

Canadian Hydrogen and Fuel Cell Sector Profile

Final Report - June 2022



Funding provided by the Government of Canada

Canada 

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CANADIAN HYDROGEN AND FUEL CELL SECTOR PROFILE 2022

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

MNP LLP was commissioned to develop the 2022 profile by the CHFCA in partnership Natural Resources Canada (NRCAN) and Global Affairs Canada. The information presented in the profile was collected through a survey of companies, educational institutions and government agencies that were directly involved in hydrogen and fuel cell-related activities in 2019, 2020, and/or 2021 in Canada. Additional information was collected through a series of interviews with CHFCA board members. All monetary results are presented in Canadian dollars.

A total of 305 organisations associated with hydrogen and fuel cells in Canada were invited to participate in the development of this Sector Profile. In total, 105 organisations provided information representing an overall participation rate of 34%. Not all participants provided information for every category requested.

Our thanks to all the organisations that contributed to the development of the Canadian Hydrogen and Fuel Cell Sector Profile 2022.

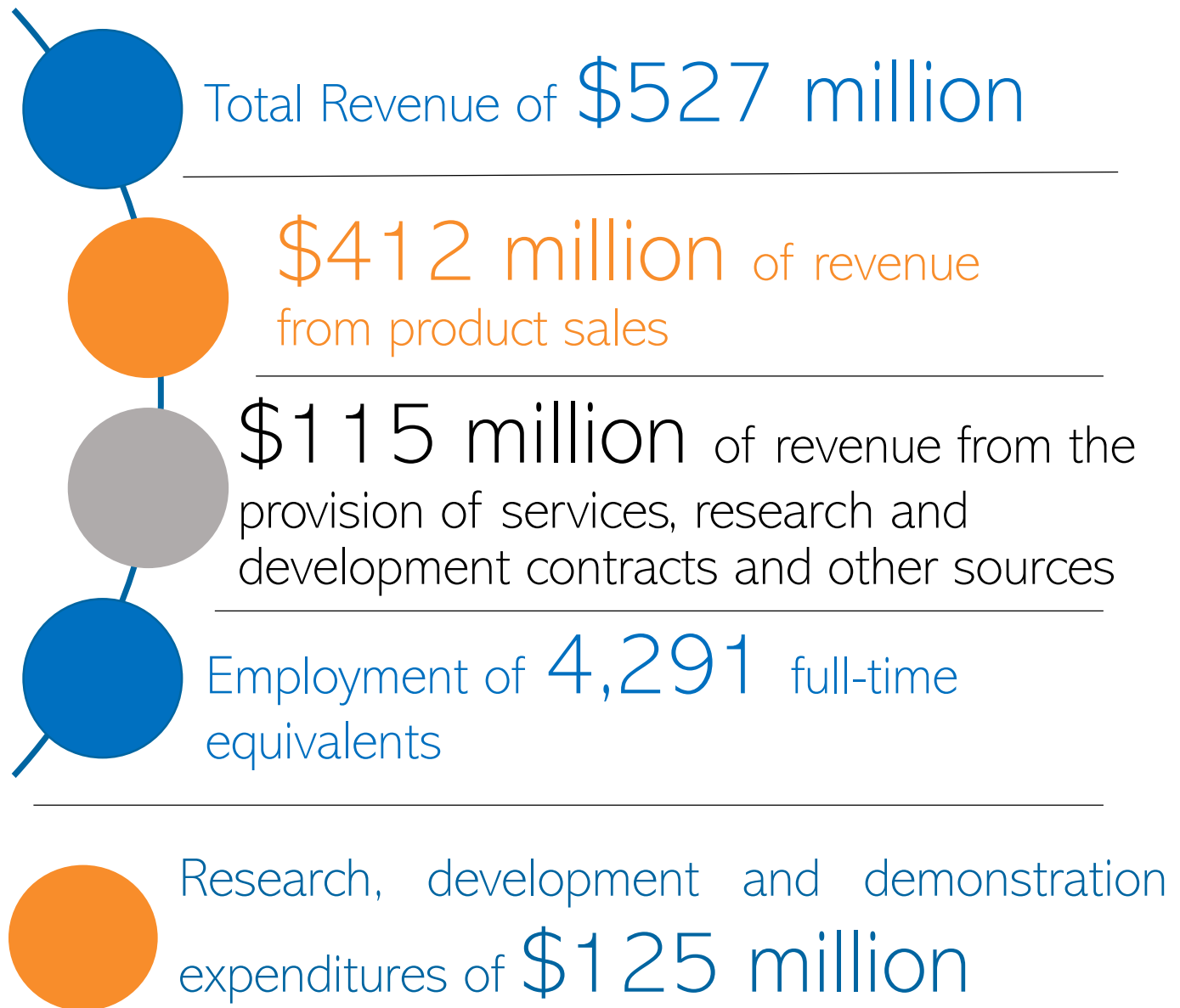
INTRODUCTION

The Canadian hydrogen and fuel cell sector is recognised as a global leader in the industry for pioneering new technologies and for its expertise. Increasing demand for clean energy products and solutions domestically and worldwide is generating opportunities and investments in a broad range of applications. Hydrogen is the leading candidate to replace coal in steelmaking and other fuels for industrial heating. Useful for both electricity and broader heating needs, it is recognized as the leading candidate for seasonal storage of renewable energy and can be used to replace liquid fuels in transportation. Its transportation uses range from passenger vehicles, buses, trucks, trains/trams, ships and planes, stationary and back-up power, and material 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. Paired with carbon capture and sequestration, hydrogen can also help the traditional energy sector transition into low emissions energy. 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 2021

In 2021, survey respondents from the Canadian hydrogen and fuel cell sector reported the following*:



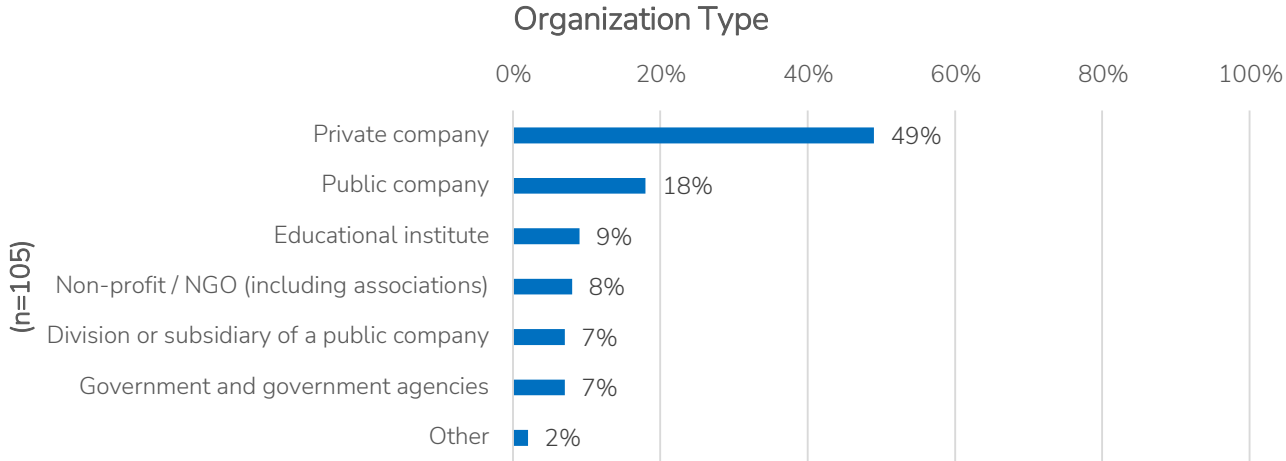
*Please note that all information was collected from voluntary survey participation. Year-over-year data may not be fully comparable due to differing survey respondents and participation rates.



ORGANISATION PROFILE

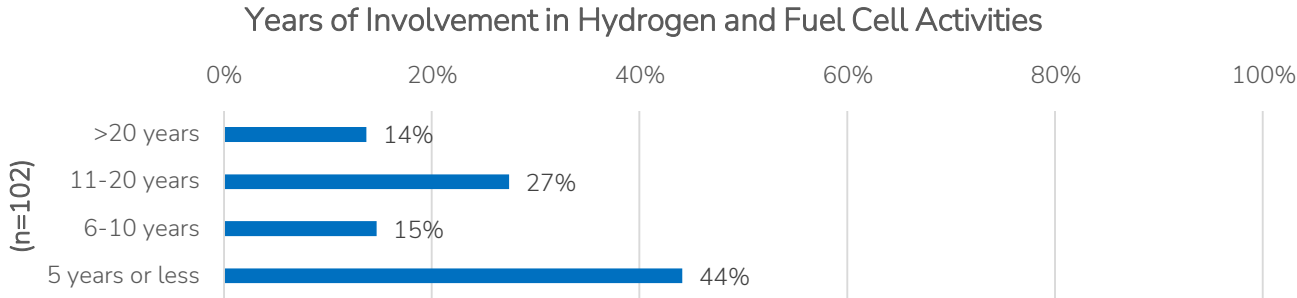
Organisation Type

Corporate organisations, including private companies, public companies and their divisions/subsidiaries represented 74% of all survey respondents. Educational institutions and non-profits represented 9% and 8%, respectively, while government and other types of organisations represented the remaining 9% of survey respondents.



Years of Involvement in Hydrogen and Fuel Cell Activities

The majority of survey respondents (56%) reported being involved in hydrogen and fuel cell activities for more than five years.



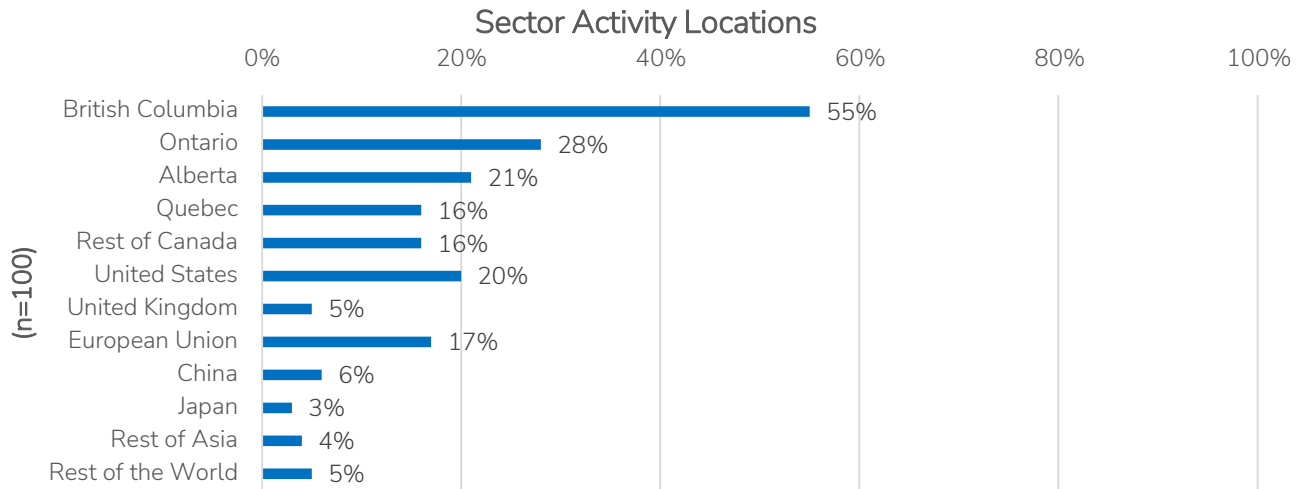
Headquarter Locations

The majority of organisations that responded to the survey (87%) reported that their headquarters for hydrogen and fuel cell activities were located in Canada. Other survey respondents had headquarters in the European Union, the United States, United Kingdom, China, Japan and Australia.



Hydrogen and Fuel Cell Activities by Region

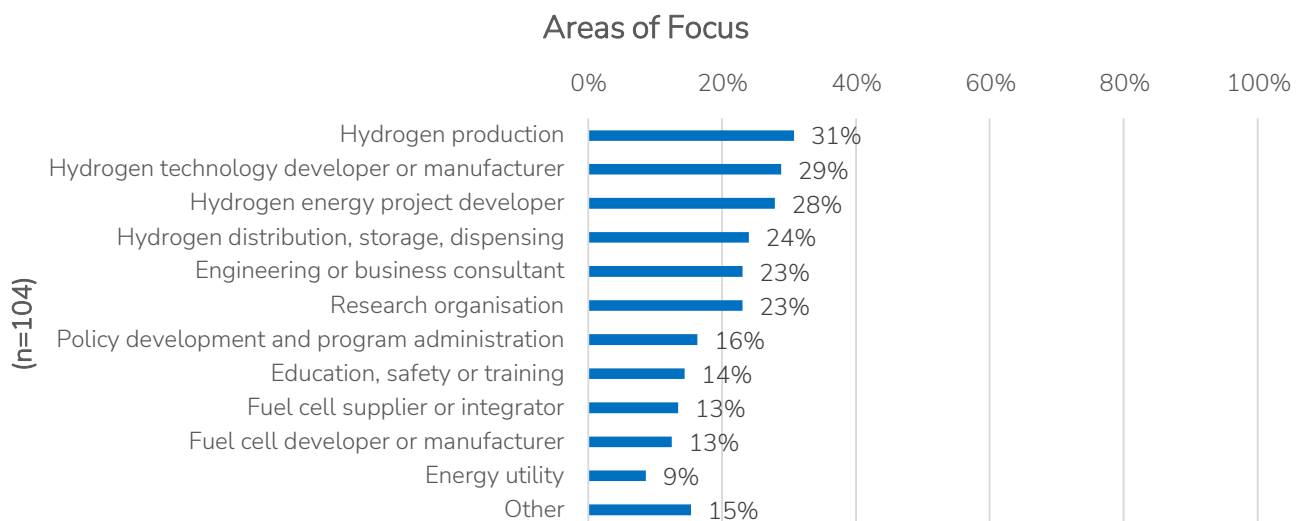
The majority of survey respondents (55%) reported that they had hydrogen and fuel cell activities in British Columbia, in 2021, while 28% had activities in Ontario, 21% in Alberta and 16% in both Quebec and the Rest of Canada. The United States (20%) and the European Union (17%) were the most common places outside of Canada that survey respondents had hydrogen and fuel cell activities.



Note: survey respondents could select multiple options, thus the percentages do not sum to 100%.

Focus Area

The main areas of focus reported by survey respondents were hydrogen production (31%), hydrogen technology developer or manufacturer (29%) and hydrogen energy project developer (28%). Other focus areas included hydrogen distribution, storage, dispensing (24%), sector consulting (23%), research (23%), policy development (16%), and education (14%).



Note: survey respondents could select multiple options, thus the percentages do not sum to 100%.



Ionomr Innovations

Ionomr Innovations develops ion-exchange membranes and polymers for clean energy.

Membranes are a central component in the hydrogen materials world, particularly for fuel cells, electrolyzers and CO₂ conversion technologies. Ionomr's materials do not require rare metals like platinum, iridium and titanium; are fully recyclable; and they eliminate the need for fluorinated materials.

Ionomr's products are used by fuel cell manufacturers and hydrogen producers around the world, with customers in North America, Europe, and Asia. Ionomr recently expanded beyond its Vancouver head office to open a facility in Rochester, New York. Ionomr is looking to further broaden its base to include Northern Europe and Shanghai by the end of 2022.

<https://ionomr.com>



Ionomr Innovations' ion exchange membrane and polymer products for water electrolysis and fuel cell applications (Source: Ionomr)

Canadian Nuclear Laboratories



Top - Operator adjusting conditions for High Temperature Steam Electrolysis materials development for hydrogen production. (Source: CNL)



Bottom - Inspection of pilot plant operation involving value added product derivation from hydrogen. (Source: CNL)

Canadian Nuclear Laboratories (CNL), headquartered in Chalk River, Ontario, develops applications of nuclear technology in numerous scientific fields. It delivers a range of services, including waste management, decommissioning, design and engineering, as well as research and development in the areas of clean energy, environmental remediation, and health sciences.

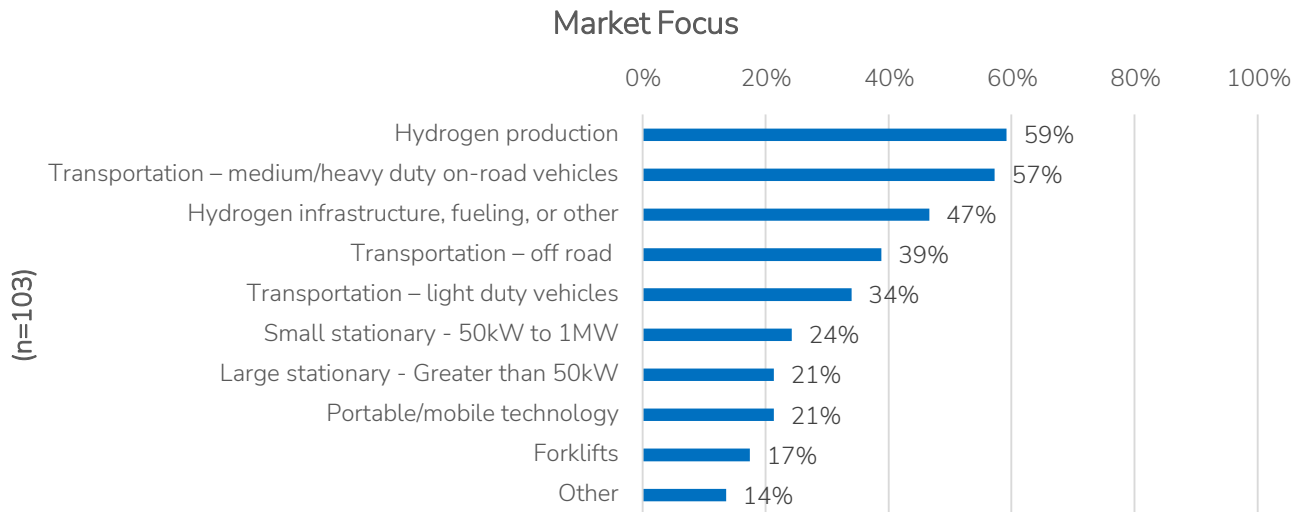
CNL and its collaborators support and develop the commercialization of technologies bringing innovative ideas closer to deployment. Some of these include CNL's hydrogen technologies, such as the production of clean hydrogen using a wide range of electrolysis technologies, hydrogen storage in metals, liquid organics and large underground locations and safety – understanding hydrogen embrittlement and hydrogen combustion. Additionally, CNL offers catalyst technologies for fuel cell applications and other specialized high temperature catalytic applications. In the future, CNL expects to focus and invest in the synthetic fuel manufacturing sector, through high-temperature steam electrolysis technology.

<https://www.cnl.ca/>



Market Focus

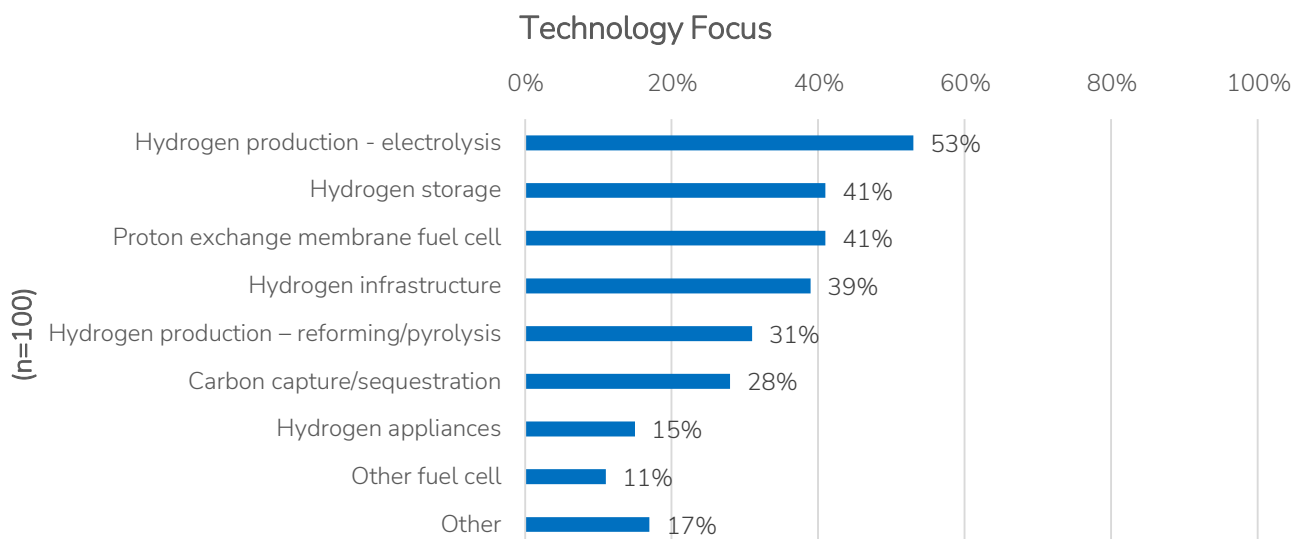
In 2021, hydrogen production (59%) and medium/heavy-duty transportation (57%) were the market focus areas reported by the largest number of survey respondents. Hydrogen infrastructure (47%), off road transportation (39%) and light duty transportation (34%) represented the next highest market focus areas for survey respondents.



Note: survey respondents could select multiple options, thus the percentages do not sum to 100%.

Technology Focus

Hydrogen production-electrolysis (53%) comprised the largest share of survey respondents' technology focus in 2021. Hydrogen storage (41%), proton exchange membrane fuel cells (41%) and hydrogen infrastructure (39%) were the next most commonly reported technology focus of survey respondents.



Note: survey respondents could select multiple options, thus the percentages do not sum to 100%.

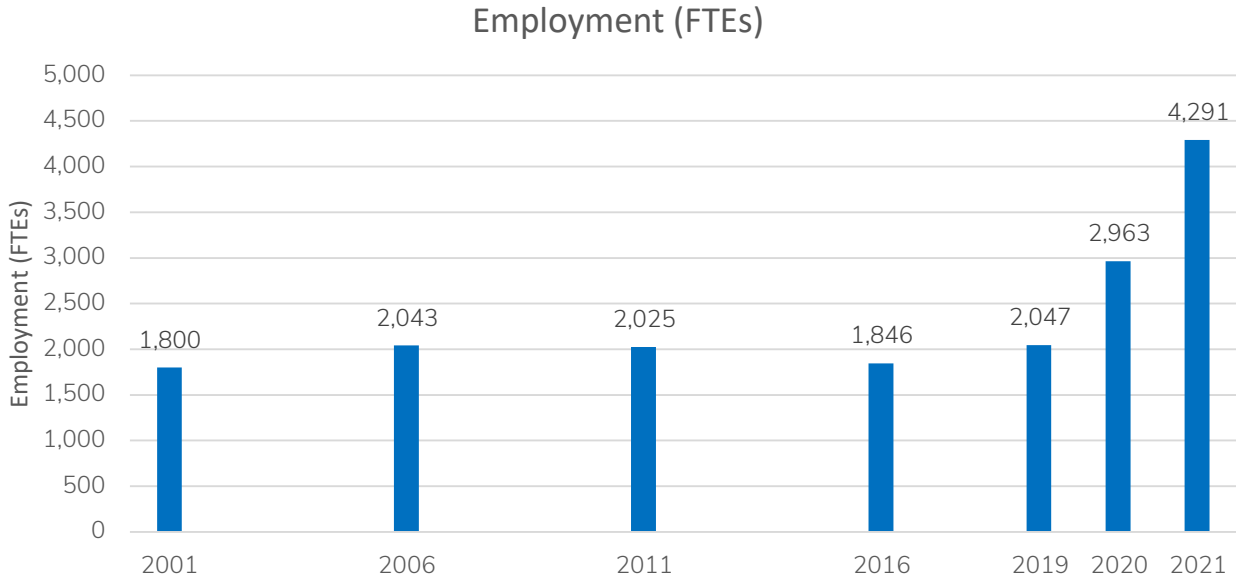


EMPLOYMENT

Survey respondents reported a total of 4,291 full-time equivalent (FTE) employees involved in hydrogen and fuel cell activities in 2021.

For survey respondents that provided their employment in both 2017 and 2021, total FTE employment increased by approximately 72%.* Among small organisations in 2017 (under 10 FTEs) that provided their employment in both 2017 and 2021, total FTE employment increased approximately 165%.

The majority of survey respondents (55%) had fewer than 10 FTE employees in 2021, while 33% had between 10 and 50 FTE employees and twelve percent had over 50 FTE employees.

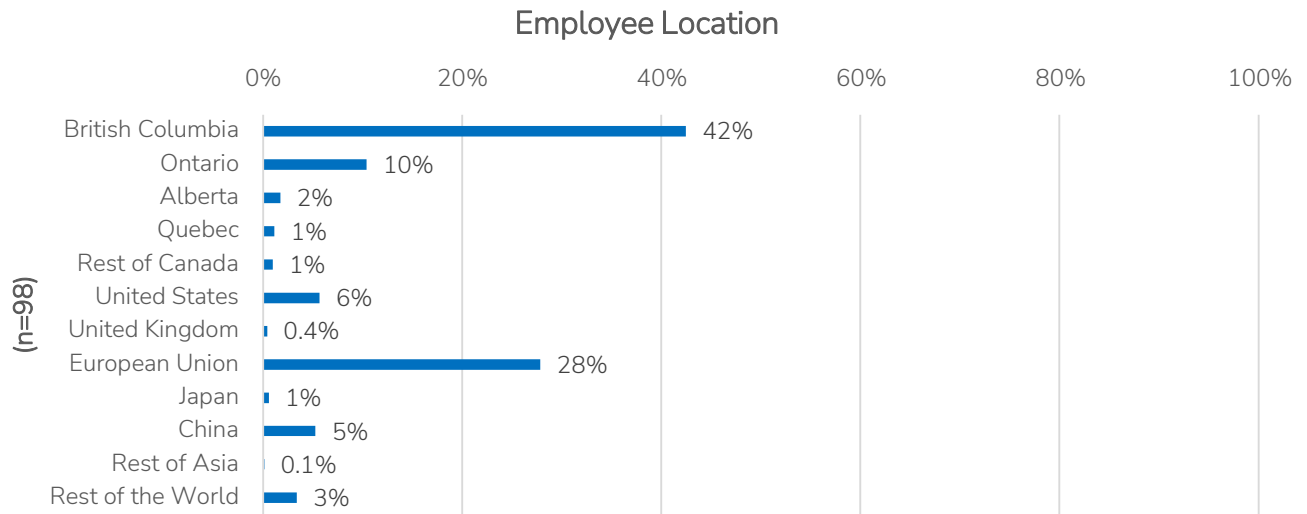


Source: Values for 2001 through 2016 from CHFCA Sector Profile 2018 version

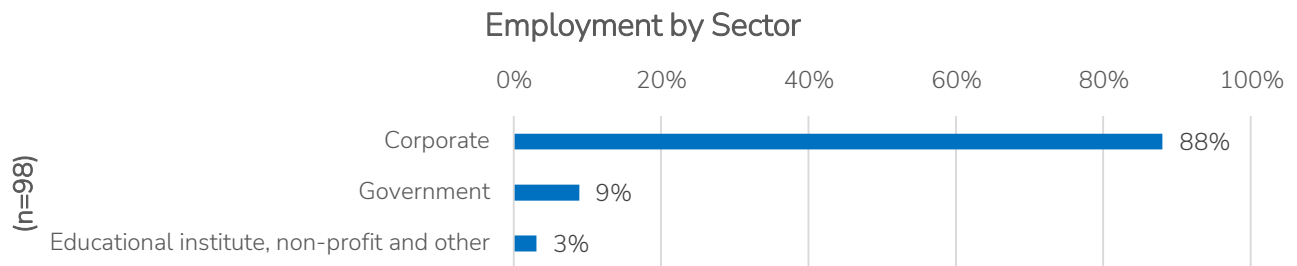
In 2021, approximately 57% of survey respondents' FTE employees were located in Canada. Within Canada, British Columbia accounted for the highest percentage of FTE employees, followed by Ontario and Alberta. The European Union accounted the second highest number of FTE employees (28%), which was largely driven by a small number of large companies with a high percentage of employees there. All other regions had 10% or less of respondent hydrogen and fuel cell sector employees.

*Please note that the results are driven by a few large organisations in the sector.

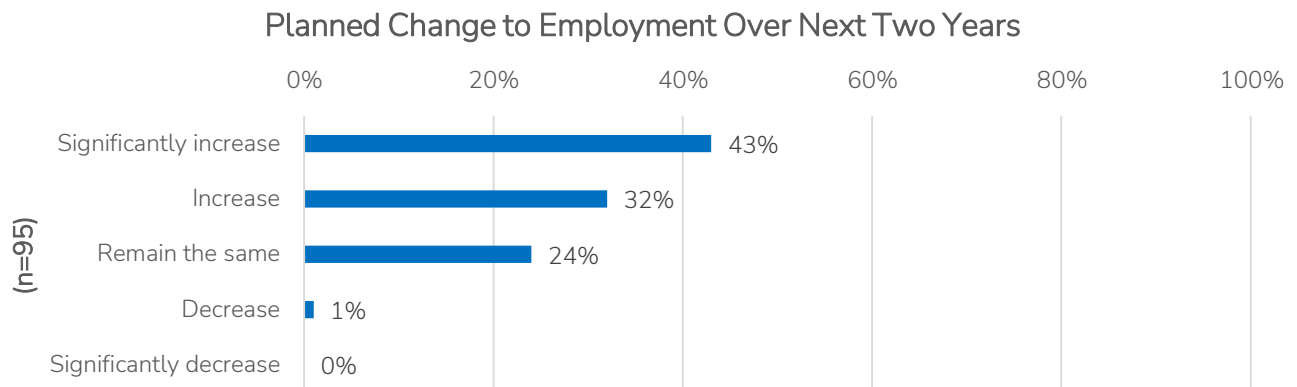




The overwhelming majority of FTE employment was in corporate organisations (88%), while government organisations had the second highest number of employees (9%). Educational institute, non-profit and other organisations accounted for 3% of FTE employment.



The overwhelming majority of survey respondents (75%) indicated they plan to increase the number of employees engaged in hydrogen and fuel cell activities in the next two years, while 24% indicated they plan to keep the number the same. Only one survey respondent indicated that they plan to decrease the number of employees they have.



CARIBOO LOW CARBON FUELS

Cariboo Low Carbon Fuels (“Cariboo”) is a Kamloops, BC-based startup that plans to build, own and operate a series of joint venture low carbon fuel projects across Canada, with intended export to Asia and the European Union. Cariboo’s current projects include the following:

- An electrolysis project on the Alberta-Saskatchewan border.
- A hydrogen storage facility in Saskatchewan to facilitate the export of energy through the Port of Churchill, Manitoba to European markets.
- A partnership with local First Nations to develop a natural gas to liquids, hydrogen production facility hub near Kamloops, BC.
- A biomass to hydrogen facility also in Kamloops, BC.



Electrolysis control set-up (Source: Cariboo)

<http://www.cariboolcf.com>

Hydro Québec

Hydro Quebec is a public energy producer and distributor. With 61 hydroelectric generation stations, it is the largest electricity producer in Canada and one of the largest hydroelectricity producers in the world, providing power that is over 99% clean.

The development of the green hydrogen industry is a strategy to help Québec in its energy transition. Green hydrogen promotes the decarbonization of the economy by enabling fuel switching to low-carbon hydrogen for hard-to-abate sectors, where electrification is difficult or challenging such as in industrial processes, heavy transportation, and chemical processes.



(Source: Hydro Quebec)

<https://www.hydroquebec.com>



Toyota Mirai and pump (Source: Toyota)

Toyota Canada Inc.

Toyota Canada distributes fuel cell electric vehicles (FCEVs) in Canada and has been working to develop fueling infrastructure and a market for hydrogen in the country. Over the past year, Toyota has sold a fleet of Mirai FCEVs to BC-based courier company Geazone for the



launch of North America's first hydrogen-powered courier fleet, has partnered with ride-share leader Lyft to make a fleet of Mirai available to ride-share drivers in the Vancouver area, and has announced an MOU to provide a fleet of FCEVs to the Edmonton International Airport. Toyota is also exploring opportunities for the use of its fuel cell modules in other applications. The new generation Toyota Mirai will be available for purchase by retail and fleet customers in the British Columbia and Quebec in 2022.

<https://www.toyota.ca>

Cellcentric

Cellcentric is a joint venture between Daimler Truck AG and the Volvo Group AB formed in March 2021. Cellcentric is focused on developing, producing and commercializing fuel cell systems. It is developing 150kW fuel cell systems designed specifically for the requirements of heavy-duty truck use. Cellcentric fuel cells are now set for installation in heavy-duty trucks manufactured by Daimler Truck AG and the Volvo Group as well as other customers.

<https://cellcentric.net>



(Source: Cellcentric)

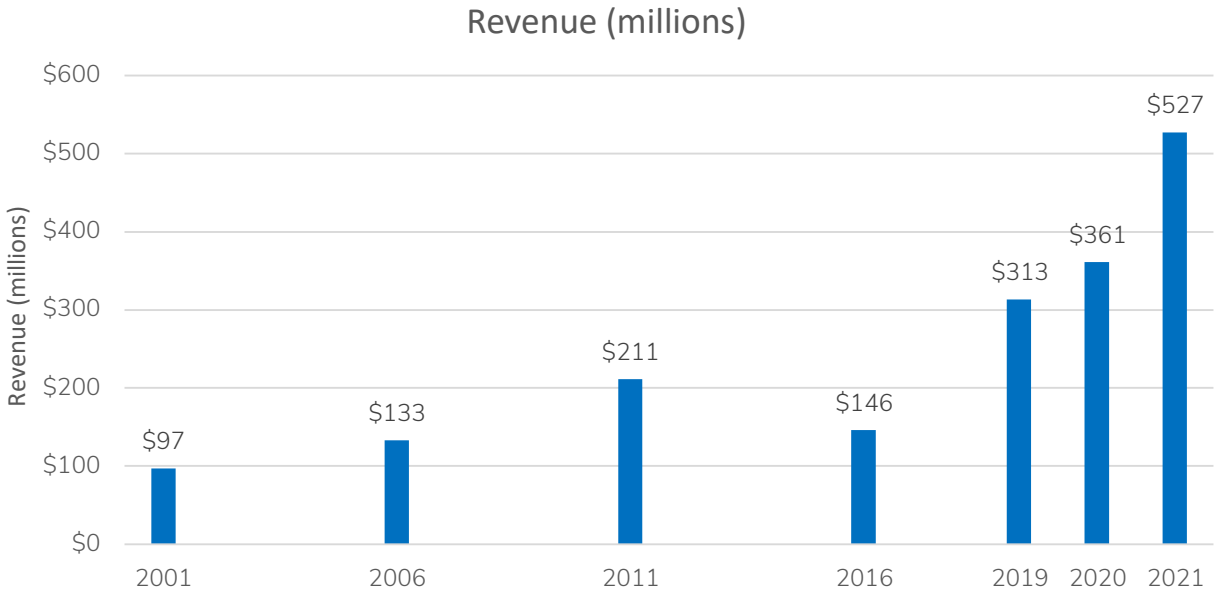


REVENUE

In 2021, 57% of survey respondents generated revenues from hydrogen and fuel cell activities, totalling approximately \$527 million.

For survey respondents that provided revenues in both 2017 and 2021, total revenue increased by 11%.* Among survey respondents that reported generating revenues in 2021, the majority (58%) reported under \$1 million in annual revenue, while 24% reported over \$5 million in annual revenues.

Survey respondents generated the majority of their revenues from product sales (78%), which accounted for approximately \$412 million of revenue. The provision of services (19%) accounted for \$98 million in revenue, while research and development contracts (2%) and other areas (1%) accounted for a combined \$17 million in revenue.

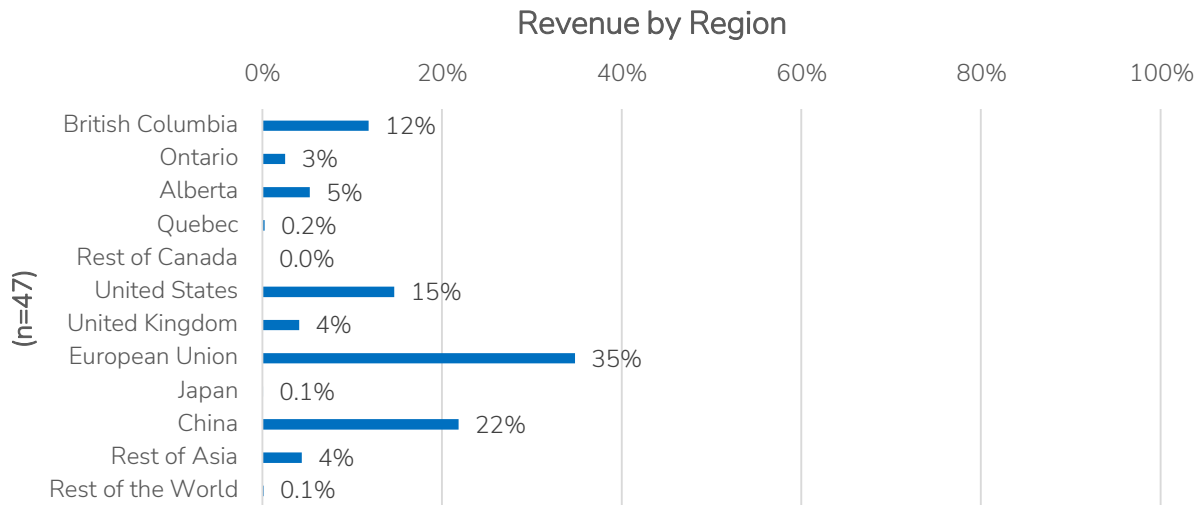


Source: Values for 2001 through 2016 from CHFCA Sector Profile 2018 version

The European Union (35%) was where survey respondents generated the largest amount of revenue. China (22%), the United States (15%) and British Columbia (12%) were the next largest sources of revenue generation. All other regions were selected by 5% or fewer of survey respondents.

*Please note that the results are driven by a few large organisations in the sector.





Loop Energy

Loop Energy™ (“Loop”), headquartered in Burnaby, BC, develops and manufactures hydrogen fuel cell systems for vehicle original equipment manufacturers (OEMs) and power generation system manufacturers. Loop currently manufactures 30kW, 50kW and 60kW fuel cells for use in trucks, small-to-medium construction equipment, transit buses, medium duty vehicles and stationary applications.

Loop holds over 30 patents with the company’s eFlow™ technology, which improves fuel efficiency, peak power and current density uniformity. Loop’s products are currently being used in China, South Korea, the European Union and the United States. Loop is currently developing a 35,000 sq.ft. production facility in Shanghai to better serve Asian markets.

In 2021, Loop announced it was in the process of developing a 120kW fuel cell for use in heavy duty trucks and buses. Loop also completed a \$100 million Initial Public Offering on the TSX, in 2021. Since going public, Loop has grown its workforce from 40 to 100 employees worldwide.

<https://loopenergy.com>



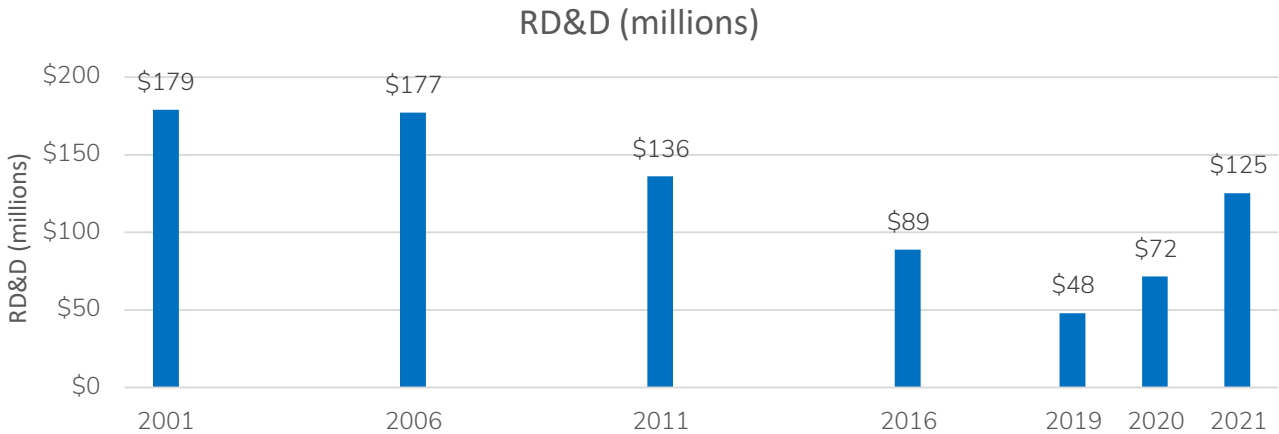
T505 50kW module. (Source: Loop Energy)



RESEARCH, DEVELOPMENT AND DEMONSTRATION (RD&D)

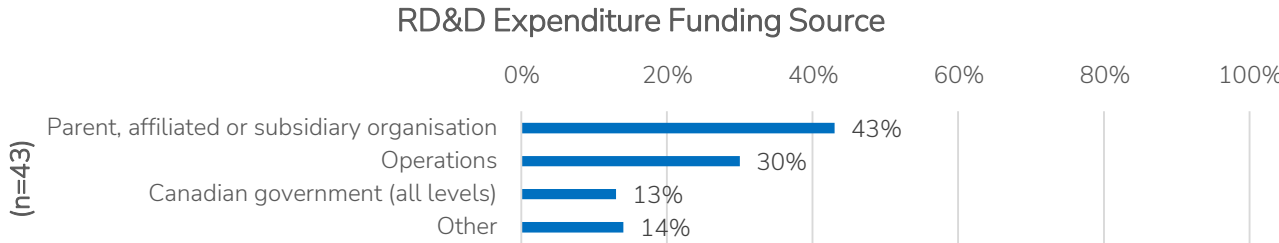
In 2021, 54% of survey respondents participated in research and development and demonstration (RD&D) activities, reporting total expenditures of approximately \$125 million.

For companies with under \$10 million in RD&D spending in 2017 that provided their RD&D expenditures in both 2017 and 2021, RD&D spending increased by 76%.



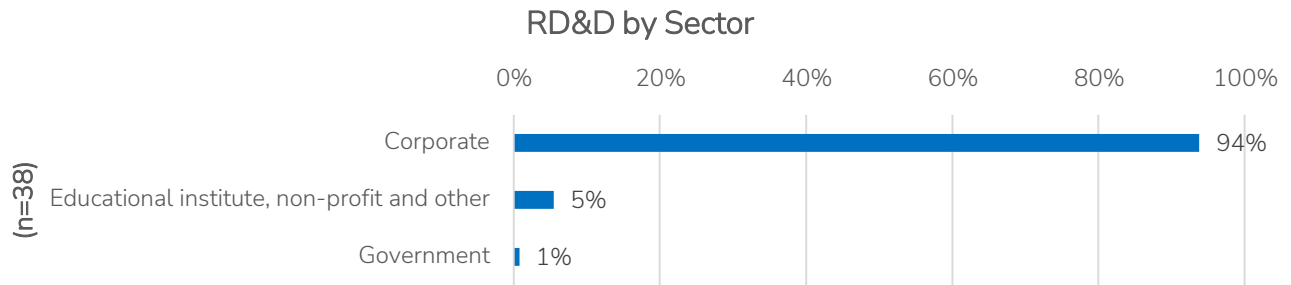
Source: CHFCA Sector Profile 2018 version

Among the survey respondents that indicated they participated in RD&D activities, just under half (43%) indicated parent-, affiliate- or subsidiary-funded RD&D, while other funding sources included operations (30%), the Canadian government (13%) and other sources (13%).

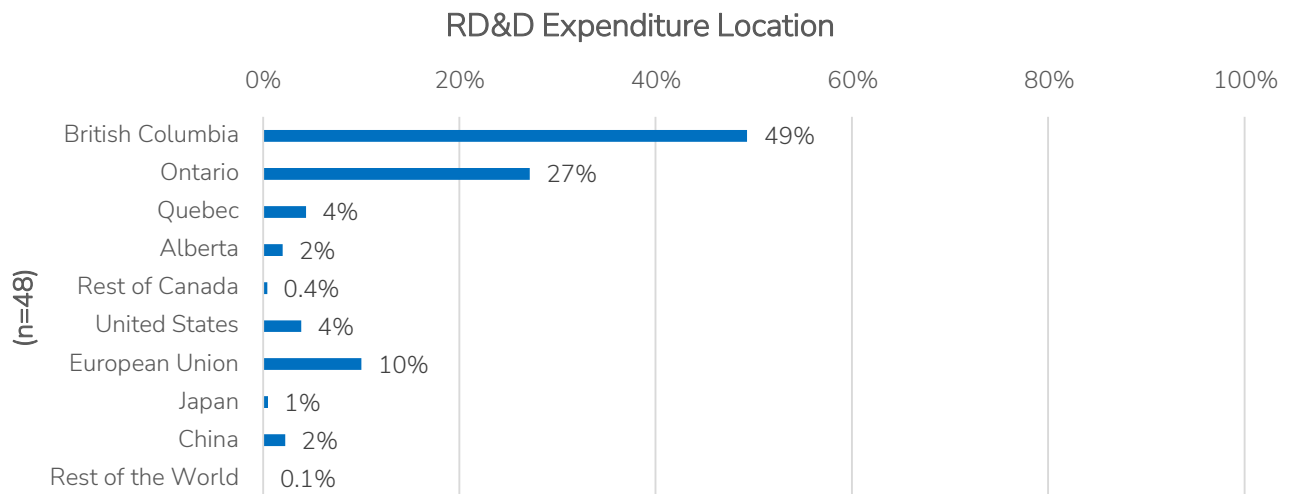


Among the survey respondents that indicated they participated in RD&D activities, the overwhelming majority of RD&D expenditures were by corporate organisations (94%), while educational institute, non-profit and other organisations accounted for 5% of RD&D expenditures. Government organisations accounted for 1% of RD&D expenditures.





In 2021, approximately 83% of RD&D expenditures took place in Canada. Within Canada, British Columbia accounted for the highest percentage of RD&D expenditures (49%) followed by Ontario (27%). Outside of Canada, the European Union (10%) accounted for the greatest share of RD&D expenditures. All other regions were selected by fewer than 5% of survey respondents.



Unilia Fuel Cell Inc.

Unilia Fuel Cell Inc. is one of the world's leading providers of fuel cell stack technology with R&D laboratories, prototyping, testing, and mass production facilities in Canada and China.

Initially focused on light-duty machinery clients with its Polaris fuel cell stack platform, Unilia is now entering new industry markets with the Electra platform. Electra will service medium-duty industry clients with the need for quick, agile transportation. Unilia is currently developing a heavy-duty fuel cell stack for long-haul trucking and heavy machinery.

<https://www.unilia.com>



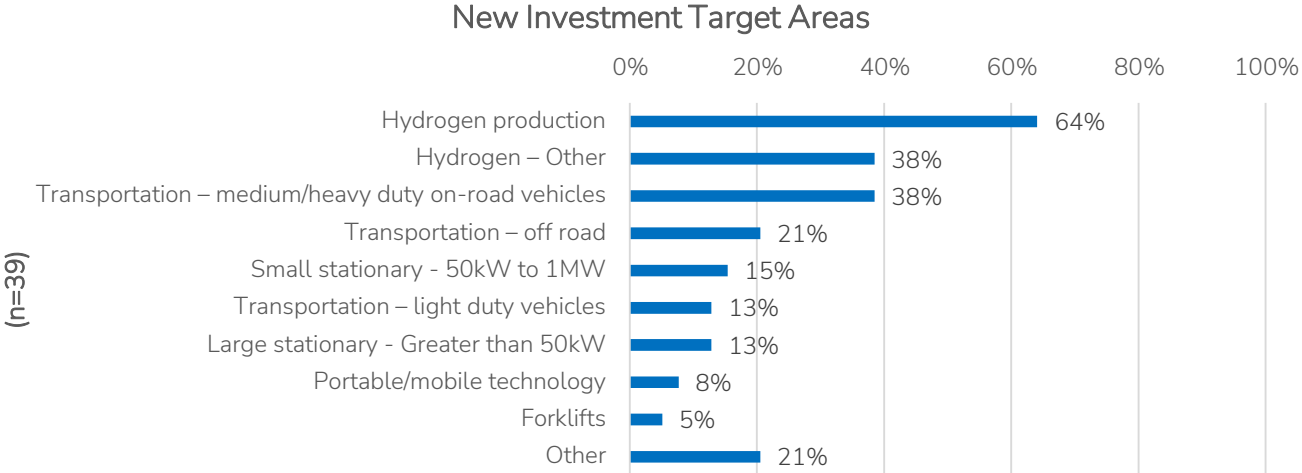
Hydrogen bus in Germany. (Source: Unilia)



INVESTMENT

Investment Areas

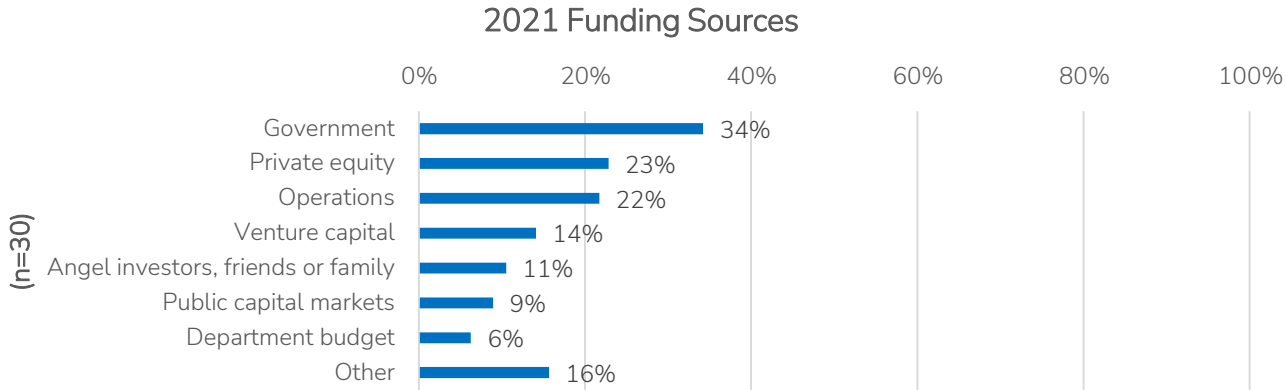
Among survey respondents that attracted new investment in 2021, 64% indicated the investments targeted hydrogen production. The next most targeted investment areas were other hydrogen applications (38%) and medium/heavy duty on-road vehicles (38%). All other target areas were selected by 21% or fewer of survey respondents.



Note: survey respondents could select multiple options, thus the percentages do not sum to 100%.

Funding Sources

Among organisations that attracted new investment in 2021, government sources contributed funding to 34% of respondent organisations, private equity sources contributed to 23% of respondents, and in-house operations contributed to 22% of respondents. All other sources contributed funding to less than 20% of respondent organisations.



Note: survey respondents could select multiple options, thus the percentages do not sum to 100%.



Terrestrial Energy

Terrestrial Energy is a technology development company that is developing a next-generation (Generation IV) nuclear cogeneration plant for industrial applications. Terrestrial Energy is developing its high-temperature integral molten salt reactor (IMSR) nuclear system for cost-competitive, carbon-free hydrogen production. It is the most construction-ready and licensing-ready Generation IV design in the global marketplace. Terrestrial Energy plans to deploy its technologies to markets in North America, Asia and Europe.



Integral Molten Salt Reactor and balance of plant. (Source: Terrestrial Energy)

Terrestrial Energy's IMSR technology also can be used in ammonia production, carbon capture, desalination, and the development of synthetic fuels. Terrestrial Energy's mission is to develop clean, cost-competitive, and resilient energy technology that will have applications across the hydrogen sector.

(<https://www.terrestrialenergy.com>)

Hydrogen in Motion

Hydrogen In Motion Inc. (H2M), headquartered in Vancouver, British Columbia, manufactures and develops low-pressure, solid-state, conformable hydrogen storage tanks for hydrogen storage, transport, dispensing and utilization in mobile and stationary application. H2M also provides off-board refueling solutions to hydrogen fuel cell vehicles owners.

(www.hydrogeninmotion.com)



Hydrogen in Motion team members. (Source: Hydrogen in Motion)

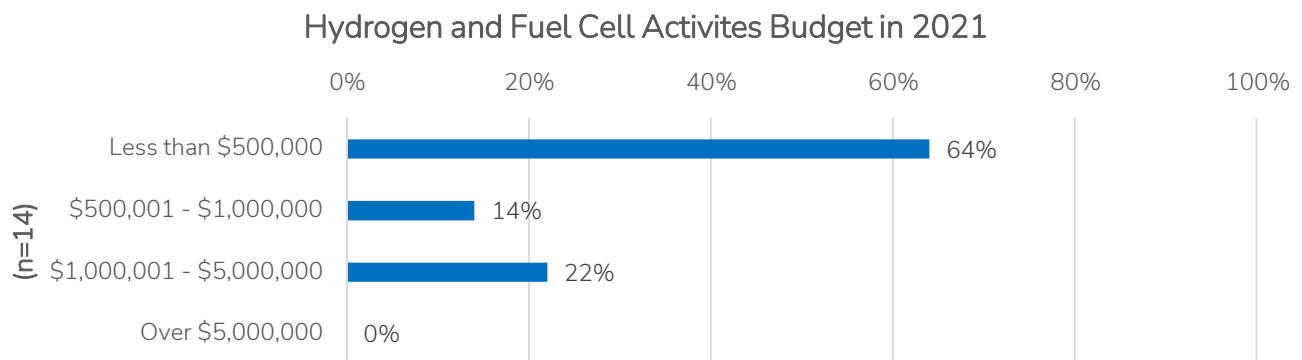


BUDGET

Information on budget and funding allocation was only collected from government, non-profit and educational institutes.

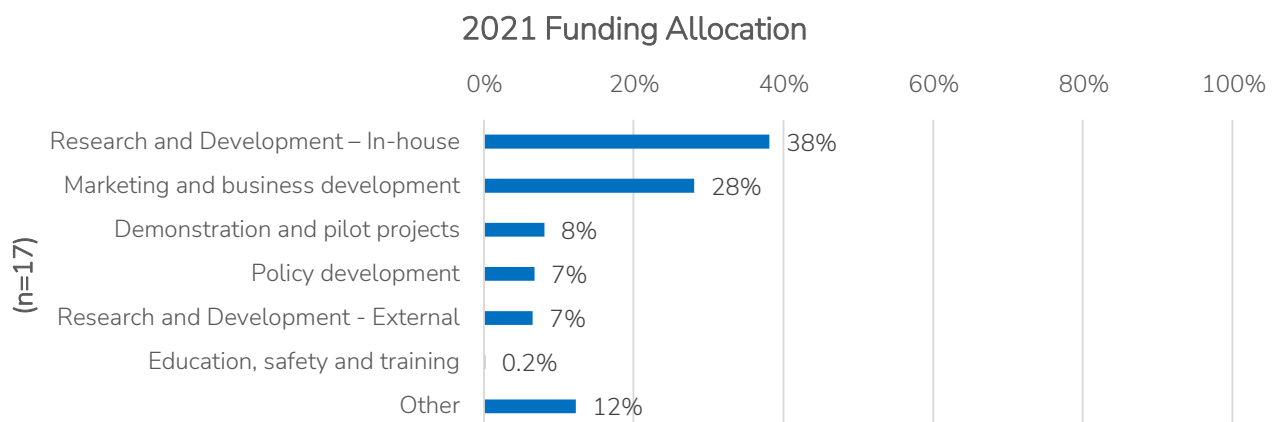
Total Budget

Among government, non-profit and educational institute survey respondents, over half (64%) had a budget for 2021 hydrogen and fuel cell activities consisting of less than \$500,000, while 14% of respondents' 2021 sector activity budgets were between \$500,001 and \$1,000,000, and 22% had between \$1,000,001 and \$5,000,000. No respondents reported having a budget over \$5,000,000.



Funding Allocation

Among government, non-profit and educational institute survey respondents, 38% indicated that their funding was allocated towards in-house research and development, while 28% indicated the allocation of funding as supporting marketing and business development efforts. Demonstration and pilot projects accounted for 8% of funding, while policy development and external research and development accounts for 7% each. Other areas and education, safety and training accounted for just over 12% of funding allocations.



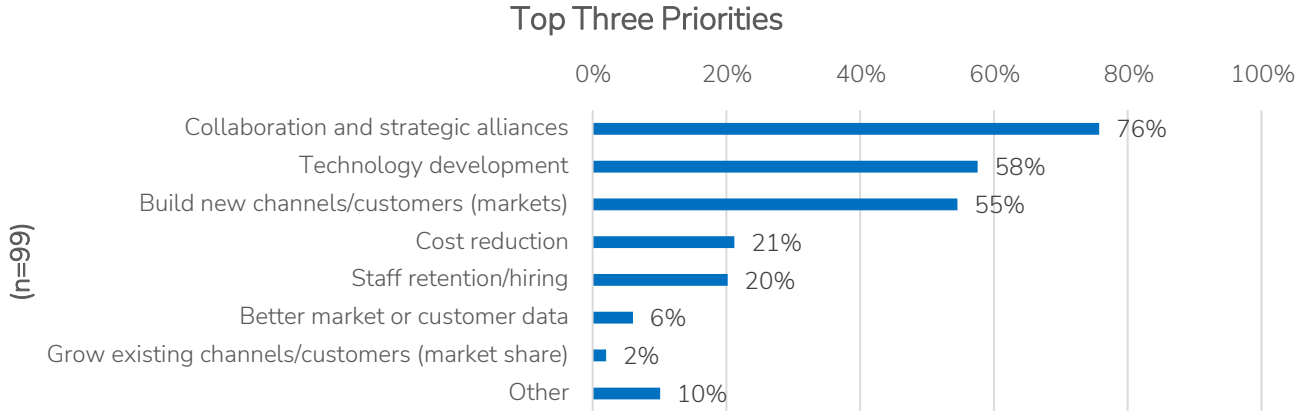
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OPPORTUNITIES AND CHALLENGES

Organisational Priorities

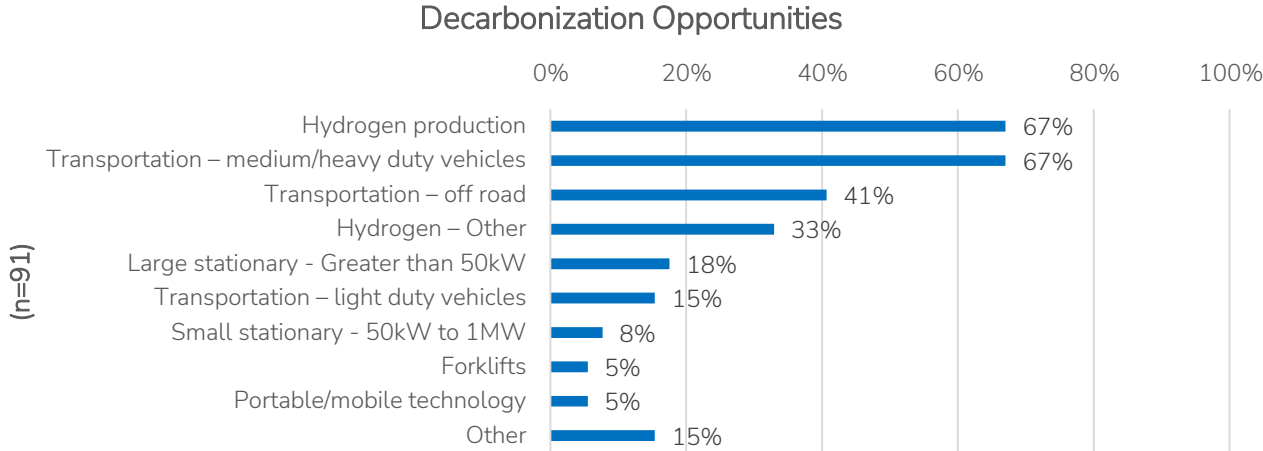
Developing strategic alliances and collaborating was indicated to be one of the top three priorities for 76% of survey respondents, while technology development (58%) and market development (55%) were the next highest priorities. Cost reduction was reported by 21% of respondents and staff retention was reported by 20% of respondents. Obtaining better market/customer data and growing existing channels/customers as well as other priorities were indicated to be a top priority for 10% or fewer survey respondents.



Note: survey respondents could select multiple options, thus the percentages do not sum to 100%.

Decarbonization Opportunities

Hydrogen production and medium/heavy duty vehicles were identified by survey respondents as their top two opportunities to assist with decarbonization. Off road transportation was identified by 41% and other areas of hydrogen by 33% of respondents, while all other areas were identified by less than 20% of respondents.

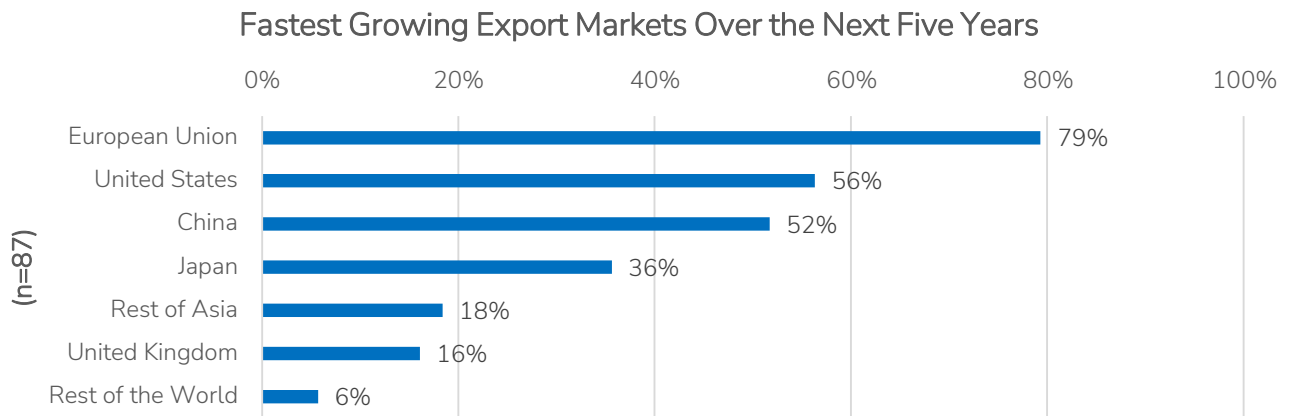


Note: survey respondents could select multiple options, thus the percentages do not sum to 100%.



Forecasted Export Market Growth

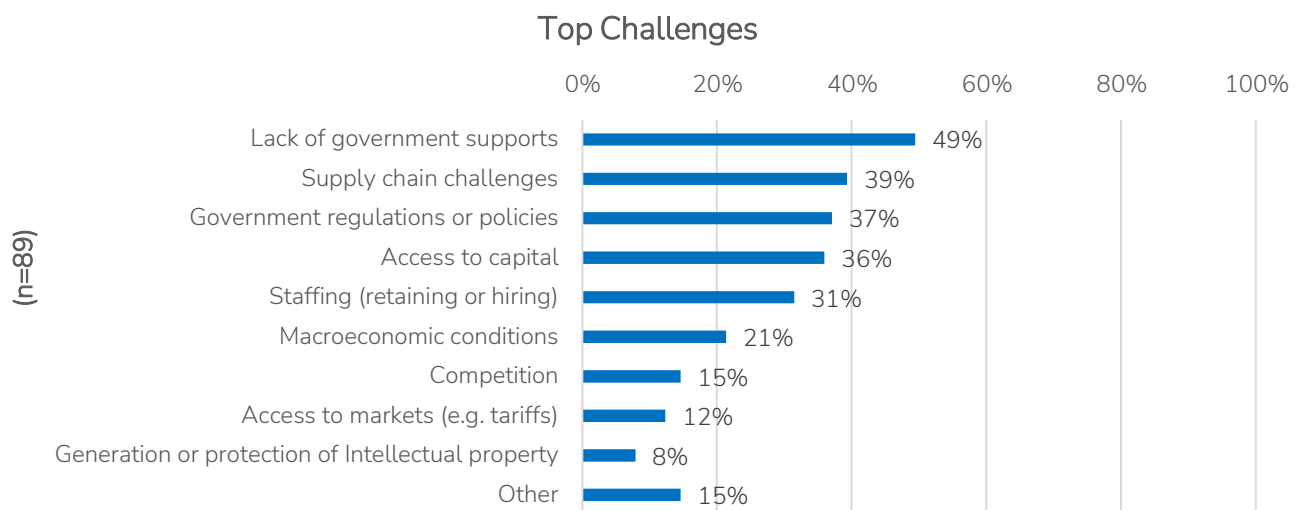
The European Union was identified by 79% of respondents as the export market for Canadian manufactured products that was expected to be the fastest growing over the next five years. The United States and China were expected to be the next fastest growing export markets, as they were identified by 56% and 52% of respondents respectively. Japan was identified by 36% of respondents and all other regions were identified by fewer than 20% of survey respondents.



Note: survey respondents could select multiple options, thus the percentages do not sum to 100%.

Organisational Challenges

Survey respondents were asked what the top three challenges their organisation faces. The top indicated challenge was a lack of government support (49%), while supply chain challenges (39%), government regulations/policies (37%), access to capital (36%) and staffing (31%) were indicated to be the next most significant challenges. All other challenges were selected by 21% or fewer of survey respondents.



Note: survey respondents could select multiple options, thus the percentages do not sum to 100%.



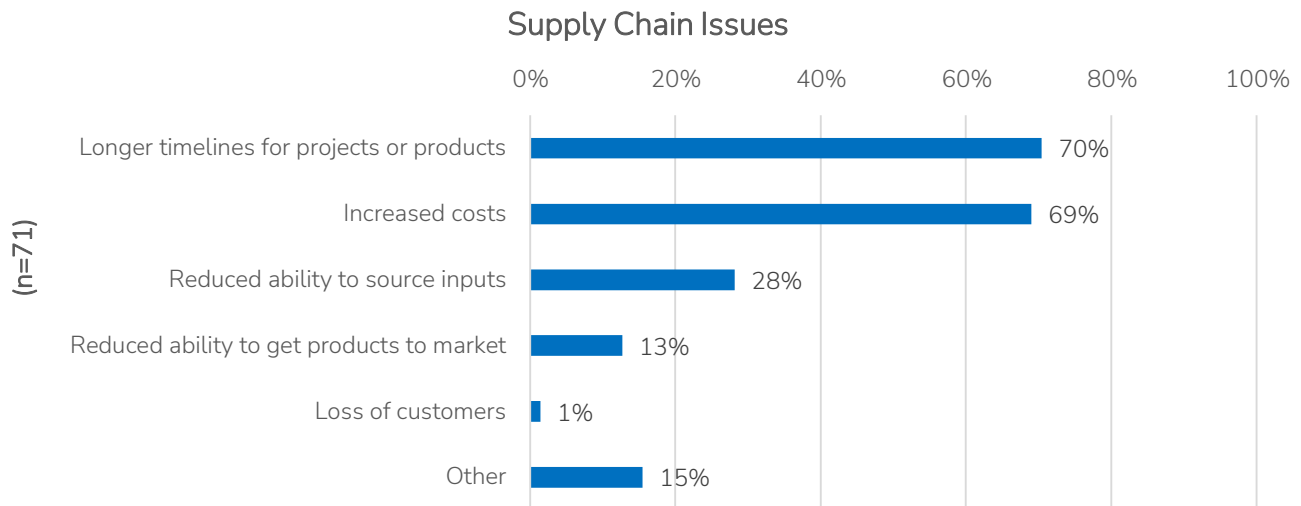
Canadian Advantages

Hydrogen and fuel cell organisations reported many significant benefits of being based in Canada. They are summarized below:

- **Talent Pool** – The Vancouver region in particular has long been a ‘hub’ for the hydrogen and fuel cell sector. This has translated to a large amount of expertise and employment in the region, making it much easier for companies to find experienced employees.
- **Resource Sharing** – The ecosystem of hydrogen and fuel cell firms in Canada allows for the ease of resource sharing, which would not be possible in many other jurisdictions. Interviewees indicated that resource sharing, particularly for expensive pieces of testing equipment, has been beneficial to them. Many smaller firms cannot afford this type of equipment, but through pooling resources it has become feasible for multiple firms to collaborate and acquire valuable equipment.
- **Federal Government Support** – Many interviewees indicated that government support has been beneficial to them. While grant and funding programs were cited as an important area, the business development and export support provided by Global Affairs Canada was also indicated to be beneficial, as it has allowed Canadian companies to make connections with business partners from around the world.

Supply Chain Issues

Longer timelines for projects and getting products to market (70%) and increased costs (69%) were the two primary ways that survey respondents indicated supply chain issues have affected them. Reduced ability to source inputs (28%) and reduced ability to get products to market (13%) were also identified as ways that supply chain issues have affected survey respondents. Other issues (15%) and loss of customers (1%) were also selected by survey respondents.

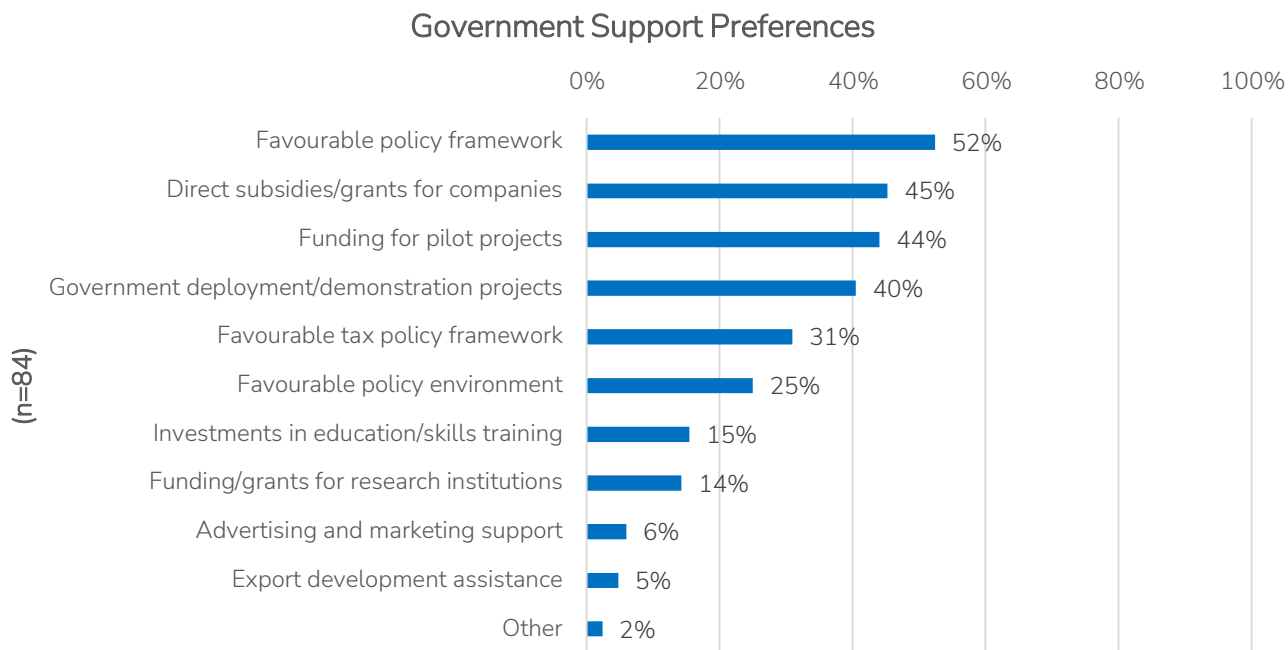


Note: survey respondents could select multiple options, thus the percentages do not sum to 100%.



Government Support

Survey respondents indicated that a favourable policy framework (52%) would be the most beneficial government support for their organisation, while direct subsidies/grants (45%) and funding for pilot projects (44%) were the next most beneficial government supports. The remaining supports were selected by 40% or fewer of survey respondents.



Note: survey respondents could select multiple options, thus the percentages do not sum to 100%.

Pandemic Impacts

Survey respondents and interviewees reported a mix of positive and negative impacts of the COVID-19 pandemic. A summary of the primary impacts is below:

- **Staffing** – Many survey respondents indicated they were either forced to lay off staff or suffered operational difficulties handling COVID-19 restrictions. Companies with laboratories and manufacturing facilities were particularly affected by not being able to have staff on-site for periods of time.
- **Supply Chain** – Survey respondents indicated that supply chain disruptions have made sourcing equipment much more difficult and made it more difficult to get products to market.
- **Knowledge Transfer** – Some survey respondents reported the ease of knowledge transfer and the shift to online work as positive spin-off effects of the COVID-19 pandemic. They found it easier to connect with organisations around the world and meet for virtual conferences.
- **Climate Change** – The focus on climate change was identified as both a positive and negative impact of the COVID-19 pandemic. While some organisations saw the pandemic as shifting resources away from climate change initiatives, other viewed the recovery from the pandemic and tying climate change initiatives into it, as a positive impact.



Looking Forward

The hydrogen and fuel cell sector is experiencing strong growth and there is significant optimism about it maturing into a key climate solution. Studies have shown that the hydrogen and fuel cell sector is following a very similar growth trend to the wind and solar sectors, but approximately 15 years behind.¹ However, there are still a number of areas that interviewees identified as issues hindering growth in the sector and applications they feel could be explored further. They are summarized below:

High-Tech Designation²

In BC, the high-tech sector is defined as businesses with at least 50% of their workforce engaged in research, analysis or development in technological, scientific or technical fields. As many hydrogen and fuel cell sector firms have large manufacturing facilities, with the majority of their employees in manufacturing roles, they are not classified as 'high-tech' firms. As a result, these firms cannot access the government support for the high-tech industry. Interviewees mentioned that they feel the definition of high-tech should be amended to allow hydrogen and fuel cell sector firms to access the same supports available to other high-tech firms.

Rail, Natural Gas and Nuclear Opportunities³

A number of interviewees identified the rail sector as an area that could be the next major source of growth for the hydrogen and fuel cell sector. Many rail firms have begun examining these opportunities, but there are very few in use, particularly in Canada. Interviewees felt that Canada could be a leader in this area, as it is already a hub for hydrogen technology and the Canadian rail sector is largely dominated by two firms, which could allow for rapid adoption.

Interviewees also mentioned the natural gas and nuclear sectors in Canada, as areas for opportunity within hydrogen production. Canada is already a nuclear nation with a great deal of expertise in nuclear power production and interviewees noted that this presents an opportunity to leverage nuclear power in the production of hydrogen. Similarly, Canada's vast natural gas reserves were identified as an opportunity for large scale low emissions hydrogen production.

Capital Funding Requirements⁴

Current Canadian government business grants require a 50% financial contribution from the business owners, though in many cases, government awards can be stacked to reduce the percentage of project contributions from business owners. For many hydrogen and fuel cell sector firms, the capital intensity of the projects are such that these firms require supplemental funding from external sources to reach the threshold for government grants and assistance. Interviewees indicated that Canadian hydrogen and fuel cell firms can struggle to find adequate supplemental funding, which can result in difficulties for firms to grow.

¹ Green Tech Media. Available here: <https://www.greentechmedia.com/articles/read/fuel-cells-in-2017-are-where-solar-was-in-2002>

² Interviews with CHFCA board members.

³ Ibid.

⁴ Ibid.



Transition Accelerator

Transition Accelerator is a non-profit, charity that works to define credible, compelling pathways capable of transitioning the energy systems of Canada to net-zero emissions by the mid-century. Founded with support by three academics in 2019, the Transition Accelerator uses techno-economic, environmental and policy assessment to bring together industry, government and academic stakeholders to deploy pilot, demonstration and commercialization projects to speed the transition. The current focus is on enhancing the emission-free production and use of electricity and hydrogen as energy carriers to replace traditional carbon-based fuels such as gasoline, diesel, jet fuel and natural gas.

<https://www.transitionaccelerator.ca>

Red River College Polytechnic

Red River College Polytechnic (RRC Polytech) is an applied learning and research institute in Winnipeg, Manitoba that mainly works in testing fuel cell and hydrogen powered vehicles. Specifically, RRC Polytech tests the actual ranges on these vehicles based on environmental conditions (temperatures, etc.). Additionally, RRC Polytech tests vehicles in these conditions for fuel cell manufacturers. RRC Polytech tests all large vehicles, including buses, trucks and heavy machinery, in its laboratory.

<https://www.rrc.ca>



CONCLUSION

The Canadian hydrogen and fuel cell sector has experienced tremendous growth between 2016 and 2021, particularly in regard to the revenue and employment metrics reported by survey respondents. Not only has the sector exhibited strong growth, but over 40% of survey respondents indicated they have been in business for over 10 years, suggesting the sector has a stable base of organisations.

In 2021, survey respondents from the Canadian hydrogen and fuel cell sector reported:

- Total revenues of \$527 million
- \$412 million in revenues from product sales
- \$98 million in revenues from the provision of services
- \$17 million in revenues from research and development contracts and other sources
- RD&D expenditures of \$125 million
- Employment of 4,291 FTEs

Canadian Hydrogen and Fuel Cell Association (CHFCA)

The Canadian Hydrogen and Fuel Cell Association (CHFCA) is the national association accelerating Canada's world-recognised hydrogen and fuel cell sector. As the collective voice of the hydrogen and fuel cell industry, the CHFCA raises awareness of the many economic, environmental and social benefits of hydrogen and fuel cells. Its mission is to champion the Canadian hydrogen and fuel cell sector, strengthen its leadership and accelerate the commercialization of members' products and services in Canada and abroad. Its 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 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 stakeholders in Canada's hydrogen and fuel cell sector.

MNP LLP

MNP is one of the leading chartered accountancy and business advisory firm in Canada. Founded in 1958, MNP has grown from a single office in Manitoba to more than 115 offices and 7,000 team members across Canada.

Economic and industry studies are carried out by MNP's Economics and Research practice. The Economics and Research practice consists of a team of professionals that has a successful track record of assisting clients with a wide variety of financial and economic impact studies. Our 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

Information on the state of the Canadian hydrogen and fuel cell industry has been collected for 17 years. As in previous years, existing and potential members of the CHFCA, 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, organisers have refined the questions to gather more detailed information to better reflect the sector and its trends.

All monetary results are presented in Canadian dollars.

A total of 305 organisations associated with hydrogen and fuel cells in Canada were invited to participate in the development of this Sector Profile.

In total, 105 responses were received, representing an overall response rate of 34%. Not all respondents provided information for every category requested. Some investigation was conducted regarding the completeness of the data provided by respondents or reasons for non-provision, but in some cases, clarification was not received.

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

Figures presented for 2019, 2020, and 2021 were collected by an online questionnaire in 2022. Figures for previous years are presented as they were reported in previous Sector Profiles and, therefore, may not be fully comparable due to differing respondents and/or participation rates.

Please note that this report presents only direct impacts of the industry. Indirect and induced impacts (or multiplier impacts) associated with the industry were not part of the study.

Industry highlights throughout the report were prepared based on publicly available information and information provided directly by participating organisations.



2022 PARTICIPANTS

[Advanced BioFuels Canada](#)

[Associated Plastics & Supply Corp](#)

[Atlantic Canada Opportunities Agency \(ACOA\)](#)

[Aurora Hydrogen](#)

[Aurora Scientific Corp.](#)

[AVL Fuel Cell Canada](#)

[Ballard Power Systems](#)

[Borden Ladner Gervais](#)

[Canadian Hydrogen and Fuel Cell Association](#)

[Canadian Nuclear Laboratories](#)

[Canadian Steel Producers Association](#)

[Canadian Urban Transit Research and Innovation Consortium \(CUTRIC\)](#)

[Cariboo Low Carbon Fuels Ltd.](#)

[cellcentric](#)

[Cellula Robotics](#)

[CEM Engineering Ltd.](#)

[Change Energy Services](#)

[CHAR Technologies](#)

[CHARBONE Corp. - HYDROGEN](#)

[Complete Truck Maintenance ltd.](#)

[CORE Energy Recovery Solutions \(dPoint Humidifiers\)](#)

[Ekona Power](#)

[Electricity Canada](#)

[Emcara Gas Development Inc.](#)

[Énergir](#)

[Energy Systems Design Laboratory \(University of Alberta\)](#)

[ETI Energy Corporation](#)

[Evolugen](#)

[Foresight](#)

[FortisBC Energy Inc](#)

[FTXT \(Canada\) Energy Technology Co. Ltd.](#)

[G\\$\\$ Budd Consulting Ltd](#)

[Government of British Columbia](#)

[Groupe Filgo-Sonic](#)

[Hatch](#)

[Hexagon Purus Systems Canada Ltd.](#)

[HTEC Hydrogen Technology & Energy Corporation](#)

[Hydra Energy Canada Corp](#)

[Hydrogen In Motion Inc. \(H2M\)](#)

[Hydrogen Optimized Inc.](#)

[Hydrogenics Corp.](#)

[iHAT Technologies Inc.](#)

[ILF CONSULTANTS INC.](#)

[Illuming Power Inc](#)

[Innovation Science & Economic Development](#)

[Intertek](#)

[Ionomr Innovations Inc](#)

[IRDI System](#)

[Loop Energy Inc.](#)

[Mitsui&Co \(Canada\) Ltd.](#)

[NATION FIRST INVESTMENT CORP](#)



[National Research Council Canada](#)

[New Flyer & MCI](#)

[Next Hydrogen Corp.](#)

[NORAM Engineering & Constructors Ltd](#)

[Ontario Tech University](#)

[Pathway Industries Inc.](#)

[Powertech Labs Inc.](#)

[pyonnier Développement Inc](#)

[Quadrogen Power Systems, Inc.](#)

[Quantum Technology Corp.](#)

[Red River College Polytechnic](#)

[Sacre-Davey Engineering](#)

[Sarnia-Lambton Economic Partnership](#)

[SBI BioEnergy Inc.](#)

[SFC Energy Ltd.](#)

[Simon Fraser University](#)

[SolarGen Energy Inc.](#)

[Solaris Management Consultants](#)

[Southern Alberta Institute of Technology](#)

[SpectrumH2](#)

[Superior Propane](#)

[Terrella Energy Systems](#)

[Terrestrial Energy](#)

[TesTneT Canada Inc.](#)

[Tetra Tech](#)

[The CCS Global Group Inc.](#)

[Thor Hydrogen](#)

[Toyota Canada Inc.](#)

[Transport Canada - Innovation Centre](#)

[Truckenbrodt Clean Energy Consulting](#)

[Unilia \(Canada\) Fuel Cell Inc.](#)

[University of Windsor](#)

[Vancouver Community College](#)

[Viridity Hydrogen Inc.](#)

[Winnipeg Transit](#)

[Wood Plc](#)

[XRG Energytech Solutions](#)

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