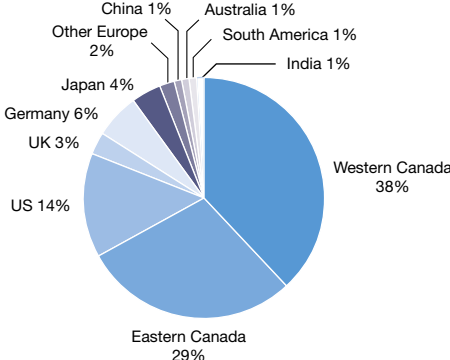
Canadian hydrogen and fuel cell organizations are most active within Canada. However, Canadian companies are also active within the United States, Germany, Japan, and the UK. South America, India and China were also identified as areas of operations, suggesting that Canadian firms may be starting to access the lower cost manufacturing environments that will become increasingly important as the industry approaches commercialization. These results also suggest that Canadian industry may be becoming more involved in the evolving energy infrastructure of developing countries that represents a large market opportunity.

Market focus was split mainly between stationary and mobile applications and fuelling infrastructure, with only 15 percent of Canadian companies focused on portable market applications.

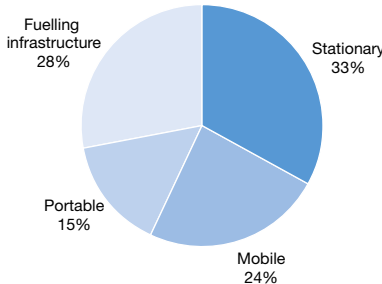
Technology focus



Location of fuel cell related activities



Market focus

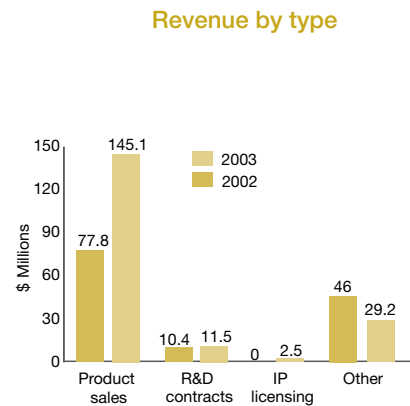
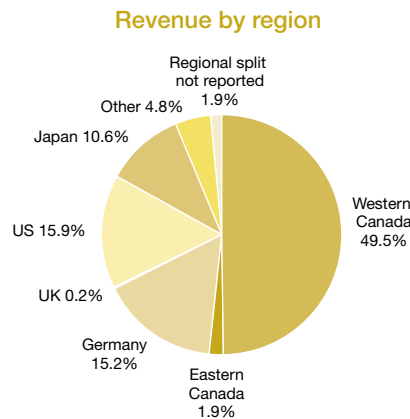
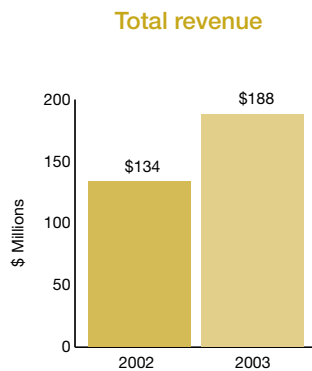


Increased participation in demonstration projects suggests a shift from pure research and development to more applied use of technology in hydrogen and fuel cell products.

Revenues

Respondents reported a 40 percent increase in total revenue from hydrogen and fuel cell-related activities, from \$134 million in 2002 to \$188 million in 2003. Half of this revenue was reported as sales in Western Canada. The United States, Germany and Japan were also identified as significant markets for the Canadian industry.²

Revenue derived from R&D contracts has stayed relatively constant, increasing only 10 percent, from \$10.4 million in 2002 to \$11.5 million in 2003. However, revenue from product sales has increased by 87 percent, from \$77.8 million in 2002 to \$145.1 million in 2003. Product sales now account for 77 percent of the total revenue—up from 58 percent in 2002. This is a clear indication that the sector is moving forward on the path towards commercialization.



2. Sector revenue may include sales allocated according to the location of the customer and the location of the operating division credited with the sale.

Product sales are driving a 40 percent increase in revenue, but the industry remains very much focused on research and development.

Research and development

Total research and development expenditure on hydrogen and fuel cell activities for respondents increased 5 percent, from \$276 million in 2002 to \$290 million in 2003. This sustained, robust expenditure emphasizes the critical role that R&D plays in this industry—remaining constant at over \$100,000 per employee per annum.

Patents

Innovation remains prevalent in the sector as evidenced by the rise in the total number of hydrogen and fuel cell-related patents reported by the industry, from 433 in 2002 to 581 in 2003.

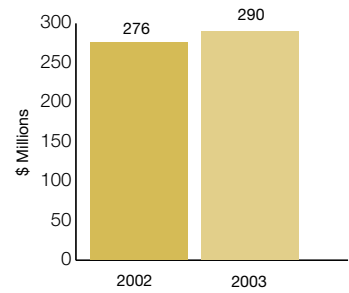
Demonstration projects

Respondents reported a 232 percent increase in the level of participation in demonstration projects—from 79 in 2002 to 262 in 2003. This trend towards more focused R&D associated with demonstration projects is a critical step towards commercialization of hydrogen and fuel cell products and the transition to a hydrogen economy.

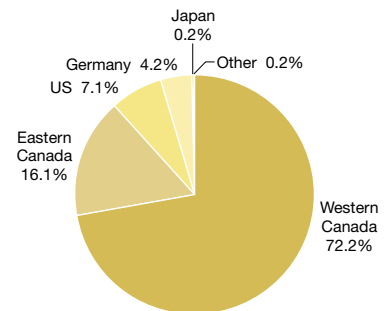
Canadian pre-commercial and early-market stage hydrogen and fuel cell products are an integral part of many demonstration projects within Canada, and around the world. Approximately 70 percent of the demonstration projects involving Canadian organizations are taking place outside of Canada. This level of activity indicates the prominence of Canadian expertise, products and services in the global industry.

Over the past few years, the federal government's involvement in demonstration activities has been mainly focused on the underlying technology and fuelling infrastructure, through programs like the Canadian Transportation Fuel Cell Alliance. Recently, the role of the public sector has been expanded to include more prominent end-user applications—primarily through the recently launched Hydrogen Early Adopters Program. It is expected that the Canadian industry will take advantage of this and other programs to undertake more domestic demonstrations to increase visibility at home.

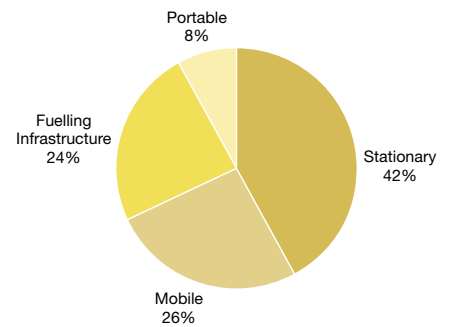
Total research and development



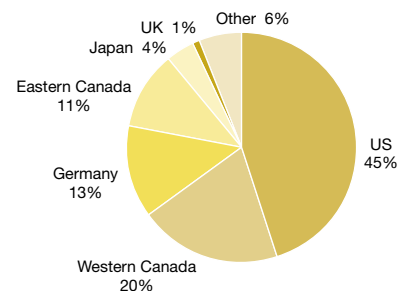
Research and development by region



Demonstration focus



Location of demonstration projects



There was a 90 percent increase in strategic alliances between 2002 and 2003.

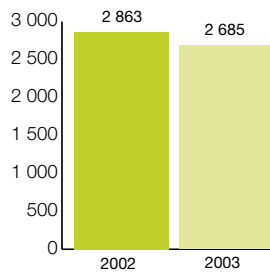
Employees

Over the past year, consolidation and internal restructuring have reshaped the industry. The impact on employment has been a 6 percent decrease in total number of employees involved in the hydrogen and fuel cell sector—from 2,863 in 2002 to 2,685 in 2003.

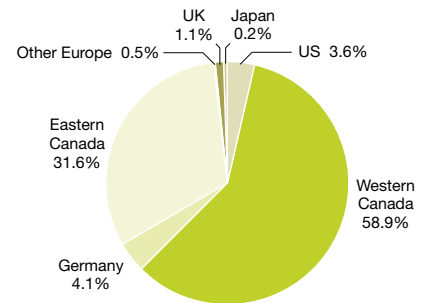
Of the total number of employees, 90 percent were based in Canada, and within Canada there was a two-to-one ratio between Western and Eastern Canada. Canadian companies also reported a significant number of employees in the United States (3 percent) and Germany (4 percent). While some companies reported activities in China, South America and India, there are presently no employees permanently stationed in these locations.

The average annual salary paid to hydrogen and fuel cell employees in Canada increased from \$56,000 in 2002 to \$60,000 in 2003. Extrapolating the \$60,000 average salary for 2003 to the 2,430 employees in Canada, the industry can be seen to contribute \$146 million in salaries to the national economy.

Employment



Employees by region



Funding requirements

Respondents were asked to identify their capital requirements for 2005 to 2010 and, if possible, to break down their requirements by year and expected funding source.

Respondents providing information on funding estimated total capital requirements for this period at \$957 million. Over one third of this total is expected to come from the public sector through continued industry-government partnerships.

Respondents also expect to receive funding from foreign markets, private equity sources outside of Canada and foreign governments.

Angel investors and venture capitalists, who have been involved in financing the industry in its early days, are not expected to be a major source of funds going forward.

Continued education of governments and the 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.

Strategic alliances

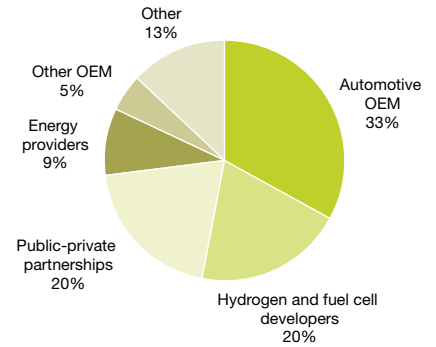
The continued importance of alliances and partnerships for the industry is evidenced by a 90 percent increase in strategic alliances; from 135 in 2002 to 256 in 2003.

At 33 percent, automotive OEMs were reported as the most prominent strategic partner for Canadian organizations involved in the hydrogen and fuel cell sector. At 20 percent each, public-private partnerships and alliances with hydrogen and fuel cell developers also featured significantly.

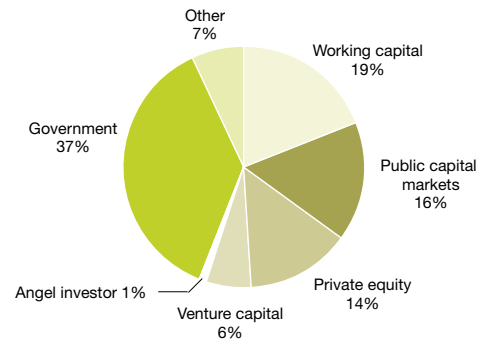
Sector-wide involvement in P3s is expected to grow as governments in Canada and abroad develop programs to support additional demonstration and infrastructure projects and other pre-commercial activities.

Over the next five years, hydrogen and fuel cell companies expect to secure funding mainly from corporate and government partnerships.

Strategic alliances



Expected domestic funding by source 2005–2010



Continued public-private cooperation is helping to build the industry and secure Canada's position in the global hydrogen economy.



Conclusion

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BC Practice Leader,
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Over the past year, the Canadian hydrogen and fuel cell sector has achieved a new level of performance. The 2004 Sector Profile reveals that while R&D expenditures continue apace, an increased emphasis is being placed on generating revenue and containing costs. Canadian organizations are benefiting from a world wide demand for Canadian hydrogen and fuel cell technology and expertise. Organizations are seen to be building IP ownership and securing the financial support and strategic alliances needed to refine, demonstrate, produce and market products. Key indicators include:

- Revenues are up 40 percent.
- R&D costs are relatively level with a 5 percent increase over 2002.
- Intellectual property ownership through patents has grown by 34 percent.
- Participation in demonstration projects is up 232 percent to 262 in 2003.
- Through industry restructuring, sector employment has decreased modestly by 6 percent from 2002 levels.

This profile is the result of overwhelming participation by public and private industry, government and academia. It is a further demonstration of the high level of cooperation that is becoming the internationally recognized trademark of the Canadian hydrogen and fuel cell industry. These stakeholders recognize the important role of accurate industry intelligence in supporting funding decisions, influencing alliance partnerships and strengthening the overall competitive position of the Canadian hydrogen and fuel cell industry.

Growth since 2001

While the past two years have been difficult for the technology industry overall, the hydrogen and fuel cell sector has thrived—almost doubling revenues and increasing employment by almost 50 percent.

The 2004 Sector Profile provides important updates to the information reported in *Economic Impact of Industrial Hydrogen Activity in Canada*—the initial sector profile conducted by Sypher Mueller and Natural Resources Canada in 2001. While some of the details may not be fully comparable due to differing methodologies, the results of 2004 Sector Profile study strongly suggest that the Canadian hydrogen and fuel cell sector has grown significantly over the past two years.

Revenue has grown 94 percent—from \$96.9 million in 2001 to \$188 million in 2003.

R&D expenditures have increased over 62 percent to \$290 million per year and have stabilized at just over \$100,000 per employee.

Employment stands at 2,685—an increase of 49 percent from 2001.

Comparative Sector Statistics: 2001 to 2003



Sources: 2001 - Sypher Mueller and Natural Resources Canada
2003 - Government of Canada, Fuel Cells Canada and PricewaterhouseCoopers

Invited to participate

Advanced Measurement Systems Inc.
Agile Systems Inc.
Air Liquide Canada
Alberta Research Council
Analytic Systems
Angstrom Power Inc.
Armstrong Monitoring Corporation
Astris Energi Inc.
Azure Dynamics Corp.
Ballard Power Systems Inc.
BC Hydro
Bell Canada
BET Services Inc.
BOC Gases
Business Development Bank of Canada
Canadian Hydrogen Association
Cellex Power Products Inc.
Centre for Automotive Materials & Manufacturing
Centre for Manufacturing of Advanced Ceramics and Nanomaterials
Chevron Texaco Technology Ventures
Chrysalix Energy Limited Partnership
Cimtex Industries Ltd.
Clean Energy Canada
Dana Canada Corporation
Deere & Co.
Deloitte & Touche LLP
Delta-Q Technologies Corp.
Dupont Canada Inc.
Dyнетek Industries Ltd.
Enbridge Gas

Energy Ventures Organization
Energy Visions Inc.
Energy3 and EnergyQBD
ESTCO Battery Management Inc.
Fuel Cell Technologies Ltd.
Fuel Cells & Reformers Canada, Ltd.
Fuel Cells Canada
Fueling Technologies Inc.
FuelMaker Corporation
General Hydrogen Corporation
Global Hydrofuel Technologies
Global Thermoelectric Inc.
Gowling Lafleur Henderson
Greater Vancouver Regional District
Greenlight Power Technologies Inc.
GrowthWorks Ltd.
H2 Concepts Alternative Fuels Consulting
Heffelfinger & Associates
Heliocentris Energy Systems Inc., North America
HERA Hydrogen Storage Systems Inc.
HSBC Bank Canada
Hydrogen Research Institute
Hydrogen Technologies Corp.
Hydrogenics Corporation
IMW Industries Ltd.
Inco Special Products
Industry Canada, Energy and Marine Branch
INRS (Institut National de la Recherche Scientifique)
James Hoggan and Associates Inc.

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Kinectrics Inc.
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Kraus Global Inc.
Laval University
MagPower Systems Inc.
Marsh Canada Limited
McCarthy Tétrauld LLP
McGill University
Membrane Reactor Technologies Ltd.
Methanex Corporation
MH2 CANADA INC.
National Bank Financial
National Research Council Canada
Natural Resources Canada
Neodym Technologies
Neutron Technologies Inc.
NORAM Engineering and Constructors Ltd.
Ontario Power Generation
Palcan Fuel Cell Co. Ltd.
Pathway Design & Manufacturing Inc.
PEM Engineers Inc.
PEM Technologies Inc.
PowerDisc Development Corporation Ltd.
PowerNova Technologies Corporation
Praxair, Inc.
PrecisionH2 Inc.
PricewaterhouseCoopers LLP
Province of Ontario
QuestAir Technologies Inc.
Royal Military College

Sacré-Davey Engineering
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Staubli Corporation
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Tekion Solutions Inc.
Teleflex Canada
Tyco Electronics Canada Ltd.
Universal Dynamics Limited
University College of the Fraser Valley
University of Alberta
University of British Columbia
University of Calgary, Western Canada
Fuel Cell Initiative
University of Victoria, Institute for Integrated Energy Systems
University of Windsor
Ventures West Management Inc.
Westport Innovations Inc.
Xantrex Technology Inc.
Yaletown Venture Partners
Zetacon Corporation

