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August 31, 2023

Edmonton Global

Alberta's Hydrogen Workforce

Labour Market Study

Acknowledgements

Funding Partners

The Province of Alberta is working in partnership with the Government of Canada to provide employment support programs and services.

Research Partner

Industry Advisory Panel Participants:

- Greg Caldwell, ATCO
- Rob Dombowsky, Alberta Motor Transport Association
- Kirk Hamilton, C-FER Technologies
- Matthew Klippenstein, Canadian Hydrogen Fuel Cell Association
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Executive Summary

R.A Malatest & Associates Ltd. (Malatest) was contracted by Edmonton Global to conduct a hydrogen labour market study in Alberta, the largest hydrogen producer in Canada. Hydrogen production is not a new innovation in itself, having been around for more than 50 years, but it is expected to grow as an industry in the coming years. Typically associated with the oil and gas, electric power, or petrochemical industries, there has not been a provincial labour market study of hydrogen worker supply, demand (current and future), skill requirements and recruitment and retention. Consequently, the purpose of this project is to provide timely and relevant labour market data that will assist in the development of a workforce strategy for the emerging hydrogen industry in Alberta.

Hydrogen sector is in its early stages

In Alberta, companies are active in all areas of the hydrogen value chain. Thus, 50% of companies surveyed were involved in production, 25% were involved in storage or distribution, and 50% supported hydrogen applications. In addition, many were involved in promoting the industry through education (25%) and/or developing hydrogen applications (50%). The large proportion of companies involved in research and development (development of applications) and promotion or education for the sector demonstrate that the sector is in its early development stages.

No current shortage of hydrogen workers in Alberta

There is no current shortage of hydrogen workers in Alberta. Only four companies reported vacancies for more than three months, for a total of seven vacancies. This represents only 2% of the total workforce needed and is lower than the Alberta average vacancy rate of 4.3%. Interviewees noted also that they did not anticipate a shortage of hydrogen workers in isolation, as workers will be drawn from other workforces. It is anticipated that the need for hydrogen workers will grow incrementally as the number of hydrogen projects increases.

Hydrogen careers remain uncertain

While the number of hydrogen projects are increasing in the province, stakeholders were unclear about the long-term employment prospects in the sector. More specifically, stakeholders noted that the labour force required to design, build, and maintain hydrogen projects will differ and thus job opportunities will be dictated by the stage and complexity of the hydrogen projects.

There would be a natural shift of workers from oil and gas to hydrogen

Given that similar skill sets are required in both sectors, there would be a natural shift of workers from oil and gas to hydrogen. Employers and industry representatives interviewed all

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agreed that the skills obtained in technical programs laid sufficient groundwork for individuals to eventually up-skill such as engineers and technologists, to prepare them to work with hydrogen.

Professional training and educational programs are the most important strategy that would support the development of a hydrogen workforce

Respondents prioritized the provision of professional training and educational programs as the most important strategy that would support the development of a hydrogen workforce because currently such programming is not available. Currently there are no trade, diploma, or degree programs specific to hydrogen in Alberta. Instead, there are a variety of courses either for credit or not, available online or in-person, exploring such topics as alternative and innovative energy, hydrogen energy technology, energy management, environmental engineering, and electrolysis

Certification of hydrogen workers was thought to be a critical element in achieving and maintaining safety in the hydrogen sector

There is a need to train staff on the unique properties of hydrogen, with an emphasis on its specific safety requirements. Similar to gasoline and natural gas, hydrogen is flammable and can be hazardous under certain conditions. Safety training must be provided to ensure the safety of hydrogen workers, the public, and the environment.

A fourfold increase in the number of employees is expected by 2027

Employers expect to see a robust growth in the size of their workforces over the next five years.

Nearly a quarter of the employers said they expected their workforce to double over the next five years, while 23% noted that they expected growth of at least 25% over the same five-year period, but overall the total anticipated workforce in 2027 is four times the size of the current workforce.

Recommendation No.1

Academic institutions and the industry must maintain a close and dynamic relationship with the stated goal of developing hydrogen training so that academic institutions are aware of the skills that employers will need in the medium or long term and nimble enough to respond when training needs arise. Promotion of hydrogen workshops in these areas would support uptake; as would encouraging employers to make use of training tax credits to up-skill their engineers and specialists. The Future Skills Centre could help validate effective training approaches and expand/develop customized short-term training to meet workplace needs.

Recommendation No.2

Certification of hydrogen workers must be designed and implemented consistently across the province, if not the country, and should be based on codes and standards that are consistent at all levels of government in consultation with industry and experts, to allow worker mobility and to achieve and maintain safety in the hydrogen sector. A model to follow could be H2S Alive®, an eight-hour course developed and certified by Energy Safety Canada designed to increase awareness of the hazards of working in a hydrogen sulfide environment.

Recommendation No.3

A relationship of trust needs to be established between employers and employees in the hydrogen industry. It may be necessary for the hydrogen sector to establish clear human resource strategies that align industry goals with the supply of hydrogen workers to ensure that hydrogen is promoted as a viable career option.

Next Step

It is anticipated that hydrogen workers will come from existing sectors, mostly from the oil and gas sector as the skill sets are similar (Section 4.4). It would therefore be relevant to better understand the current skill sets of oil and gas workers in Alberta to assess their readiness to take the next steps in the transition to a net zero economy, as well as understand the appetite for reskilling among this workforce.

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1.0 Introduction

1.1 Background

As a result of the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change in the fall of 2021, more countries announced targets to achieve net-zero greenhouse gases (GHG) emissions over the next decade.[1] Canada has joined over 120 countries in committing to have net-zero emissions by 2050.[2] Viewed as a pillar of decarbonizing the global energy system, hydrogen and hydrogen-based fuel systems have the potential to play a strong part in Alberta's emissions reduction strategy and future energy system.

Global hydrogen demand increased to 94 million metric tons in 2021, a 5% increase from the previous year, representing about 2.5% of global final energy consumption.[3] The emerging hydrogen industry will influence both the supply and demand sides of Alberta's future energy economy; however, hydrogen is costly and requires investment. Investment requires alliances of companies and the government to support the development and implementation of national hydrogen strategies.

In 2021, the Edmonton Region Hydrogen HUB was launched and included an alliance between government, Indigenous groups, academic and economic development leaders. Its aim is to kickstart the Edmonton region's low-carbon hydrogen economy.[4] The number of new hydrogen-related projects are multiplying quickly in Alberta and can be found in areas such as: transportation innovation (heavy-duty trucks and public transit), hydrogen refueling stations, a fully hydrogen-powered community, and a hydrogen energy complex. The current labour market

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[1] United Nations. *Climate Change – COP26 : Together for our planet*. www.un.org/en/climatechange/cop26.

[2] Government of Canada. *Net-Zero Emissions by 2050*. www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050.html

[3] International Energy Agency. (2022). *Global Hydrogen Review 2022*.

[4] Transition Accelerator. (2021). *Canada's first hydrogen HUB launches in the Edmonton Region backed by over $2 million in funding from three levels of government*. www.transitionaccelerator.ca/news-release-canadas-first-hydrogen-hub-launches-in-the-edmonton-region-backed-by-over-2-million-in-funding-from-three-levels-of-government/.

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is under pressure in multiple related industries which experts anticipate will need to be drawn upon to provide the knowledge and skills required to advance Alberta's hydrogen sector, which brings up the question: will the current Alberta labour market be able to keep up with the demands of the hydrogen sector as it emerges and grows?

1.2 Research Objectives

The purpose of this project is to produce timely and relevant labour market data that will help inform the development of a workforce strategy for the emerging hydrogen industry in Alberta. This study aims to provide an actionable roadmap for industry workforce development and growth, in order to address gaps, leverage opportunities, and support the effective transition into the new hydrogen economy.

The questions underpinning this project are listed in Figure 1.1.

Figure 1.1 Key Research Questions – Alberta's Hydrogen Labour Market Sector

Current Workforce Trend	• What is the size and composition of the workforce? • Are there shortages of hydrogen workers?
Recruitment & Retention	• What challenges does the hydrogen sector experience in finding and retaining workers?
Skills, Training & Education Requirements	• How do hydrogen workers get the skills required to transition into the sector?
Perception of Future Labour demand	• How many workers will be required to meet labour demand?

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2.0 Methodology

A mixed-methods research approach was used to collect data for this workforce study. Information was gathered from a document and literature review, an employer survey, and key informant interviews with industry stakeholders. A combination of quantitative and qualitative data from multiple sources was adopted in order to support more comprehensive and robust findings. This section presents a detailed discussion of each of these data sources.

2.1 Document and Literature Review

A review was conducted of documents provided by Edmonton Global. These documents provided context for activities taking place in the emerging sector in the province and helped shape the research design for the study. In addition, a literature review was conducted to gather information on the hydrogen industry from other sources and jurisdictions such as Australia, United Kingdom, and the United States, using publicly available search tools (e.g., Google), government websites, and other stakeholder websites (e.g., Transition Accelerator, Edmonton Region Hydrogen HUB). In addition to the documents reviewed, researchers attended two webinars on the challenges and opportunities facing the current hydrogen economy in North America. See Appendix A for a complete list of references for the documents accessed.

Additionally, a scan of programs and courses related to the hydrogen sector offered by Alberta's post-secondary institutions was conducted to better understand education and training availability. This is discussed in Section 4.4.

2.2 Employer Survey

An employer survey was administered with companies working on or planning to work on hydrogen related projects in Alberta. The questionnaire was designed to collect information to draw an overall portrait of the companies who participated in the study and to answer the key research questions:

- General profile of the companies
- Current hydrogen workforce
- Recruitment and retention issues
- Skills, training, and education requirements
- Future workforce expectations

Findings from the document review on the labour market impacts of the energy transition and from the scoping interviews were used in the development of the employer questionnaire. A total of six scoping interviews were conducted between September 15 and October 4, 2022, with stakeholders involved in major hydrogen projects in Alberta. Scoping interviews provided

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information about the occupational focus in the hydrogen workforce, issues impacting the sector and the "coopetition"[5] with the oil and gas industry.

The finalized questionnaire was programmed in Voxco for employers to complete online. The survey was tested and provided to Edmonton Global for review prior to being launched. The survey was launched online on December 5, 2022, and was available until May 12, 2023. Initially, employers were recruited from a list of companies provided by Edmonton Global that were thought to be involved or potentially involved in hydrogen projects in Alberta. Contacts within each employer were sent email invitations to complete the survey. Up to six email reminders were sent during the data collection period to encourage participation. Given the low response rate, the sample of employers was expanded to include Canadian and international companies who were attendees at the Canadian Hydrogen Convention 2022. Additionally, a social campaign aimed at recruiting employers involved in hydrogen work in Alberta was launched on March 20, 2023, to promote the survey. In-person recruitment was also conducted at the Canadian Hydrogen Convention in Edmonton on April 25, 2023. Thirty-two companies involved in hydrogen projects or in the hydrogen industry in Alberta ultimately completed the survey.

2.3 Key Informant Interviews

Key informant interviews were conducted with different stakeholders within the Alberta hydrogen industry. Three interview guides were developed to help facilitate the discussion: an employer guide, educational institutions guide, and a labour and industry representatives guide. In the employer guide, participants were asked about similar topics to those in the employer questionnaire:

- Challenges and opportunities in the hydrogen sector
- Current conditions of the labour force in Alberta
- Recruitment and retention issues
- Skills, training and education requirements for a hydrogen worker
- Future hires

[5] "Coopetition" is a neologism derived from the combination of "cooperation" and "competition"; it denotes hybrid behavior that includes competition and cooperation between decision makers (players). This behavior refers to the collaborative efforts of competitors with the aim of achieving mutually beneficial results. (Hafezalkotob, 2017)

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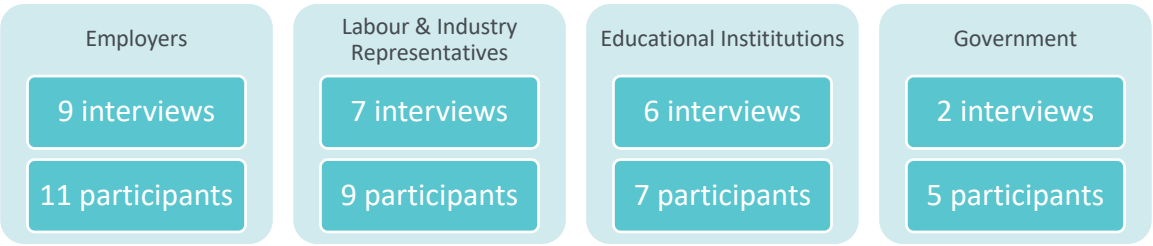
The education interview guide focused more on the perceptions/misconceptions of a career in hydrogen or in the energy sector in general, and educational programs and support available to the industry. The labour and industry representatives guide focused on labour supply and partnerships in Alberta designed to promote and grow the hydrogen sector. All guides were submitted to Edmonton Global for review and approval prior to being used.

Edmonton Global provided a list of key stakeholders to invite for the interviews. Individuals were contacted through email and telephone follow-up to encourage their participation. In addition, in-person recruitment was conducted at the Canadian Hydrogen Convention in Edmonton on April 25, 2023. Interviews took approximately 60 minutes and were conducted virtually through Microsoft Teams. A total of 24 interviews were completed with 32 participants.



2.4 Data Analysis

Upon completion of survey administration, all data were cleaned to ensure logical consistency of responses and to identify data entry errors, response errors, inconsistent or illogical information and outliers. No outliers were identified during the cleaning of the survey data. For all "other, please specify" response options included in the survey, a review of written responses was conducted to develop a coding list. Using the coding list, written responses were up-coded (aggregated) to existing response options where appropriate. Idiosyncratic and/or un-codable responses were left in the "other" category. Open-ended questions were also reviewed, coded and used in the analysis as appropriate. Survey data were analyzed using descriptive statistics. Frequencies and crosstabs were used to summarize responses across all participants.

Thematic analysis was used to analyze the open-ended responses collected through the key informant interview using Nvivo10, a qualitative data analysis software. This inductive approach used six phases according to Braun and Clarke (2006).[6]

[6] Braun, Virginia and Victoria Clarke (2006). *Using thematic analysis in psychology*, Qualitative Research In Psychology, Vol.3 (2).

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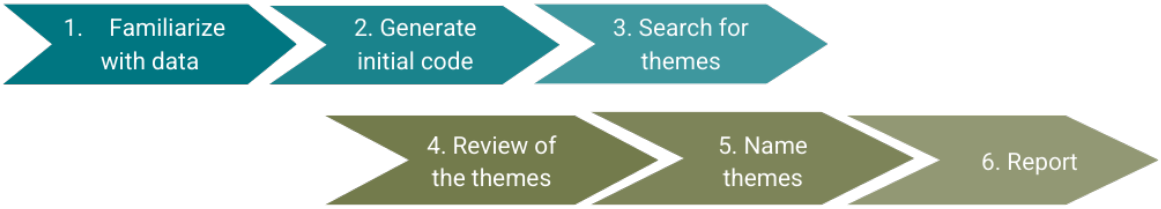

This approach allowed themes and categories to emerge directly from participants' raw responses through examination and comparison, ensuring that the findings were not biased to fit a pre-determined framework based on expectations of what the research would find, while also developing enough structure to allow for the clear reporting of the qualitative results by major themes.

2.5 Research Limitations

While this project used a rigorous mixed methods approach and collected data from a large variety of stakeholders to ensure a robust and comprehensive analysis, there are limitations that could affect the conclusions. Individuals should be aware of these limitations when considering the report's findings. It should also be noted that the results reported in the study reflect the views and opinions of the employers who responded to the survey.

The hydrogen industry is not yet defined by existing labour market data collected by Statistics Canada. There is no North American Industry Classification System (NAICS) for this specific sector and there is no National Occupational Classification (NOC) for hydrogen workers. Hydrogen production is not a new innovation in itself, having existed for more than 50 years, but is usually associated with the oil and gas, electric power, or petrochemical industries.

Challenges in reaching and encouraging employers to participate in the study may have affected the data available. There are an increasing number of hydrogen projects being developed in Alberta, some of which are major, but all of them are still in the early stages, and the sample pool was challenging to define especially for small and medium-sized companies. In addition, it is possible that confidentiality and competition for innovation in the sector may have discouraged survey participation.

Employers were encouraged to consult various staff within their company to obtain the information requested in the survey, however we cannot guarantee that the respondents have consulted the "right" staff for each question, as sometimes only a small portion of the company's work involved hydrogen projects or activities.

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3.0 Overview of Alberta's Hydrogen Labour Market Sector

3.1 Hydrogen in Alberta

Hydrogen production presents a significant opportunity for Alberta's economy and energy diversification. The demand for hydrogen is projected to increase tenfold over the next thirty years.[7] As the largest hydrogen producer in Canada, Alberta is well positioned to expand into and lead the development of the hydrogen sector. In 2022, the Alberta's hydrogen production was estimated at 2.5 million tonnes and the forecast for 2032 could be around 3.5 million tonnes taking into account projects commissioned to date and estimated future production capacity[8]. Building upon existing natural gas production, infrastructure, and workforces the government of Alberta has developed blueprints to move the hydrogen sector forward.

The Emissions Reduction and Energy Development Plan goal of a net-zero economy by 2050 set the stage for energy diversification and promoted the necessary conditions for innovation in the hydrogen industry. The focus on carbon capture, utilization, and storage (CCUS) to safely capture the greenhouse gas carbon dioxide (CO_2) produced through natural gas production provides Alberta with the opportunity to use it in hydrogen production[9]. Building on the production of hydrogen for domestic industrial processes, Alberta's Natural Gas Vision and Strategy pledged to support the development of the hydrogen economy through short, medium and long-term actions[10]. In the short term, the province committed to ensuring that Alberta's interests were represented in Canada's hydrogen strategy, *The Hydrogen Strategy for Canada: Seizing the Opportunities for Hydrogen*, produced in 2020. Medium term, the strategy committed to developing a roadmap for hydrogen in the province, as well as supporting hydrogen projects though policy, legislation, or standards, examining hydrogen inclusion in the Liquefied Natural Gas (LNG) value chain, and working with industry to advance pilot projects including accelerating joint provincial, federal, and private funding. Long term, the Alberta government committed to working with industry leaders and other governments to support infrastructure

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[7] Government of Canada. (2020). *Hydrogen Strategy for Canada: Seizing the Opportunities for Hydrogen.*

[8] Alberta Energy Regulator. (2022). *Emerging Resources – Hydrogen.*

www.aer.ca/providing-information/data-and-reports/statistical-reports/st98/emerging-resources/hydrogen.

[9] *Ibid.*

[10] Government of Alberta. (2020). *Natural Gas Vision and Strategy: Getting Alberta Back to Work.*

build-out, hydrogen transportation, commercial deployment, and hydrogen transmission across Canada.

Arising out of the Strategy, Alberta's Hydrogen Roadmap articulated the province's vision for hydrogen by 2030 and included the actions needed to ensure implementation of each of the seven policy pillars:[11]

- Build new market demand: establishing hydrogen demand.
- Enable CCUS: ensuring CCUS infrastructure is widely available.
- De-risk investment: supporting long-term investment certainty and funding.
- Activate technology and innovation: enabling demonstration projects and research needed to prove and scale up clean hydrogen technologies along with ensuring training is available through universities and technical post-secondary institutions.
- Ensure regulatory efficiency, codes, and standards to drive safety: enshrining hydrogen safety in codes and standards.
- Lead the way and build alliances: coordinating public-private partnerships and government-to-government relationships including with Indigenous governments.
- Pursue hydrogen export: establish market access and close intra-Alberta and hydrogen export gaps in supply chain logistics.

Further, recognizing the importance of hydrogen in Alberta's economy, the province has provided funding to spur innovation and support a competitive business landscape.

Emission Reductions Alberta[12] provides funding to develop and demonstrate greenhouse gas-reducing technologies while Alberta Innovates funds research and innovation, including research infrastructure and talent supply, as well as promotes industry growth.[13] Housed within Alberta Innovates is the Hydrogen Centre of Excellence (HCOE), which contains two subsidiaries, InnoTech Alberta and C-FER Technologies. Collectively the centre funds projects, provides a testing and service facility, and facilitates partnerships to reduce the risk associated

[11] Government of Alberta. (2021). *Alberta Hydrogen Roadmap – Executive Summary*.

[12] Emissions Reduction Alberta. *About ERA*. www.eralberta.ca/about-era/.

[13] Alberta Innovates. *Fundings & Grants*. www.albertainnovates.ca/what-we-offer/funding-grants/.

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with hydrogen technology development.[14] Between the two funding agencies, a total of $92 million in funding was provided to 35 hydrogen projects in Alberta, with the HCOE awarding $20 million of this funding for 18 of those projects.

Other funding is also available through the Alberta Petrochemicals Incentive Program which provides capital investment in the form of grants of up to 12% for hydrogen production projects, and smaller funding opportunities available through Alberta municipalities.[15] [16] Alberta policy, infrastructure, and funding opportunities designed to support hydrogen project development have resulted in significant private sector investment as well. Such projects have included innovations in transportation, hydrogen refueling stations, and development of a hydrogen energy complex.[17]

The opportunities in hydrogen in Alberta have also spurred on the development of several partnerships aimed at furthering the industry. One such partnership, the Edmonton Region Hydrogen HUB, brings together hydrogen producers with transportation, storage, and end-use projects.[18] Hubs are also being contemplated in other regions of the province. Two reports have been produced by the Transition Accelerator, working with groups such as the Southeast Alberta Hydrogen Task Force to envision transition pathways for a net zero future, discuss the feasibility of creating a geographic hydrogen hub centred in Southeast Alberta and the Calgary

[14] Alberta Innovates. *Hydrogen Centre of Excellence.* www.albertainnovates.ca/programs/hydrogen-centre-of-excellence/.

[15] Government of Alberta. *Alberta Petrochemicals Incentive Program.* www.alberta.ca/alberta-petrochemicals-incentive-program.aspx.

[16] Morrison Luke, and al.(2023). *Keys Takeaways from the 2023 Canadian Hydrogen Convention: Part 1.* Bennett Jones. www.bennettjones.com/Blogs-Section/Key-Takeaways-from-the-2023-Canadian-Hydrogen-Convention-Part-1.

[17] Government of Alberta. *Hydrogen economic opportunities.* www.alberta.ca/economic-opportunities.aspx.

[18] Edmonton Region Hydrogen Hub. www.erh2.ca.

region: *Towards Hydrogen: A Hydrogen HUB Feasibility Study for Southeast Alberta*[19] and *Toward a Fuel Hydrogen Economy in the Calgary Region: A Feasibility Study*.[20]

3.1.1 Hydrogen Projects

A project currently underway in Alberta is Air Products' hydrogen facility, which will connect to the existing pipeline network, deliver net-zero emissions[21], and eventually include a multimodal hydrogen fueling station nearby.[22] Other projects in the planning and Final Investment Decision (FID) phases in Alberta include:

- Dow's integrated ethylene cracker: the world's first net-zero carbon emissions integrated ethylene cracker and derivatives facility would be in Fort Saskatchewan, Alberta. The process will convert cracker off-gas into hydrogen as a clean fuel for use in the production process and capture carbon dioxide on site for transport and storage by adjacent third-party CO_2 infrastructure. Dow selected the Fort Saskatchewan site for this investment because of the region's highly competitive energy and feedstock position.[23] Dow selected Linde as its clean hydrogen and nitrogen partner for this project.[24]

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[19] Transition Accelerator. (2022). *Towards Hydrogen: A Hydrogen Hub Feasibility Study for Southeast Alberta,* Vol. 4 (3).

[20] Transition Accelerator. (2023). *Towards a Fuel Hydrogen Economy in the Calgary Region: A Feasibility Study,* Vol. 5 (1).

[21] Air Products. *Canada Net-zero Hydrogen Energy Complex*. www.airproducts.com/campaigns/alberta-net-zero-hydrogen-complex.

[22] Air Products. *Air Products Announces Plan to Build the First Commercial-Scale Hydrogen Refueling Station in Edmonton,* Alberta, Canada. www.airproducts.com/company/news-center/2023/04/0425-air-products-plan-to-build-first-commercial-scale-hydrogen-refueling-station-in-edmonton.

[23] Dow. (2021). *Dow announces plan to build world's first net-zero carbon emissions ethylene and derivatives complex.* www.investors.dow.com/en/news/news-details/2021/Dow-announces-plan-to-build-worlds-first-net-zero-carbon-emissions-ethylene-and-derivatives-complex/default.aspx.

[24] Dow. (2023). *Dow selects Linde as clean hydrogen and nitrogen partner for its proposed net-zero carbon emissions ethylene and derivatives complex in Canada.* www.corporate.dow.com/en-us/news/press-releases/dow-selects-linde-as-clean-hydrogen-and-nitrogen-partner-for-its.html.

- A partnership between ATCO and Suncor proposes to produce more than 300,000 metric tons per year of clean hydrogen using advanced technology, resulting in the capture of more than 90% of the emissions generated in the hydrogen production process, thereby reducing Alberta's CO_2 emissions by more than two million metric tons per year.[25]
- In partnership with Kansai, ATCO announced a project to produce hydrogen through autothermal reforming with carbon capture and sequestration to develop low-carbon-intensity hydrogen or derivatives that would be transported to Canada's west coast before being shipped overseas to Japan.[26]
- Shell has proposed a large-scale carbon capture and storage facility at Scotford. In its initial phase, the project would capture and store approximately 750,000 tonnes a year of CO_2 from the Scotford refinery and chemicals plant and produce hydrogen in the refining process. It would reduce Shell's direct and indirect emissions by up to 40% from the refinery and by up to 30% from the chemicals plant. It would also create up to 2,000 jobs. Future phases would eventually produce hydrogen on a large scale.[27]

Given the significant interest in and activities aimed at promoting the hydrogen industry in Alberta, Edmonton Global commissioned this study to understand the current and projected future labour force needs to support the establishment and growth of Alberta's hydrogen sector.

Section 3.2 discusses what has been done to date in other jurisdictions to support the hydrogen workforce. Sections 3.3 and 3.4 provide a profile of the companies that completed the employer survey. These employers were working in Alberta's hydrogen sector at the time of the study.

Section 4 discusses the economic and environmental influences impacting the hydrogen sector in Alberta, reports on current workforce trends, recruitment and retention strategies, training/education requirements for hydrogen workers, and examines future workforce needs in the hydrogen sector.

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[25] ATCO. (2021). *Suncor and ATCO partner on a potential world-scale clean hydrogen project in Alberta.* www.atco.com/en-ca/about-us/news/2021/122920-suncor-and-atco-partner-on-a-potential-world-scale-clean-hydroge.html.

[26] ATCO. (2023). *ATCO and Kansai pursue export of clean fuels from Canada to Japan.* www.atco.com/en-ca/about-us/news/2023/122982-atco-and-kansai-pursue-export-of-clean-fuels-from-canada-to-japa.html.

[27] Shell. (2021). *Shell proposes large-scale CCS facility in Alberta*. www.shell.ca/en_ca/media/news-and-media-releases/news-releases-2021/shell-proposes-large-scale-ccs-facility-in-alberta.html.

3.2 Hydrogen Workforce Development in Other Jurisdictions

United Kingdom

To help the country's energy sector meet its emissions target and support transition to a net-zero economy by 2050, United Kingdom Energy and Utility Skills produced a Hydrogen Competency Framework Report in 2021. Additionally, National Grid conducted a labour market study to better understand the labour force required to support the net zero energy sector. The UK energy sector expects to need 400,000 workers by 2050. Three strategies were identified to meet these workforce needs. The first involves retaining and retraining existing employees currently working in the energy sector. The second focuses on reframing or repositioning jobs in the energy sector as belonging to the Net Zero Energy Workforce to encourage new entrants; while the third strategy emphasizes the need to inspire the next generation of workers to obtain the necessary STEM qualifications to enter the Net Zero Energy Workforce.[28] As part of workforce development, the strategy also recognizes the need to develop skills matrices specific to net-zero jobs along with training specifications for hydrogen workers.[29]

United States

In the United States, a study published in the Journal of Renewable Energy and Environmental Sustainability found that the hydrogen and fuel cell industries requires various types of occupations, experience, and skills. These occupations require associate degrees, on-the-job training, or trade certifications. Jobs include scientists, engineers, chemists, managers, and technicians, all of which pay higher wages than the U.S. average.

The hydrogen and fuel cell industry is felt to be an ideal sector for job creation in most states, due to the diversity of skills it requires, at all levels of education.[30] However, a key challenge to the development of the necessary workforce is the degree to which training institutions and industry are collaborating to develop the necessary skills. Currently, employers are typically weakly involved in the development of training programs, which can result in a mismatch between the skills obtained from training at post-secondary institutions and the skills required by employers. Additionally, the processes that oversee and manage the development and

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[28] National Grid. (2020). *Building the Net Zero Energy Workforce.*

[29] Energy & Utility Skills. (2021). *Hydrogen Competency Framework Report.*

[30] Bezdek, Roger H. (2019). *The hydrogen economy and jobs of the future.* Renewable Energy Environmental and Sustainability, Vol. 4 (1).

certification of new training programs may be part of the challenge in scaling up successful training programs.[31]

Australia

In Australia, a recent study published in the International Journal of Hydrogen Energy points to the urgent need to augment the current training system to meet the skill needs of the hydrogen sector.

Their findings revealed that industry stakeholders believe there is insufficient training opportunities and limited expertise available to support the hydrogen sector in its current phase of growth, or to facilitate the (re)skilling of the workforce to the degree required to realise the promise of the hydrogen economy. There is a risk that Australia will miss the opportunity to implement hydrogen energy at scale because of a lack of skills and expertise.[32] Nonetheless, the Australian Department of Employment and Workplace Relations published a report on developing Australia's hydrogen workforce which included a capability matrix that articulates the hydrogen-specific skills and knowledge needed for the jobs to support the hydrogen economy.[33] That assessment divided jobs related to hydrogen into six occupational clusters: engineers, technicians and tradespersons, safety and quality control, specialists, management, and logistics.

Twenty-six hydrogen-specific capabilities were identified as requirements for jobs that would support the hydrogen economy. The Australian Department of Employment and Workplace Relations regrouped the hydrogen-specific capabilities into five categories:

- Hydrogen's fundamental properties and its material reactions;
- Hydrogen safety and regulation;
- Hydrogen production and storage techniques;
- Integrating assemblies or components into a larger system; and

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[31] Hanson, Gordon H. (2023), *Local Labor Market Impacts of the Energy Transition: Prospects and Policies*, Harvard Kennedy School.

[32] Beasy, Kim, *and al.* (2023). *Skilling the green hydrogen economy: A case study from Australia*, International Journal of Hydrogen Energy, Vol. 48 (52).

[33] Department of Employment and Workplace Relations. (2022). *Developing Australia's hydrogen workforce,* PwC Consulting, Australia.

- Understanding factors influencing hydrogen market architecture.

Hydrogen-related occupational clusters were analyzed to see whether new skills and knowledge would be expected of the role, and whether the responsibilities and day-to-day tasks of the job role would change. They were then rated on a scale of insignificant, low, moderate, high to significant augmentation. Based on the results, engineers are expected to be particularly well prepared for the transition to the hydrogen workforce, as are specialists and safety and quality control personnel. However, management will require up-skilling on the technical aspects of hydrogen and logistics, will need to develop knowledge of hazard identification and handling safety, and gain an understanding of the use of hydrogen fuel cell technology. The most significant change in job roles will occur for automotive mechanical and electrical technicians who will need to adapt their respective systems to the complexity of the hydrogen fuel cell.

There is not yet a provincial study of the hydrogen workforce in other Canadian provinces or territories; however, in 2022, the Transition Accelerator published a national report which examines the workforce requirements needed to advance the hydrogen economy at a national level: Assessing the Workforce Required to Advance Canada's Hydrogen Economy.[34] This living document which will evolve with the development of Canada's hydrogen economy, also addresses the requirements of the hydrogen workforce, but with the core occupations for different chain levels:

- low carbon production;
- storage, upgrading and transporting;
- expanding existing and creating new markets for low-carbon hydrogen;
- manufacturing for the hydrogen economy; and
- roles common across the value chains.

Similar to the Australian assessment, matrices of core occupations and their typical qualifications, key activities, unique requirements for hydrogen, potential talent, and risk and/or opportunity were developed.

[34] Transition Accelerator. (2022). *Assessing the Workforce Required to Advance Canada's Hydrogen Economy,* Vol. 4 (7).

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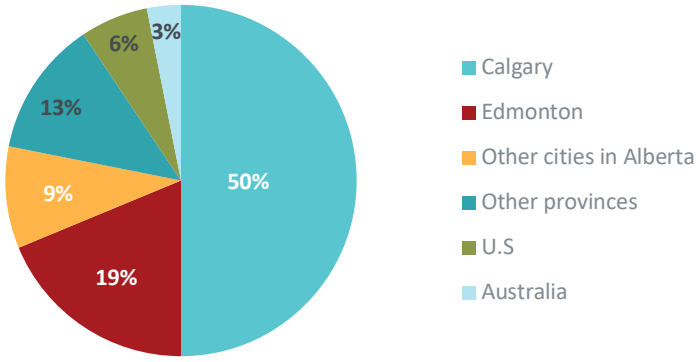
3.3 Employer Survey Participant Profile

A total of 32 companies completed the employer survey. As shown in Figure 3.1, companies that are currently working on hydrogen projects in Alberta are headquartered throughout Alberta, other Canadian provinces, the U.S and Australia. About a quarter of the companies surveyed had headquarters located outside of Alberta, suggesting that there is significant external investment in Alberta's economy.

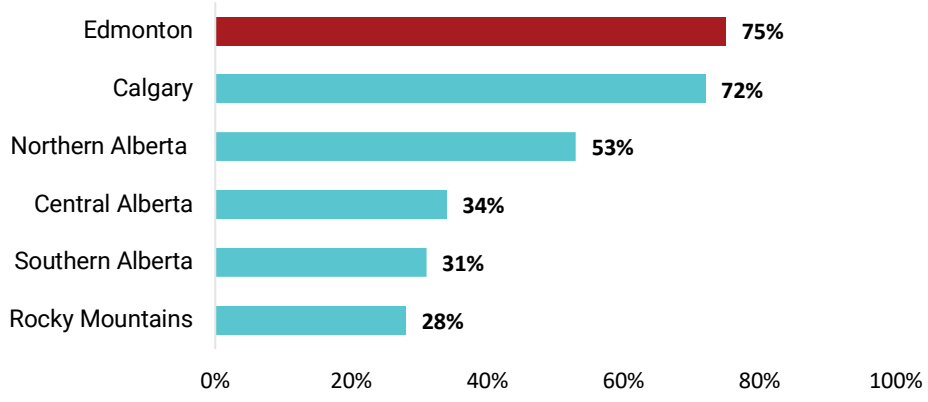
Figure 3.1 Head Office Location



Source: EG Employer Survey – A1a, A1b.

Companies involved in Alberta hydrogen projects operated in both Alberta (Figure 3.2) and outside of the province (Figure 3.3). When operating in Alberta, operations primarily occurred in the Edmonton region (75%) or Calgary region (72%), although companies operated throughout the province (see Figure 3.2).

Figure 3.2 Location of Operations in Alberta



Source: EG Employer Survey – A2.

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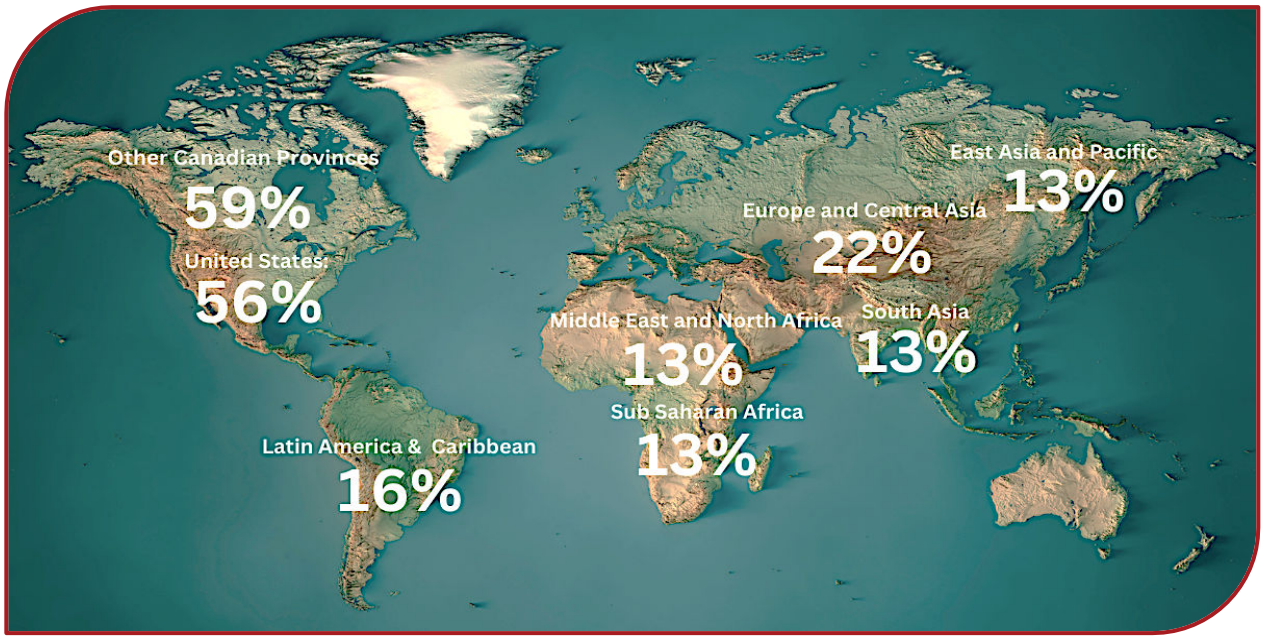
Note: For geographic location(s), responses sum to more than 100% due to multiple responses (i.e. respondents might have multiple locations).

Example of cities included in the area:

- Northern Alberta (Fort McMurray, Grande Prairie, Peace River)
- Central Alberta (Red Deer, Sylvan Lake, Lac La Biche)
- Southern Alberta (Medicine Hat, Lethbridge, High River)
- Rocky Mountains (Jasper, Banff, Canmore, Lake Louise)

On a broader geographic scale, several of these companies operated in other Canadian provinces (59%), in the United States (56%) and throughout the world (Figure 3.3).

Figure 3.3 Global Business Operations



Source: EG Employer Survey – A4.

Note: For geographic location(s), responses sum to more than 100% due to multiple responses (i.e. respondents might have multiple locations).

Companies of diverse sizes are currently active in the hydrogen sector. Companies' gross revenue ranged from less than $10 million (46%) to more than $100 million (39%) (Figure 3.4).

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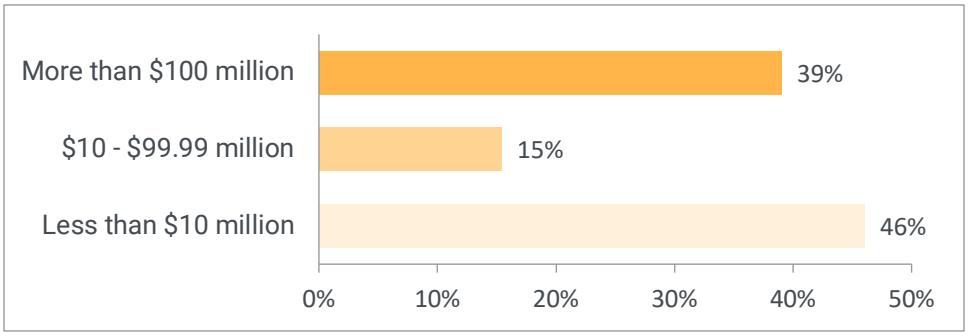
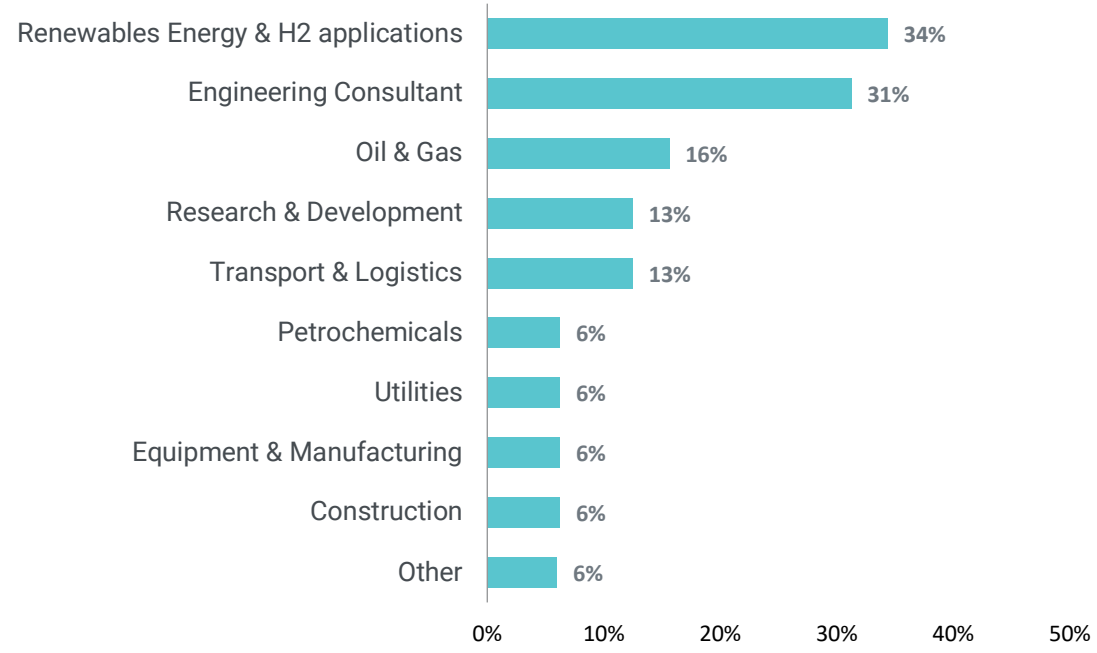
Figure 3.4 Companies Gross Revenue 2022



Source: EG Employer Survey – A5.

Figure 3.5 shows the main business activity areas of the companies surveyed. Many of the companies were involved in the energy sector although not exclusively in renewable energy or hydrogen applications. Thus, 66% of the companies participated in the energy sector whether it was renewable energy and hydrogen applications (34%), oil and gas (16%), petrochemicals (6%), or utilities (6%). Reflecting the early development stage of the hydrogen sector in Alberta, many companies were involved in engineering consulting (31%) or research and development (13%).

Figure 3.5 Business Areas



Source: EG Employer Survey – A6.

Note: Responses sum to more than 100% due to multiple responses (i.e. respondents might have multiple business activities).

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3.4 Hydrogen Business Area

In terms of examining hydrogen-related revenues, it appears that for the most part, hydrogen related activities represent only a portion of activities of most firms surveyed, as only 16% indicated that their revenues were exclusively related to hydrogen activities. For example, among companies with hydrogen projects currently underway or being explored or planned:

- → 16% derived all corporate revenue from hydrogen-related work;
- → 12% generated half or more of their corporate revenue from hydrogen activities;
- → 6% of the companies had a quarter of their revenue from hydrogen work;
- → 38% generated only one to 10% of the corporate revenue from hydrogen work; and
- → 28% of the companies were in the early planning stage and did not have revenues from hydrogen work.

Overall, 66% of the companies derived 10% or less of the corporate revenue from work in the hydrogen sector. Companies working primarily in the hydrogen space tended to have smaller operating revenues.

- → Nine out of 10 of the companies surveyed with a gross business revenue of more than $100 million derived 5% or less of their revenue from hydrogen-related work.
- → Half of the companies with a business revenue of less than $1 million generated 50% or more of their revenue through work in the hydrogen sector.

In Alberta, companies operate in every area of the hydrogen value chain (Figure 3.6). Thus, 50% were involved in production, 25% were involved in storage or distribution, and 50% supported hydrogen applications such as oil refining, bitumen upgrading and chemical or fertilizer production. In addition, many were involved in promoting the industry through education (25%) and/or the development of hydrogen applications such as fuel cells to generate electricity, power and heat (50%). The large proportion of companies involved in research and development (development of applications) and promotion or education for the sector demonstrate that the sector is in its early stages.

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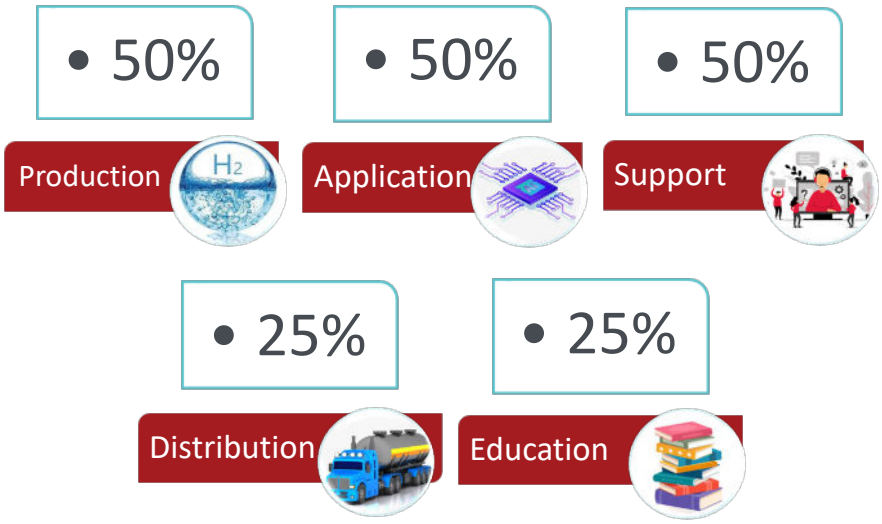
Figure 3.6 Hydrogen Value Chain in Alberta



Source: EG Employer Survey – A8a.

Note: Responses sum to more than 100% due to multiple responses (i.e. respondents might have multiple business hydrogen areas).

Alberta companies are involved in various processes to produce low carbon intensity hydrogen (Figure 3.7), with carbon capture most common (44%), followed by steam methane reforming and autothermal reforming (38%) as well as electrolysis (34%). Companies are developing methods for distribution (pipelines 38%, ammonia 19%, and truck 16%) and storage (6%) of hydrogen. Significant work is also currently underway to support hydrogen consumption, including heat and power generation (34%), transportation using hydrogen (31%), and the development of hydrogen fueling stations (31%).

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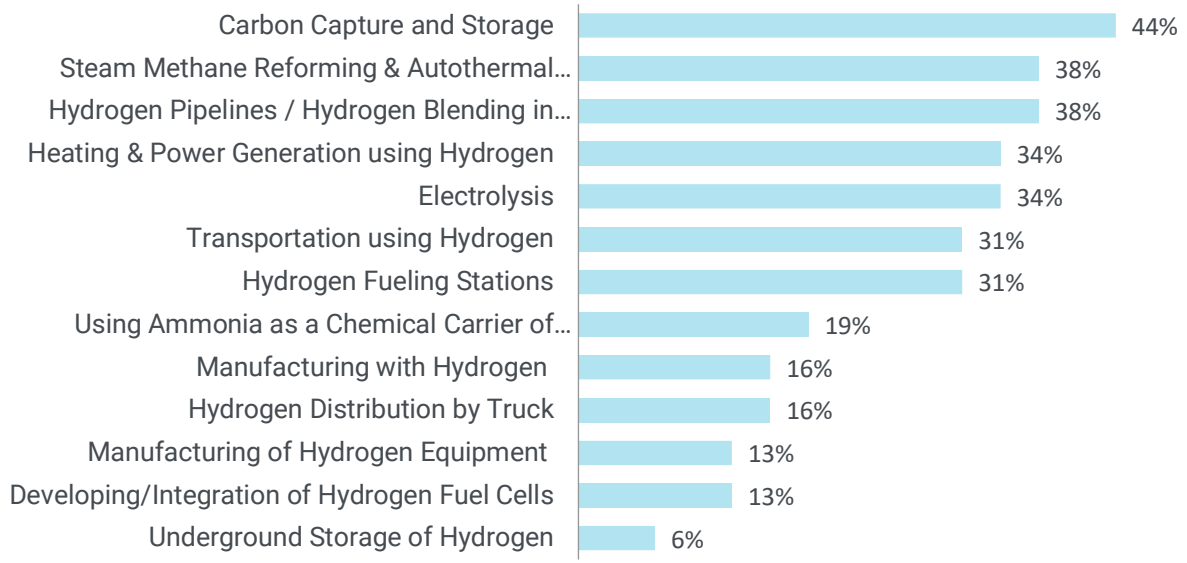
Figure 3.7 Hydrogen Related Processes



Source: EG Employer Survey – A8b.

Note: Responses sum to more than 100% due to multiple responses (i.e. respondents might have multiple business hydrogen processes).

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4.0 Findings

This study was designed to gather information on the current and projected workforce needs for hydrogen project development and implementation to ensure that the necessary workforce is available and ready to support the hydrogen sector when opportunities arise. Section 4 provides a discussion of employment in the sector and estimates of the number of workers that will be needed over the next five years to fill vacancies and replace workers leaving the industry due to the instability in the energy sector[35] or for retirement.

4.1 Economic and Environmental Influences

In 2021, total hydrogen production in Alberta increased by 4% from 2020 levels. Forecasted production for 2024 is 3.11 million tonnes per annum, an increase of 30% from 2020, mostly attributable to production using natural gas resulting in low carbon intensity hydrogen.[36] Concurrently, carbon capture and storage, investment in environmental, social and governance (ESG) and sustainability initiatives, energy management, energy efficient buildings and transportation and cleantech manufacturing are contributing to Alberta's low-carbon economy. Consequently, Alberta's environmental employment needs are expected to grow by 29% from 2020 to 2030[37], and the hydrogen and sustainable fuels industry could employ 70,000 workers by 2050.[38] For context, in April 2023, the Alberta's oil and gas sector employed 126,000 workers.[39]

Employers interviewed identified a range of opportunities within Alberta's hydrogen sector over the next five years. While some employers identified opportunities related to specific technologies (e.g. as fuel for vehicles or aircraft) or technological evolution (e.g. blending

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[35] Careers in Energy. (2022). *Canada's energy services sector is experiencing a worker shortage,* www.careersinenergy.ca/news/q1-2022-characterized-by-low-unemployment-and-a-shortage-of-workers-in-canadas-energy-services-sector/.

[36] Alberta Energy Regulator. (2022). *Emerging Resources – Hydrogen.* www.aer.ca/providing-information/data-and-reports/statistical-reports/st98/emerging-resources/hydrogen.

[37] Eco Canada. (2022). *Alberta's Cross-sectoral and Multidisciplinary Environmental Workforce: A snapshot of Employment and Hiring Needs to 2030.*

[38] Parkland Institute. (2023). *No Worker Left Behind: A Job Creation Strategy for Energy Transition in Alberta.*

[39] Petro LMI. (2023). *Employment and Labour Data.* www.careersinenergy.ca/employment-and-labour-data/.

hydrogen into the gas distribution system to decarbonize the building heat sector), others identified Alberta as a base for growth and development opportunities more generally. For example, some employers described Alberta as 'best positioned' to lead hydrogen production since companies in Alberta have already been doing so for many years. Further, Alberta was described as the "heartland of hydrogen production" since "we know how to produce it, we know how to sequester it and we know how to scale it up to meet demand in a cost-efficient way." To this end, NAIT and SAIT were identified as key in building capacity to develop new technologies by developing relevant training programs for drivers, mechanics, first responders, and so forth.

Although Alberta was viewed as having significant opportunities to grow its hydrogen sector, challenges were also identified. While employers identified building demand as a potential emerging trend, one of the biggest identified challenges was the tension between the uncertainty about future demand and the desire to develop and innovate. Several key informants noted there was appetite to develop, but the lack of an existing market, coupled with the difficulty of estimating hydrogen's growth trajectory, leads to uncertainty about the extent to which investments should be made. How this progress should or would be funded was unclear. For example, employers described how, on the one hand, the market "on its own" was unable to bear the costs inherent to decarbonization, and at the same time, consumers could not be expected to bear the cost either.

> *"It's difficult to ask the customer to absorb higher costs to help transportation companies adapt and acquire this new technology that's needed."*

Although progress towards decarbonization was occurring, employers stated that there continued to be only a small number of projects and, as was the case with some of the existing pilot projects, there was little to encourage adoption. While there is a regulatory framework for some applications of hydrogen use (refining, chemicals), there is not yet one for other areas, such as the mobility sector, which may create uncertainty about future demand.

> *"The broader challenge that the industry faces are that these projects require a regulatory landscape to support them. But the risk that everybody is concerned about is the certainty: that you are executing a project with an investment horizon of 20 years or more. And what we don't know is: what does that policy environment look like for the duration of the project?"*

A potential knock-on effect of this lack of legislation for the mobility sector was that, while there was capacity and interest, nothing would occur unless projects were sanctioned.

> *"There's a chicken and egg scenario happening here: put in the infrastructure when there's only one or two customers or potential customers, yet the customers don't want to buy the trucks unless they have a supply. I don't see anybody taking the leap right now with the infrastructure side. There has to be some risk sharing there."*

That being said, one employer described how they essentially became their own customer by consuming the hydrogen-generated electricity produced at their own plant to meet their internal energy needs; they were thus mitigating the uncertainty of growth demand by creating their own.

4.2 Current Workforce Trends

To provide an overview of the current workforce in the hydrogen labour market, the employer survey examined the numbers of employees working on hydrogen projects in Alberta, their position-type and core occupation, and workforce vacancies.

Of the companies surveyed, 28% were in the early planning stages of hydrogen projects with no revenues from hydrogen work in 2022. Similarly, 28% had no employees currently working on hydrogen projects and nearly half of the companies had 50% or less of their full-time employees working in the hydrogen sector.

Table 4.1 shows the number of employees currently working on hydrogen projects in five position types across the 32 companies surveyed. Across all companies, Professional Specialists are most likely to be working on a hydrogen project, with 40% of companies employing staff in this category.

Table 4.1 Number of Employees by Position Type Currently Working on Alberta Hydrogen Projects

POSITION TYPE	NUMBER OF EMPLOYEES
i. Senior Managers and Managers: such as President, CEO, Vice President, Plant Manager, Fleet Manager, Hydrogen /fuel cell R&D Director, and other management occupations.	51
ii. Professional Specialists: such as Chemical, Electrical, Mechanical, Control Systems Engineers and, Geologists, Geophysicists, and other professional occupations.	109
iii. Technicians: such as Instrumentation/Automation Engineers, Heavy Duty Mechanics, Hydrogen Integration Specialists, Fabrication Technicians, Sampling and Analysis Technicians, Compression and Corrosion Technicians, and other technicians.	79
iv. General Staff: such as Hydrogen Fueling Station Operators, Truck Drivers, and Drilling and Seismic Operators, and other general labourers.	20
v. All Other Positions: not included in the above (but who support hydrogen activities)	78

Source: EG Employer Survey – B1.d.

Note: Employers were encouraged to consult various staff within their company to obtain the information requested in the survey, however we cannot guarantee that the respondents have consulted the "right" staff for each question, particularly this one. These data should be used only as a representation of each position type.

4.2.1 Vacancies

Findings from the employer survey indicate that there is no current shortage of hydrogen workers in Alberta. Only four companies reported job vacancies in the positions of Senior Managers/Managers, Professional Specialists and/or Support Staff for more than three months. In total, all companies reported a total of seven vacancies. This equates to only 2% of the total required workforce; lower than the average vacancy rates in Alberta of 4.3%.[40]

[40] Government of Alberta. (2023). *Labour Market Notes.* www.alberta.ca/labour-market-notes.aspx.

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Similarly, employers interviewed indicated they continued to build their team as opportunities arose and at a pace that made sense for their current hydrogen projects. This low rate of staff vacancies most probably reflects the embryonic stage of hydrogen projects, rather than best practices in recruiting and retaining staff in this transitioning sector.

4.2.2 Hiring Requirements

Employers surveyed as part of this study noted that they expected to see a robust growth in the size of their workforces over the next five years. For example, 23% of the employers noted that they expected they would see their workforce double over the next five years, while almost a quarter noted that they expected growth of at least 25% over this same five-year period.

Forecasting employment requirements is difficult as numerous employers/stakeholders noted that there would in fact be two workforces required over the medium to long term. The first (and largest) workforce would be those workers required to assist in the capital construction of new hydrogen projects. While some of these workers would need specific hydrogen-related skills, many of these workers would be associated with typical construction associated with industrial projects. Thus, it was noted by key informants that once projects are planned and financing is in place, time will be required to secure the required workforce, particularly if projects are occurring simultaneously. The second workforce would be workers responsible for the maintenance of operation of these new hydrogen facilities across Alberta, most of whom would require hydrogen related training.

4.3 Recruitment and Retention

4.3.1 Hydrogen as a Viable Career Option

Key informants suggested that the cyclical nature of the Oil and Gas sector may act as a deterrent to individuals considering the sector as a viable career. This in turn would impact the availability of hydrogen workers, as the majority of Alberta's hydrogen workforce is expected to come from the Oil and Gas sector. Employment in the energy sector is influenced by oil and gas pricing. In 2020, Alberta saw total employment levels decline from 2.35- to 2.16-million and from 99.9- to 96.1-thousand in environmental employment (environmental protection activities and clean technologies) as a result of COVID-19 measures and the oil and gas downturn. Despite the economic slow down during this period, environmental employment declined at a lower rate (-4%) than overall employment in Alberta (-8%).[41] Interviewees suggested that the diversification

[41] Eco Canada. (2022). Alberta's Cross-sectoral and Multidisciplinary Environmental Workforce: A snapshot of Employment and Hiring Needs to 2030.

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of the oil and gas sector to include hydrogen production may help mitigate the boom-and-bust cycle commonly seen in the sector, potentially enticing workers not to leave or enter the sector.

Interviewees stressed that the long-term viability of hydrogen careers is currently unknown; noting that while information about the location and financial investment required for upcoming Alberta based hydrogen projects is publicly available, there is less clarity around the skill sets which will be required to maintain the specific projects once built. Thus, despite a promising market outlook, interviewees suggested that people are motivated to pursue careers in areas providing economic stability.

4.3.2 Labour Supply in the Hydrogen Sector

According to the interviewees, workers for hydrogen projects will have to come from existing sectors, mostly from the oil and gas sector. Interviewees believed that there would be a natural shift of workers from oil and gas to hydrogen, given that similar skill sets are required in both sectors (see Section 4.4). In the short-term, interviewees believed there is an opportunity for existing professionals to inform and guide the emerging market sector with the goal of increasing participation by under-represented groups, particularly youth, and to promote the hydrogen industry to attract new employees.

Interviewees also suggested that future labour shortages in Alberta will most likely directly impact the oil and gas, petrochemical and fertilizer sectors, while indirectly impacting staffing levels in the hydrogen sector. Interviewees further noted that they did not anticipate a shortage of hydrogen workers in isolation, as workers will be drawn from other workforces. It is anticipated that the need for hydrogen workers will grow incrementally as the number of hydrogen projects increases. Most interviewees felt that Alberta would be able to meet the gradual increase in labour force demand by drawing from the significant pool of skilled workers that already exists in the province. For larger international companies, respondents suggested that the global workforce, to which they have direct access, may potentially meet the future labour force demands for highly specialized workers in Alberta's hydrogen sector.

Despite confidence among larger employers and companies already operating in the hydrogen space that Alberta would be able to supply sufficient skilled workers to meet the demands of the hydrogen sector, smaller companies or new entrants into the hydrogen space were more concerned about the ability of the current system to meet labour force needs. Such employers were unclear where the people will come from to meet workforce demand,

> *"I really question how fast we can get some of this deployed. You know, those kind of specialty folks that we'd need to help troubleshoot. Those [workers] are probably going to be in higher demand. It's skilled labor that we'd be short, right? So welders, millwrights, boilermakers… folks like that. If all those projects go ahead [at once], there will be a labor crunch."*

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particularly skilled tradespeople. Regardless of size or experience, most employers cautioned that should new projects happen 'all at once', there would be a strain on the workforce.

According to employers, forthcoming workforce challenges are likely to be exacerbated by general workforce trends, namely that the cohort of baby boomers are retiring, and the resulting labour gaps cannot be filled by subsequent workforce cohorts, since they are not as big.

4.3.3 Best Practices in Recruitment and Retention

A human resource (HR) strategy is the plan an organization creates to manage its human capital in a way that is consistent with the organization's overall goals. It addresses all major areas of HR, including recruiting and training employees, organizing benefits, evaluating performance, and providing development opportunities.[42] Half of the companies surveyed had a written human resource strategy in place that outlined the company's approach to meeting its labour needs over the medium to long term. Few companies had a mentoring program, either formal or informal, to help retain and develop employees in their workforce:

- → 44% of the companies had an informal program; and
- → 38% of the companies had a formal program.

Respondents were asked to rank six strategies from one to five (one being a lowest priority, five being the highest priority) that could be used to develop the hydrogen workforce in Alberta. Respondents' ranking of the six strategies are shown in Figure 4.1. Respondents prioritized the provision of professional training and educational programs (Ranking 4.17) as the most important strategy that would support the development of a hydrogen workforce because currently such programming is not available. The development of certification and occupational standards (Ranking 3.93) was ranked as the second most important priority given that such standards do not exist for hydrogen occupations. Key informants also stressed the importance of training, education, certification, and occupational standards for the development of a professional hydrogen workforce.

HR strategies that may be implemented at a corporate level were ranked by survey respondents below training and certification, and they included development of school-based resources (Ranking 3.73), public relations (Ranking 3.63), job fairs (Ranking 3.45) and HR tool kits (Ranking 3.17). Key informants stressed that corporately, they did not currently have an HR

[42] Indeed. *Human Resources Strategies: A Guide for Managers.* www.indeed.com/hire/c/info/human-resources-strategies.

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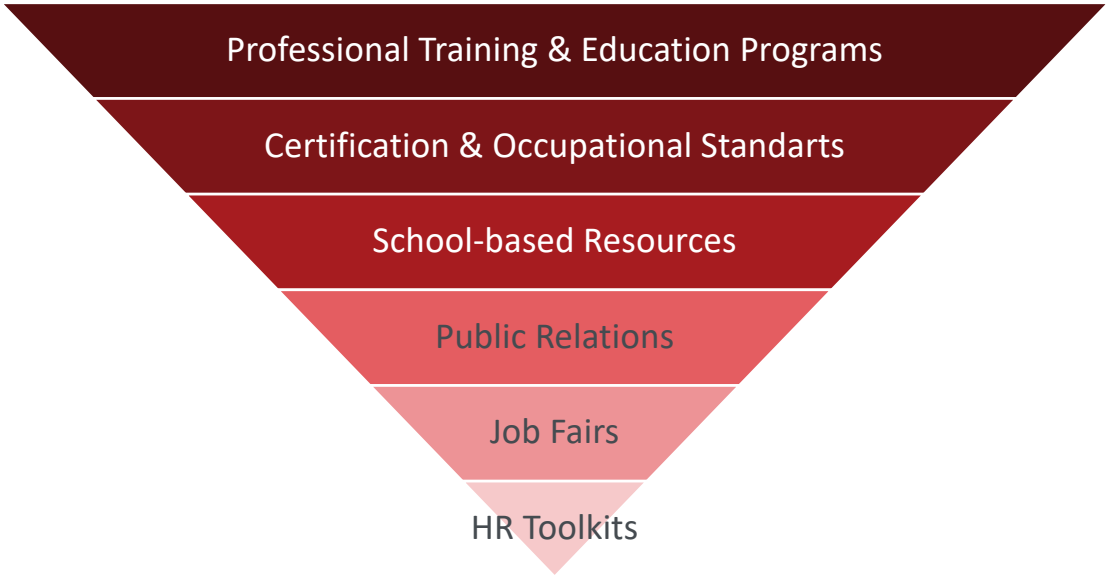
strategy specifically designed to develop a hydrogen workforce. Instead, HR departments tended to use traditional corporate recruitment strategies for all occupations.

It is important to note that priority rankings for all strategies were moderate, ranging from 4.17 to 3.17, suggesting that employers are not yet highly concerned about developing and growing a hydrogen workforce to meet project demands.

Figure 4.1 Strategies for Hydrogen Workforce Development



Source: EG Employer Survey – D5.

4.3.4 HR Challenges

Figure 4.2 illustrates the three highest ranked barriers to finding and retaining workers in the hydrogen sector. Ranked 3.55, uncertainty in the sector was thought to be the biggest challenge companies faced in recruiting talent, followed by lack of certification (Ranking 3.41) and competition from other sectors (Ranking 3.29). Other challenges which typically impact a company's ability to find and retain employees were not thought to significantly impact the hydrogen workforce. These challenges included: career progression (Ranking 2.26), earning potential (Ranking 2.31), salary (Ranking 2.64), and access to professional development (Ranking 2.72). Key informants generally agreed that the companies engaged in hydrogen projects did not face significant challenges in finding and retaining workers and could offer those workers competitive compensation and benefits.

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Figure 4.2 Barriers in Recruitment and Retention

Source: EG Employer Survey – C6.

Employers generally reported that they did not have a recruitment strategy specifically designed to hire workers for hydrogen projects, nor a strategy to improve equity, diversity and inclusion in the sector. This was typically because the skills required to work on hydrogen products were the same as those required to work on other projects; thus, transitioning between hydrogen and non-hydrogen projects did not require companies to seek specialized workers in addition to their existing workforce.

“We've identified certain skills pools that have a deeper knowledge or a specific group that has a hydrogen technology skillset. We already centralized some of the deeper, technical skills and knowledge that's necessary,” described one employer about the difficulty in developing a recruitment strategy in an industry in a constant state of change.

4.3.5 Partnerships and Programs

Should the number of hydrogen-related projects grow incrementally in Alberta, interviewees were confident and optimistic that the current pool of skilled workers in the province would be sufficient to meet the necessary workforce needs. However, key informants stressed that if projects were to occur simultaneously there may be workforce gaps. Key informants also noted that workers required for hydrogen projects could be classed into three groups: those involved in research/development and design of projects, those involved in the building of infrastructure and applications and those involved in the use or support of applications. The challenges associated with the recruitment of each group differed. Workers involved in design were said to be difficult to find given the unique and emerging skill set, while those involved in construction of infrastructure did not require any hydrogen specific skills. These workers might be in short supply if several large projects, from any sector, occurred simultaneously in Alberta. Key informants anticipated that once built, hydrogen facilities and applications would not be hard to

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staff given that workers from related fields could be upskilled or retrained to meet labour needs. Should workforce need outstrip supply, due to the implementation of multiple projects simultaneously, or the ability of the current training system to meet the required workforce needs, key informants noted that, companies may need to utilize the Temporary Foreign Worker (TFW) program. That said, key informants suggested that the workforce requirements would be met through up-skilling and retraining of workers transitioning from other sectors such as oil and gas.

To support the development of the necessary hydrogen workforce, key informants pointed to the development of partnerships. Such partnerships included those between the Edmonton Region Hydrogen HUB, the Hydrogen Centre of Excellence from Alberta Innovates, Alberta's Industrial Heartland Association, and other organizations outside the province including The Transition Accelerator and the Canadian Hydrogen and Fuel Cell Association (CHFCA). In these partnerships the government was said to be working with industry to establish a two-way strategic dialogue designed to support the growth of this emerging sector.

4.4 Skills, Training and Education Requirements

4.4.1 Skills

It is anticipated that hydrogen workers will come from existing sectors, mostly from the Oil and Gas sector as the skill sets are similar. Employers and industry representatives interviewed all agreed that the skills obtained in technical programs laid sufficient groundwork for individuals such as engineers and technologists to eventually up-skill to prepare them to work with hydrogen which is consistent with the results of the Australian workforce assessment (Section 3.2).

> *"I'll just talk about process engineering. What I look for is someone that understands the fundamentals of process engineering, not necessarily hydrogen. We can teach hydrogen, but if you don't understand first principles of, you know, the physics involved, it's harder to teach."*

As pointed out by an industry representative, the requirements for hydrogen-related jobs would be a natural expansion of something that already exists, "every job has a close cousin somewhere."

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Key informants envisioned the need to train staff on the unique properties of hydrogen with emphasis on its specific safety requirements. Further, key informants thought this should be a priority for workers that would be first on site should an emergency arise. For example, one employer noted that provinces are expected to create certification programs for hydrogen companies, similar to other existing certifications (e.g. gas), to ensure that people working in the facility have the exact skillsets required. However, to date there is no such certification. Other employers, mostly with engineering backgrounds, foresaw that required skillsets would change for end users, rather than from the production side, due to the unique nature of hydrogen fuel cell utilization. In the same vein, an industry representative pointed out that the biggest knowledge gap, which would need to be addressed, would occur for vehicle mechanics, aligning with information presented in the Australian workforce assessment. Thinking about the proportion of the hydrogen work force that will require extensive training as compared to add on training or upskilling that could be provided on the job; one employer estimated that 90% of the hydrogen workforce would only require upskilling.

> *"Where it begins to differentiate itself are going to be when we start looking at those end uses. You know, the mechanic that works on the bus that has a hydrogen fuel cell in it. The people that are building and installing the fueling stations: let's just say your company that makes the pumps that pump fuel at the service station. You're now going to install a high-pressure hydrogen [pump] and so there will be a certification required and there's a really important reason for that: public safety. You know there's going to be some specific skill sets and certification required for those people."*

For management positions, there was a consensus among the key informants that candidates must be innovative, creative, and able to problem solve to facilitate energy transition. It was further noted that these skills are not always acquired through training, but rather through experience gained on projects.

4.4.2 Training and Education - Demand

Most of the of the companies surveyed (65%) had a corporate training program that allowed them to provide in-house training to their employees (Figure 4.3).

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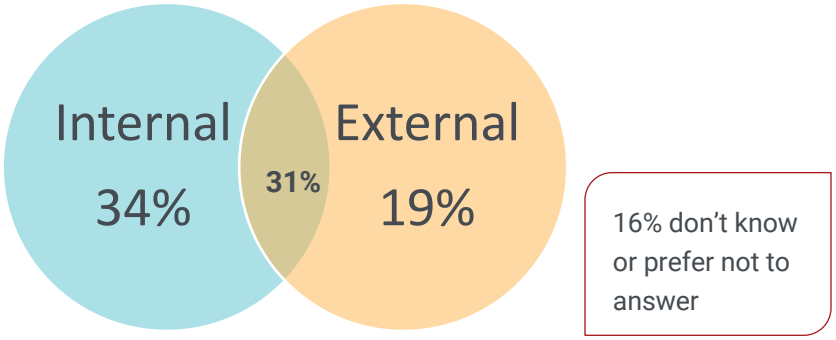
Figure 4.3 Method of Training for Hydrogen Workers



Source: EG Employer Survey – D1.b.

Key informants also stressed the importance of the internal training being provided within their company. One such multinational company had developed training modules emphasizing personal and environmental safety to upskill existing workers in preparation to work on a hydrogen-related project.

To support staff training, companies would like training institutions or professional associations to offer courses and programs on:

- → Hydrogen technologies for industry professionals;
- → Certification in hydrogen technologies; and
- → Hydrogen safety.

Certification of hydrogen workers was thought to be a critical element in achieving and maintaining safety in the hydrogen sector.

4.4.3 Training and Education - Supply

Currently there are no trade, diploma, or degree programs specific to hydrogen in Alberta. Instead, there are a variety of courses either for credit or not, available online or in-person, exploring such topics as alternative and innovative energy, hydrogen energy technology, energy management, environmental engineering, and electrolysis. Within engineering programs (chemical and mechanical), key informants noted that hydrogen may be covered in a chapter or a few modules along with another course such as a catalyst design course.

Key informants noted that hydrogen production is not new; Alberta has experts with decades of knowledge in almost all of its universities, colleges, and institutes. However, large industry had not yet signaled the need for hydrogen specific training within existing post-secondary programs. Further, relationships were not established between educational institutions and industry with the expressed goal of developing hydrogen training. Initial efforts by institutions have included one Alberta-based college providing a 45-hour online introductory course on

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hydrogen. Additionally, academic institutions provide tailored hydrogen workshop training sessions to companies directly, although uptake of this training has not been extensive. The development of communities of practice may help to address inefficient or limited knowledge sharing between education providers and industry and improve the ability of educational institutions to provide the skills needed for the hydrogen sector to move forward[43].

Despite the lack of hydrogen specific training currently available, key informants from academic institutions noted it was still important for academics to remain aware of trends in the emerging sector to proactively meet training needs ahead of demand, particularly because the creation of a credited program is a lengthy process. Academic institutions are collaborating with each other to ensure that knowledge is shared and that the programs are complementary rather than repetitive. Further, all academic representatives acknowledged the necessity for micro-credentials; suggesting industry and academic institutions should partner to identify which micro credentials should first be introduced.

The Future Skills Centre, a pan-Canadian initiative that inform and support approaches to skills development and employment training to help Canadians transition in a changing economy, may be useful in developing an effective approach to meet future skill requirements in the hydrogen sector. This may include the introduction of short-term training supported by micro-credentials, which could be used to meet industry needs more quickly that undergraduate degree programs.[44]

4.5 Perception of Future Labour Demand

For many companies (53%), it is too early to estimate hydrogen-related capital investments in the next one to five years. Of the fifteen companies that provided an estimate for future hydrogen investments in 2023, 80% estimated that their hydrogen investments will at least double by 2027, with total investment projected to be $185 million in 2023 for these respondents, and $892 million in 2027. According to their estimates, the total investment in hydrogen would almost quintuple in four years.

The majority (81%) of the companies surveyed expect their hydrogen workforce to increase over the next five years. Table 4.2 shows, among the 32 companies surveyed, the number of employees currently working on hydrogen projects in five position types (Table 4.1) and

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[43] Coursera. (2022). *6 Ways Higher Education Institutions Can Drive Skills Development for the Workplace of the Future.* www.blog.coursera.org/6-ways-higher-education-institutions-can-drive-skills-development-for-the-workplace-of-the-future/.

[44] Government of Canada. *Canada – A learning nation: A skilled, agile workforce ready to shape the future.* www.canada.ca/en/employment-social-development/programs/future-skills/report-learning-nation.html.

employer estimates of the number of employees needed for the same positions in the next one, three, and five years. A fourfold increase in the number of employees is expected by 2027. As an example, one company estimates requiring up to 500 employees in 2023, and 800 in 2025, to build a hydrogen project, while another expected to need 300 drivers by 2027.

Table 4.2 Estimated Number of Employees by Position in Alberta Hydrogen Projects (2022-2027)

POSITION TYPE	CURRENT WORKFORCE	2023		2025		2027	
		New positions	Anticipate workforce	New positions	Anticipate workforce	New positions	Anticipate workforce
i. Senior Managers and Managers	51	28	79	36	115	43	158
ii. Professional Specialists	109	82	191	120	311	104	415
iii. Technicians	79	37	116	77	193	103	296
iv. General Staff	20	81	101	150	251	56	307
v. All Other Positions	78	17	95	35	130	51	181
Total	337	245	582	418	1000	357	1357

Source: EG Employer Survey – C2a.

Note: Employers were encouraged to consult various staff within their company to obtain the information requested in the survey, however we cannot guarantee that the respondents have consulted the "right" staff for each question, particularly this one. Retirement and turnover rates are not included, the approximation from the responses was close to zero given the small number of employees per company working in the hydrogen sector.

Overall, 69% of employers were confident, either fully confident (25%), or somewhat confident (44%) they could meet their estimated future workforce needs (Figure 4.4). The fact 44% were

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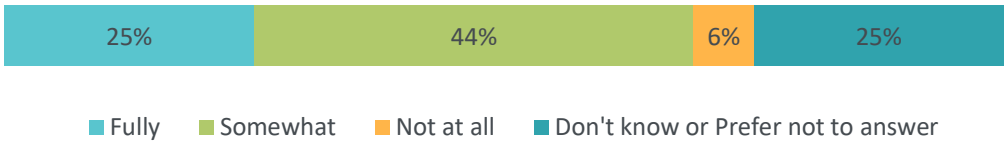
only somewhat confident may reflect the uncertainty of the hydrogen sector rather than the ability of the education sector or industry to train and up-skill the needed workers.

Figure 4.4 Anticipation to Meet Labour Force Needs



Source: EG Employer Survey – D7.

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5.0 Conclusion and Recommendations

As Canada's largest producer of hydrogen, Alberta is naturally positioned to become a world leader in the hydrogen industry. Within the province, the existing infrastructure, resources and workers can be used to transition to large scale hydrogen production. Interviewees highlighted the availability of a skilled workforce that can easily shift workers from oil and gas production to hydrogen production, as both sectors require similar foundational knowledge and skills. The majority (81%) of companies surveyed expect their hydrogen workforce to increase over the next five years (Section 4.5), and interviewees did not anticipate a shortage of hydrogen workers, as workers were expected to be drawn from the same or similar workforces and trained in-house. To this end, most (65%) of the companies surveyed had a corporate training program that allowed them to train their employees in-house, including upskilling staff for hydrogen projects. Most interviewees anticipated the need for hydrogen workers to grow incrementally as the number of hydrogen projects increased, with interviewees estimating that hydrogen investment would double or even quintuple by 2027.

Given the early stages of hydrogen production, work is still occurring to build Alberta's hydrogen value chain. A sufficient workforce will be required to both develop and maintain that value chain. The following recommendations suggest ways to support hydrogen workforce development in Alberta to ensure sufficient workers are available to meet the labour force needs anticipated by a doubling or quintupling of investment in the sector.

Recommendation No.1

Respondents prioritized the provision of professional training and educational programs as the most important strategy that could be used to develop the hydrogen workforce in Alberta (Figure 4.1). Specifically, companies would like educational institutions or professional associations to offer courses and programs on hydrogen technologies for industry professionals and provide certification in hydrogen technologies and training in hydrogen safety (Section 4.4).

On the other hand, key informants from academic institutions mentioned that in general industry had not yet signaled the need for hydrogen-specific training to existing post-secondary programs. To this end, it is essential that the academic institutions and the industry maintain a close and dynamic relationship with the stated goal of developing hydrogen training so that academic institutions are aware of the skills that employers will need in the medium or long term and nimble enough to respond when training needs arise. However, since some professions are almost ready for the transition to hydrogen work, such as engineers and specialists (Sections 3.2 and 4.4.1), their training should start as early as possible.

The Transition Accelerator has already identified two knowledge areas in which training could be provided: hydrogen properties and behavior, and potential hazards posed by hydrogen. Training in these two areas would already be useful to many occupations working on hydrogen

projects (Section 4.4.3). Promotion of hydrogen workshops in these areas would support uptake; as would encouraging employers to make use of training tax credits to up-skill their engineers and specialists. The Future Skills Centre could help validate effective training approaches and expand/develop customized short-term training to meet workplace needs. Such an approach could include micro-credentials which can be combined to recognize broader skills requirements over time (Section 4.4.3).

Recommendation No.2

Respondents saw a need to train staff on the unique properties of hydrogen, with an emphasis on its specific safety requirements (Section 4.4). Similar to gasoline and natural gas, hydrogen is flammable and can be hazardous under certain conditions. Safety training must be provided to ensure the safety of hydrogen workers, the public, and the environment. In the same vein, certification of hydrogen workers was thought to be a critical element in achieving and maintaining safety in the hydrogen sector (Section 4.4). Certification and occupational standards were the second most important strategy that companies surveyed believed could be used to develop the hydrogen workforce in Alberta (Figure 4.1), and the lack of certification was the second top HR challenge (Figure 4.2). Consequently, certification needs to be designed and implemented consistently across the province, if not the country, and should be based on codes and standards that are consistent at all levels of government, in consultation with industry and experts, to allow for worker mobility. A model to follow could be H2S Alive®, an eight-hour course developed and certified by Energy Safety Canada designed to increase awareness of the hazards of working in a hydrogen sulfide environment.[45]

Recommendation No.3

Interviewees emphasized that a hydrogen career is perceived with uncertainty. Therefore, a relationship of trust must be established between employers and employees in the hydrogen industry. Employers need to know that employees will invest in the necessary skills and training, and workers need to know that there will be sustainable jobs and that they will be employed for the long term if they participate in the energy transition.[46] Employees need to be encouraged and supported to pursue professional development to fill skills gap in the hydrogen industry as

[45] Western Canada Fire & First Aid Inc. *H2S Alive®.* www.wcff.ca/courses/h2s-alive/.

[46] Hanson, Gordon H. (2023), *Local Labor Market Impacts of the Energy Transition: Prospects and Policies*, Harvard Kennedy School.

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well as support future career advancement.[47] Since only half of the companies surveyed had a written human resources strategy in place and 38% had a formal mentoring program (Section 4.3), there may be a need for the hydrogen sector to establish a clear HR strategy that aligns industry goals with the supply of a hydrogen labour workforce.

Next Step

It is anticipated that hydrogen workers will come from existing sectors, mostly from the oil and gas sector as the skill sets are similar (Section 4.4). It would therefore be relevant to better understand the current skill sets of oil and gas workers in Alberta to assess their readiness to take the next steps in the transition to a net zero economy, as well as understand the appetite for reskilling among this workforce.

[47] Meyer, Tami. (2023). *How to Encourage Employees to Pursue Professional Development,* Business News Daily, www.businessnewsdaily.com/10092-encourage-professional-development.html.

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