

B.C. HYDROGEN VALUE CHAIN AND WORKFORCE MAP



PRESENTED FOR:



Fraser Basin Council

PRESENTED BY:

Creative Links Inc

Linking People to Solutions and Results





ACKNOWLEDGEMENTS

Fraser Basin Council gratefully acknowledges the financial support of the British Columbia Ministry of Energy and Climate Solutions to complete this ***B.C. Hydrogen Value Chain and Workforce Map***.

It was developed to support the ***B.C. Hydrogen Labour Market and Skills Analysis***.

This document was prepared by Pat Hufnagel-Smith of Creative Links Inc. with the support of Parker Smith of Creative Links Inc., Kerry Jothen of Human Capital Strategies, and Robyn Huth of robyn huth design co.

Fraser Basin Council wishes to thank the organizations that contributed their insights to this document.





INTRODUCTION

There is a strong desire from government and industries for low-carbon hydrogen to play a significant role in achieving British Columbia's (B.C.) net-zero by 2050 goals. Low-carbon hydrogen is particularly important as an emissions reduction strategy for hard-to-electrify industries that are important to B.C.'s economy, including heavy-duty transportation, mining, natural gas, petroleum refining, pulp and paper manufacturing, mining, and wood products manufacturing.

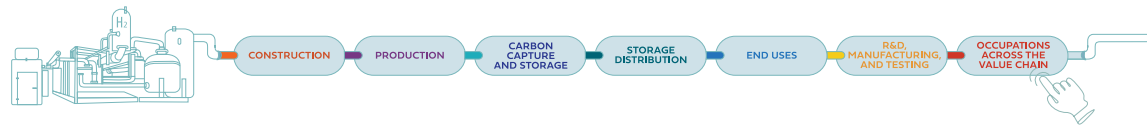
Recognizing that a skilled hydrogen workforce is required to fully realize the Province's vision of becoming a leading hydrogen economy, the B.C. Ministry of Energy and Climate Solutions (ECS) engaged Fraser Basin Council to gain an understanding of the hydrogen industry's workforce development requirements. To assess these requirements, it is necessary to first define B.C.'s hydrogen industry.

B.C.'s Hydrogen Industry and Workforce Requirements

B.C.'s hydrogen industry comprises of low-carbon hydrogen production pathways, storage and distribution, and end-uses. It is also supported by research and development (R&D), manufacturing, and testing. Additionally, it will rely on the construction industry to build and maintain necessary infrastructure, including production facilities, distribution pipelines, and refuelling stations.

Breaking down B.C.'s hydrogen industry into its value chain components provides insights into the types of activities the industry will undertake and, by extension, the types of occupations required to carry out those activities. Research and interviews conducted with industry identified 154 core occupations necessary to perform the activities associated with the B.C. hydrogen industry value chain.

This document offers an overview of the B.C. hydrogen industry and maps the core occupations required by each value chain component. Users can use the buttons at the top of each page to navigate across the hydrogen value chain components.



Expanding B.C.'s hydrogen industry will also create career opportunities supporting the business, including administration, human resources, accounting, and sales. These jobs have not been specifically identified in the map.

Definitions

Industry: a group of value chain components that are related based on their primary business activities.¹

Value chain: series of primary and secondary activities involved in producing a product, its distribution, and end-use.²

Core occupations: occupations required for the value chain components to operate successfully.

1 Adapted from <https://www.investopedia.com/terms/i/industry.asp>

2 Adapted from <https://learn.saylor.org/mod/book/view.php?id=32061&chapterid=10483>



Developing B.C.'s Hydrogen Workforce

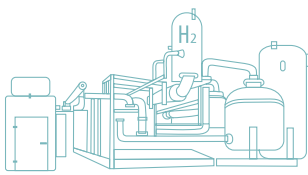
B.C. already employs approximately 2,000 workers with hydrogen-related expertise. This hydrogen workforce is primarily engaged in the R&D, manufacturing, and testing value chain components. To become a world-leading hydrogen economy, it is essential to develop a workforce ready to work across all the low-carbon hydrogen value chains, including production, storage and distribution, and end uses. Building hydrogen infrastructure, including facilities, pipelines, and refuelling stations, will place demands on an already constrained construction labour force.

The addition of new hydrogen infrastructure will generate new jobs. However, the initial expansion of the end-use value chain components will likely occur by retrofitting and converting existing systems, equipment, and infrastructure to use hydrogen. This incremental deployment of hydrogen end-use applications could involve activities such as fuel-switching, co-combustion, and blending. In these cases, fewer new jobs will be created. Rather, there will be a greater need to develop the skills and knowledge of the existing workforce. The following are examples of upskilling required for the existing workforce.

There is a growing need for experienced heavy-duty equipment technicians who can work on hydrogen fuel cell vehicles (HFCV) and co-combustion engines, in addition to diesel engines. Gasfitters will need training in piping systems that handle hydrogen-natural gas blends. Process engineers, plant operators, and maintenance trades in industrial plants using hydrogen to decarbonize processes will need upskilling to safely work with and handle it. Design, facility, and process engineers will need to understand how to effectively integrate the use of hydrogen into existing systems and processes.

For more information on the skills and knowledge needed to advance B.C.'s hydrogen industry, refer to the research and analysis presented in the *B.C. Hydrogen Labour Market and Skills Analysis*.

HTEC plans to build and operate an interprovincial network of up to 20 hydrogen refuelling stations to support the deployment of fuel cell vehicles and advance greener transportation solutions. The refuelling stations will be supported by three new hydrogen production facilities located in Burnaby, Nanaimo and Prince George, and a facility that liquefies 15 tonnes per day of vented by-product hydrogen in North Vancouver. It is estimated that more than 280 full-time jobs will be created to build, operate and support the hydrogen infrastructure.
(HTEC May 24, 2024)



CONSTRUCTION

PRODUCTION

CARBON CAPTURE AND STORAGE

STORAGE DISTRIBUTION

END USES

R&D, MANUFACTURING, AND TESTING

OCCUPATIONS ACROSS THE VALUE CHAIN



LOW-CARBON HYDROGEN (H2) PRODUCTION PATHWAYS

CONSTRUCTION

Activities that progress a H2 infrastructure project from planning and design phase to operations.



Planning, Design, Engineering, and Procurement



Fabrication



Construction and Installation



Start-Up and Commissioning

Electrolytic H2

Using renewable electricity to split water into H2 and oxygen.

Natural Gas with CCS

Reforming natural gas into H2 coupled with carbon capture and storage (CCS) to reduce carbon intensity.

Methane Pyrolysis

Reforming natural gas into H2 where solid carbon is the by-product, which eliminates the need for CCS.

By-Product of Other Industrial Processes

Capturing H2 from industrial processes that would otherwise vent it to the atmosphere.

RESEARCH AND DEVELOPMENT (R&D), MANUFACTURING, AND TESTING



R&D

Ongoing innovation, development, and improvement of H2 value chain components.



Manufacturing

Fabricating, assembling, and installing H2 fuel cells and electrolyzers, and a broad range of other technologies and equipment that enables the advancement of the H2 industry.



Testing

Designing and testing H2 equipment, technology, and systems.

STORAGE | DISTRIBUTION

Underground Storage of H2

Using depleted natural gas reservoirs or salt caverns to store H2 gas underground.

Pipelines

Transporting H2 in pipelines.

Tube Trailer

Storing and transporting compressed gas and cryogenic liquid H2.

Chemical Carrier

Storing and distributing H2 as part of a chemical compound like ammonia (NH3).

Fuelling Stations

Designing and operating a network of H2 fuelling stations.

END USES

Lower-Carbon Natural Gas

Blending H2 with natural gas to reduce the carbon intensity of heating and power.

Zero-Emissions Transportation (at the Tailpipe)

Fuelling medium and heavy-duty transport trucks, trains and return-to-base vehicles such as municipal transit.

Industrial Processes

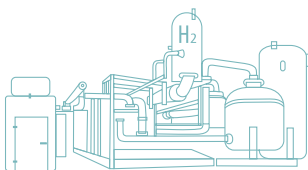
H2 as a feedstock or decarbonizing industrial processes that are not practical to electrify, which also reduces the life-cycle emissions of the produced product.

Power Generation and Storage

Fuel-switching for remote locations reliant on diesel-powered generation for electricity. Power-to-gas converts electricity into H2 using electrolysis, which can then be blended with natural gas for lower carbon power and heating.

Export

Exporting Canada's low-carbon H2 or other chemical carriers in tanker ships.



CONSTRUCTION

PRODUCTION

CARBON CAPTURE AND STORAGE

STORAGE DISTRIBUTION

END USES

R&D, MANUFACTURING, AND TESTING

OCCUPATIONS ACROSS THE VALUE CHAIN



CONSTRUCTION (Following Final Investment Decision (FID))



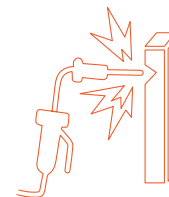
01]

- Automation engineer
- Automated systems technician
- Business development
- CAD/engineering technologist
- Civil/Structural engineer
- Contracts manager
- Design engineer
- Electrical and instrumentation engineer
- Environmental engineer
- Government relations
- Health and safety advisor
- Inventory control
- Materials management technician
- Mechanical engineer
- Project engineer
- Project manager
- Purchasing manager
- Regulatory specialist
- Supply chain specialist
- Quality engineer

Planning, Design, Engineering and Procurement



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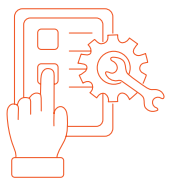


Fabrication
(Typically employed at a facility, not located on the construction site)

- B pressure welder
- Construction manager/supervisor
- Crane and hoisting operator
- Environmental inspector
- Fitter/fabricator
- Health and safety inspector
- Industrial electrician
- Instrumentation technician
- Insulator/painter
- Labourer
- Machinist
- Reinforcing iron worker
- Scaffolder
- Sheet metal worker
- Steamfitter/pipefitter
- Structural iron worker
- Truck driver
- Welder
- Quality control/quality assurance (QC/QA) inspector



04]



Start-Up and Commissioning

- Commissioning coordinator
- Commissioning engineer
- Process operator
- Control room operator
- Process engineer
- Automation engineer
- Training coordinator
- Electrical and instrumentation engineer
- DCS/Instrumentation specialist
- Maintenance trades: industrial electrical, instrumentation and control, industrial mechanic (millwright), industrial refrigeration
- Health and safety advisor

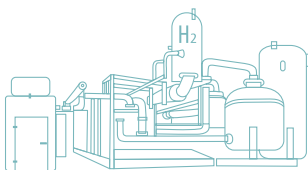


03]

Construction and Installation

- B pressure welder
- Boilermaker
- Carpenter
- Cement mason
- Community benefits coordinator
- Construction manager/supervisor
- Crane and hoisting operator
- Environmental inspector
- Health and safety specialist
- Heavy equipment operator
- Industrial electrician
- Industrial mechanic (millwright)
- Instrumentation technician
- Insulator/painter
- Labourer
- Reinforcing iron worker
- Scaffolder
- Sheet metal worker
- Steamfitter/pipefitter
- Structural iron worker
- Truck driver
- Welder
- QC/QA inspector





CONSTRUCTION

PRODUCTION

CARBON CAPTURE AND STORAGE

STORAGE DISTRIBUTION

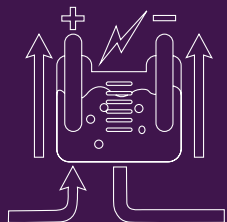
END USES

R&D, MANUFACTURING, AND TESTING

OCCUPATIONS ACROSS THE VALUE CHAIN

H₂

LOW-CARBON HYDROGEN (H₂) PRODUCTION PATHWAYS



Electrolytic H₂

- Automation and control specialist
- Chemical/process engineer
- Control room operator
- Electrical engineer
- Electrical and instrumentation engineer
- Facility engineer
- Lab technician
- Maintenance planner
- Maintenance trades: industrial electrical, instrumentation and control, industrial mechanic (millwright), industrial refrigeration
- Mechanical engineers: equipment and high-pressure piping, reliability
- Measurement specialist
- Plant manager
- Plant operator (power engineer)
- Process control engineer
- Process safety engineer
- Production engineer
- Renewable interconnect specialist
- Water treatment plant operator
- Water treatment specialist



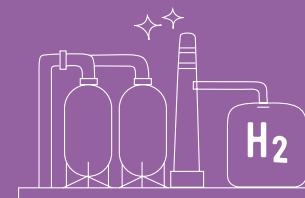
Natural Gas with CCS

- Automation and control specialist
- Control room operator
- Electrical and instrumentation engineer
- Facility engineer
- Lab technician
- Maintenance planner
- Maintenance trades: electrical, instrumentation and control, industrial mechanic (millwright)
- Measurement specialist
- Mechanical engineers: equipment and piping, reliability
- Plant manager
- Plant operator
- Process control engineer
- Process engineer
- Process safety engineer
- Production engineer



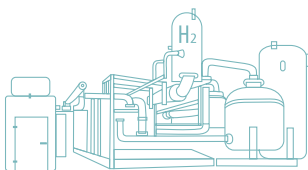
Methane Pyrolysis

- Automation and control specialist
- Black carbon product manager
- Combustion engineer
- Control room operator
- Drafter/CAD designer
- Maintenance trades: industrial electrical, instrumentation and control, industrial mechanic (millwright)
- Mechanical engineer
- Plant manager
- Plant operator
- Process control engineer
- Process engineer
- Process safety engineer
- Test engineer



By-Product of Other Industrial Processes

- Automation and control specialist
- Chemical/process engineer
- Control room operator
- Electrical engineer
- Electrical and instrumentation engineer
- Facility engineer
- Lab technician
- Maintenance planner
- Maintenance trades: industrial electrical, instrumentation and control, industrial mechanic (millwright), industrial refrigeration
- Mechanical engineers: equipment and high-pressure piping, reliability
- Measurement specialist
- Plant manager
- Plant operator (power engineer)
- Process control engineer
- Process safety engineer
- Production engineer



CONSTRUCTION

PRODUCTION

CARBON CAPTURE AND STORAGE

STORAGE DISTRIBUTION

END USES

R&D, MANUFACTURING, AND TESTING

OCCUPATIONS ACROSS THE VALUE CHAIN

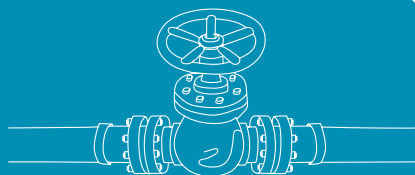
H₂

CARBON CAPTURE AND STORAGE (CCS)



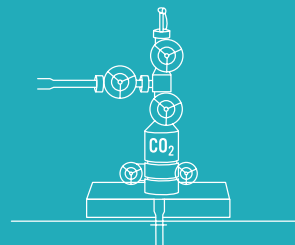
Carbon Capture

- Automation and control specialist
- Control room operator
- Electrical and instrumentation engineer
- Facility engineer
- Lab technician
- Maintenance planner
- Maintenance trades: electrical, instrumentation and control, industrial mechanic (millwright)
- Measurement specialist
- Mechanical engineers: equipment and piping, reliability
- Plant manager
- Plant operator (power engineer)
- Process control engineer
- Process engineer
- Process safety engineer
- Production engineer



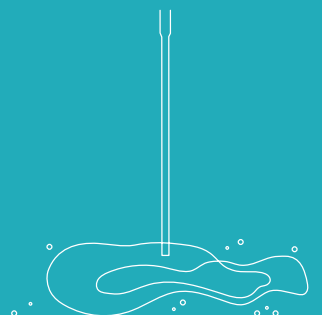
Pipeline Transmission

- Automation and control specialist
- Compression specialist
- Control centre operator
- Corrosion specialist
- Electrical and instrumentation engineer
- Hydraulics engineer
- Measurement specialist
- Pipeline engineer
- Pipeline integrity specialist
- Pipeline scheduler
- Pipeline technicians: electrical, instrumentation, industrial mechanic (millwright)
- Process safety engineer
- Station operators: compression, pump



Underground Storage of CO₂

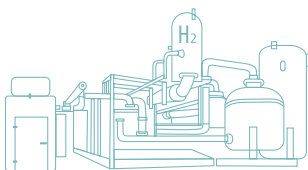
- Drilling and completion engineer
- Drilling crew
- Geoscience professionals: geologist, geophysicist
- Heavy duty mechanic
- Reservoir engineer
- Reservoir technologist
- Service rig crew
- Well completions operator
- Well completions supervisor



Measurement, Monitoring, and Verification (MMV)

- Geoscience professionals: geologist, geophysicist
- Instrumentation technician
- Measurement specialist
- Reservoir engineer
- Reservoir technologist
- Sampling and analysis technician
- Seismic crew





CONSTRUCTION

PRODUCTION

CARBON CAPTURE AND STORAGE

STORAGE DISTRIBUTION

END USES

R&D, MANUFACTURING, AND TESTING

OCCUPATIONS ACROSS THE VALUE CHAIN

H₂

STORAGE | DISTRIBUTION




Underground Storage of H₂

- Cavern engineer
- Control centre operator
- Compression specialist
- Drilling and completion engineer
- Drilling crew
- Geoscience professionals: geologist, geophysicist, geotechnical specialist
- Heavy duty mechanic
- Maintenance trades: electrical and instrumentation, industrial mechanic (millwright)
- Measurement specialist
- Reservoir technologist
- Service rig crew
- Well completions operator
- Well completions supervisor



Pipelines

- Automation and control specialist
- Compression specialist
- Control centre operator
- Corrosion specialist
- Electrical and instrumentation engineer
- Measurement specialist
- Pipeline engineer
- Pipeline integrity specialist
- Pipeline scheduler
- Pipeline technicians: electrical and instrumentation, industrial mechanic (millwright)
- Process safety engineer
- Station operator (compression)



Tube Trailer (compressed and liquid H₂)

- Cylinder technician
- Heavy duty mechanic
- Logistics coordinator
- Tank tester/inspector
- Truck drivers (classes 1 and 3)



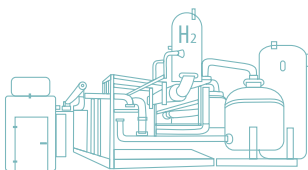
Chemical Carrier

- Automation and control specialist
- Control room operator
- Electrical and instrumentation engineer
- Facility engineer
- Lab technician
- Maintenance planner
- Maintenance trades: electrical, instrumentation and control, industrial mechanic (millwright)
- Measurement specialist
- Mechanical engineers: equipment and piping, reliability)
- Plant manager
- Plant operator
- Process control engineer
- Process engineer
- Process safety engineer
- Production engineer



Fuelling Stations

- Automation and control specialist
- Electrical and instrumentation engineer
- Fuelling station technician
- Logistics coordinator
- Maintenance technicians: compression, electrical and mechanical, refrigeration
- Mechanical engineers: compression, equipment and piping, reliability
- Process controls engineer
- Process engineer
- Process safety engineer
- Product engineer
- Quality engineer
- Truck drivers (classes 1 and 3)



CONSTRUCTION

PRODUCTION

CARBON CAPTURE AND STORAGE

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END USES

R&D, MANUFACTURING, AND TESTING

OCCUPATIONS ACROSS THE VALUE CHAIN

H₂

END USES



Lower-carbon Natural Gas (Heating and Power)

- Asset performance manager
- H2 integration specialist
- Gas fuser
- Gasfitter
- HVAC technician
- Utility inspector
- Utility operator
- Utility services planner
- Utility service technician
- Welding engineer



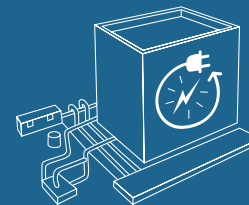
Zero-emissions Transportation (Medium and heavy-duty transport and rail)

- Dual fuel heavy-duty mechanic
- Fleet manager
- Fuel cell electric vehicle (FCEV) technician
- Locomotive engineer
- Locomotive mechanics: field, shop
- Transportation solutions advisor
- Truck drivers (classes 1 and 3)



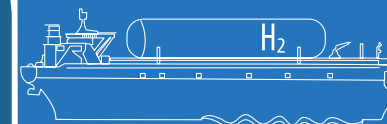
Industrial Processes

- Automation and control specialist
- Chemical/process engineer
- Control room operator
- Compression specialist
- Electrical engineer
- Electrical and instrumentation engineer
- Facility engineer
- H2 integration specialist
- Maintenance planner
- Maintenance trades: electrical, instrumentation and control, industrial mechanic (millwright)
- Mechanical engineers: equipment and piping, reliability
- Plant manager
- Plant operator (power engineer)
- Process control engineer
- Process safety engineer



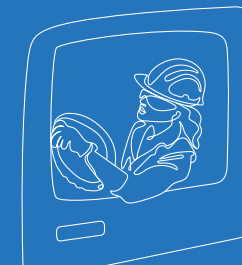
Power Generation and Storage

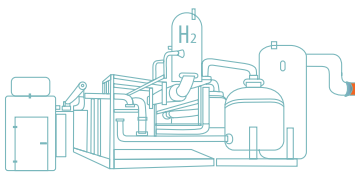
- Automation and control specialist
- Control room operator
- Compression specialist
- Electrical engineer
- Electrical and instrumentation engineer
- Facility engineer
- H2 integration specialist
- Maintenance planner
- Maintenance trades: electrical, instrumentation and control, industrial mechanic (millwright)
- Mechanical engineers: equipment and piping, reliability
- Plant manager
- Plant operator (power engineer)
- Power scheduler
- Process control engineer
- Process engineer
- Process safety engineer



Export

- Construction craft worker
- Crane operator
- Facility engineer
- Forklift operator
- Harbour master
- Harbour patrol officer
- Logistics coordinator
- Maintenance trades: industrial electrician, industrial mechanic (millwright), painter, welder
- Material handler
- Operations coordinator
- Security guard





CONSTRUCTION

PRODUCTION

CARBON CAPTURE AND STORAGE

STORAGE DISTRIBUTION

END USES

R&D, MANUFACTURING, AND TESTING

OCCUPATIONS ACROSS THE VALUE CHAIN

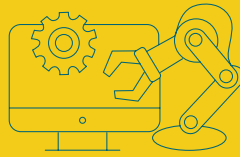
H₂

RESEARCH AND DEVELOPMENT (R&D), MANUFACTURING, AND TESTING



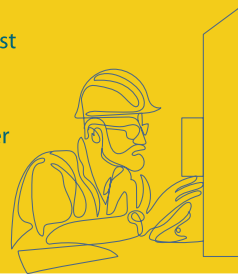
R&D

- Commercial development specialists
- Contracting/licensing professionals
- Engineers: automotive, chemical, electrical and instrumentation, electrochemical, electromechanical, mechanical
- Intellectual property specialists
- Lab technicians
- New Product Introduction (NPI) characterization scientist
- New product introduction (NPI) characterization technologists
- Process development engineer
- Scientists
- Technologists: chemical, electrical and instrumentation, mechanical
- Quality program specialist



Manufacturing

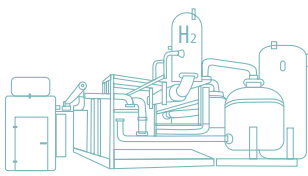
- Applications engineer
- Assembly technician
- Compliance specialist
- CNC fabrication technician
- Design engineers: electrical and instrumentation, mechanical, mechatronics
- Facility maintenance planner
- Maintenance trades: electrical, electromechanical, instrumentation and control, industrial mechanic (millwright), welder
- Manufacturing engineer
- Materials specialist
- Mechatronics engineer (facility)
- Pipefitter/steamfitter
- Production scheduler
- Production supervisor
- Quality control specialist
- Sourcing specialist
- Test technician
- Test validation engineer



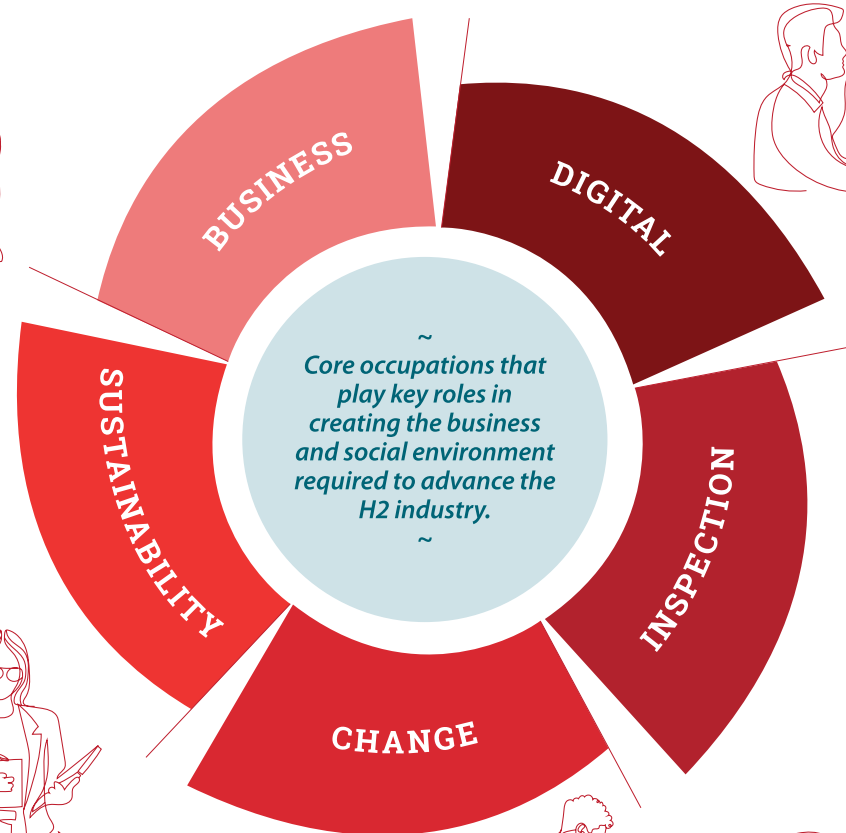
Testing

- Commissioning project engineer
- Electrical technician
- Field commissioning engineer
- Mechanical technician
- Technical procurement specialist
- Test engineer



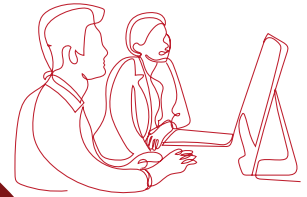


OCCUPATIONS EMPLOYED ACROSS THE HYDROGEN (H2) VALUE CHAINS



Business and commercial development occupations Key for building market pull to drive the H2 economy. Responsibilities include conducting market research, developing business plans, and communicating benefits and risks associated with the H2 industry.

- Account manager
- Business development representative
- Market researcher



IT/digital occupations
The value chains associated with the H2 economy will be highly digitized.

- Cybersecurity specialist
- Data analyst
- Data engineer
- Data scientist
- Machine learning specialist
- Software developer
- Systems integration specialist



Inspection
The emerging nature of some H2 technologies will drive the need for more regular inspections.

- Cathodic protection technician
- Coating inspector
- Construction inspector
- Corrosion specialist
- In-service pressure equipment inspector
- Non-destructive (NDE) inspector and technician
- Safety codes inspector
- Welding inspector

Regulatory, Indigenous relations, sustainability and environmental, social, governance (ESG) specialists
Supports the development of the H2 industry by improving regulatory, Indigenous relations, sustainability, and ESG-related performance. Key for meeting values-driven goals and attracting investment and talent.

- Environmental specialist
- ESG Analyst
- Government relations specialist
- Health and safety advisor
- Indigenous relations professional
- Regulatory analyst and compliance specialist
- Stakeholder engagement and communications specialist
- Sustainability specialist



Change management specialists
Focus on the people side of change, which involves preparing, supporting, and equipping people to adopt and use changes.

- Change analyst
- Change coordinator
- Change management specialist



