OPPORTUNITY ASSESSMENT

ENVISIONING A NORTHEAST BC HYDROGEN HUB IN 2035

FORESIGHT CANADA

JAN 2025

Acknowledgements

Foresight acknowledges that the lands on which we conducted this work are the traditional, ancestral, and unceded territories of the xʷməθkʷəy̓əm (Musqueam), Sḵwx̱wú7mesh (Squamish), and səlilwətaɬ (Tsleil-Waututh) Nations.

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About Foresight

Foresight Canada helps the world do more with less, sustainably. As Canada's largest cleantech innovation and adoption accelerator, we de-risk and simplify public and private sector adoption of the world's best clean technologies to improve productivity, profitability, and economic competitiveness, all while addressing urgent climate challenges.

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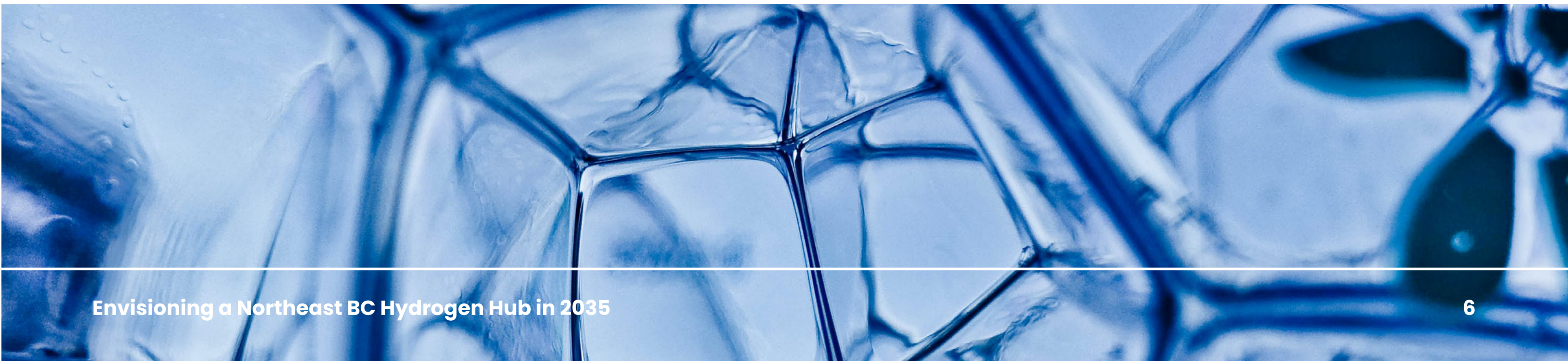
Table of Contents

Glossary

Term	Definition
Ammonia	A colourless, toxic gas with a pungent odour. Chemical formula is NH_3. Ammonia is commonly used in fertilizer production and its applications for use as a clean fuel is currently being explored.
Battery electric vehicle (BEV)	A zero-emissions vehicle that is powered by electricity from a battery.
Blue hydrogen	Common term used to refer to hydrogen produced from methane through reformation processes, paired with carbon capture, utilization, and storage (see definition of CCUS). The fraction of CO_2 that is captured varies depending on the process.
Carbon capture, utilization, and storage (CCUS)	Refers to a suite of technologies that capture carbon dioxide (CO_2) from point sources or directly from the atmosphere, store it in geological formations, or use it in a variety of applications.
Carbon intensity	A measure of total carbon emissions of something per unit of production or economic activity. Ex: for hydrogen, carbon intensity is measured as the mass of CO_2 equivalents emitted per kilogram of hydrogen produced (kg CO_2e/kg H2).
Clean energy transition	The global shift away from fossil fuel-based energy systems to renewable energy systems.
Combustion	A chemical reaction that produces heat and light in the form of a flame (e.g., burning).
Cryogenic tanker	A ship designed to store and transport liquefied gases, such as hydrogen, at very low temperatures.
Decarbonization	The process of reducing the levels of carbon emissions associated with a system or process.
Electrolysis	A process by which electric current is passed through a substance to create a chemical change. When referring to production of hydrogen, electric current is passed through water to produce hydrogen and oxygen.

Term	Definition
Energy carrier	An energy carrier is a transmitter of energy. Includes electricity and heat as well as solid, liquid and gaseous fuels such as hydrogen.
Fuel cell	A power generation device that uses hydrogen as fuel to produce electricity, with water and heat as the only by-products.
Fuel cell electric vehicle (FCEV)	A zero-emissions vehicle that runs on a fuel cell powered by hydrogen.
Green hydrogen	Common term used to refer to hydrogen produced by electrolysis (see definition of electrolysis) using electricity generated from renewable energy sources.
Greenhouse gas (GHG)	Any gas in the Earth's atmosphere that absorbs infrared radiation (heat) emitted from the Earth's surface and reradiates it back, creating the greenhouse effect. Include gases such as carbon dioxide (CO_2), methane, and water vapour.
Hydrogen	The chemical element of atomic number 1. A colourless, odourless, highly flammable gas that can be used as a chemical feedstock or energy carrier.
Hydrogen carrier	A carrier is a molecule containing hydrogen (such as ammonia) that can be easily transported and then broken down to isolate hydrogen for use at its destination.
Low carbon hydrogen	Common term used to refer to hydrogen produced from methods that produce fewer to no carbon emissions. Includes hydrogen produced by electrolysis, methane reforming with CCUS, and methane pyrolysis (green, blue, and turquoise hydrogen). The Government of Canada categorizes low carbon hydrogen as that which has a carbon intensity that does not exceed 67.8 gCO_2e/MJ.
Methane pyrolysis	A process to produce hydrogen from natural gas/methane that produces solid carbon as a byproduct instead of CO_2.
Methane reforming	Industrial processes used to produce hydrogen from natural gas. Includes methods such as steam methane reforming (SMR) or auto-thermal reforming (ATR). SMR and ATR produce carbon dioxide as well as hydrogen.

Term	Definition
Methanol	A clear, colourless liquid alcohol. Chemical formula is CH_3OH. Methanol is commonly used as an industrial substance and its applications for use as a clean fuel is currently being explored.
Molecule	Two or more atoms bonded together.
Natural gas	A gaseous, naturally occurring hydrocarbon consisting primarily of methane.
Net zero	A stage where economies emit no greenhouse gas emissions or offset any emissions.
Renewable energy	Energy created from natural processes that are replenished at a rate that is equal to or faster than the rate at which they are consumed. Includes energy generated from solar, wind, geothermal, hydropower, and ocean resources, solid biomass, biogas and liquid biofuels, but biomass is considered renewable only if its rate of use does not exceed its rate of regeneration.
Sustainable Aviation Fuel (SAF)	Sustainable aviation fuel (SAF) is a term that refers to fuels derived from non-fossil sources that have the same approximate composition and energy content but significantly lower life-cycle carbon emissions of conventional jet fuel.
Synthetic fuel	A term used to describe any manufactured fuel that has the approximate composition and similar energy content of a fuel derived from crude oil sources.
Turquoise hydrogen	Common term used to refer to hydrogen produced from methane through pyrolysis (see definition of methane pyrolysis).
Technology Readiness Level (TRL)	A measurement of the maturity of a given technology, from conception to proven commercial stbility, on a scale of 1-9 or 1-11.



Introduction

Hydrogen is a versatile energy carrier that, when produced sustainably, could play an important role in reducing British Columbia's (BC's) greenhouse gas (GHG) emissions. It can be utilized in fuel cells to power vehicles, in industrial processes as a heat source, and as a means of storing and transporting energy. However, to realize this potential growth, the sector must overcome a key challenge facing hydrogen development in BC: matching supply and demand.

Released in 2021, the BC Hydrogen Strategy highlights a regional hydrogen hub model as a solution to this challenge. [1] By co-locating hydrogen production and end-use applications, these hubs can ensure a balanced market while accelerating the growth of the local economy. This strategic approach can optimize resource utilization and create synergies among different sectors.

As part of the implementation of the BC Hydrogen Strategy, the BC Clean Energy and Major Projects Office (CEMPO) is working with Foresight to examine the potential for hydrogen hub development in the following regions where project development is underway and potential sources of demand exist: The Lower Mainland, Northeast BC, Interior BC (Kootenays and Okanagan), and Vancouver Island. Additionally, the City of Prince George and the City of Prince Rupert are exploring the development of a Northern BC hydrogen hub through opportunity assessments in each respective region.

Northeast BC has unique attributes that are advantageous to developing a hydrogen hub for several reasons:

- **Existing infrastructure:** The region has oil and gas infrastructure that can be adapted for hydrogen production, storage, and distribution.
- **Low carbon electricity:** BC's renewable hydroelectric power provides a low carbon pathway for hydrogen production.
- **End-use applications:** There are potential demand-side applications for hydrogen use in the region, including trucking and industrial decarbonization.
- **Proximity to Alberta:** The Northeast is in close proximity to Alberta hydrogen development zones, including Grand Prairie. [2,3]

This report is the second in a series of high-level assessments that intend to review regional potential for local supply and demand, and discuss opportunities and challenges associated with hydrogen hub development in the region, over the next decade.

The report is divided into three sections:

1. **Supply:** This section reviews potential sources of supply in the region, including feedstocks, production methods and locations, and transportation and storage.

2. **Demand:** This section explores the potential sources of hydrogen demand within the region, cost trends, and forecasts for demand growth.

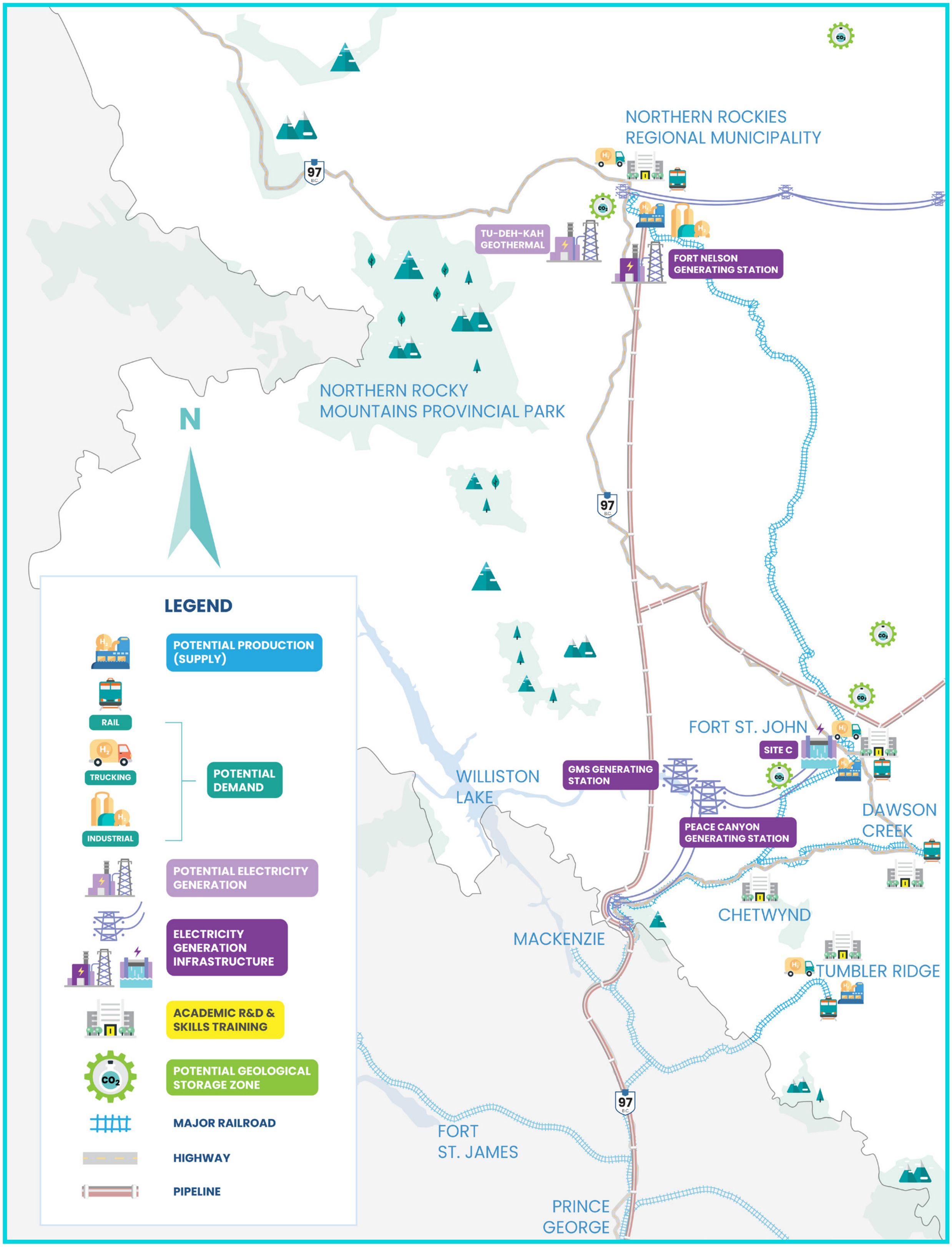
3. **Regional Considerations:** This section assesses the competitive landscape and opportunities for collaboration with neighbouring jurisdictions, as well as workforce considerations.

Each section's insights were collected from a literature review, interviews, and an in-depth workshop that was hosted in Fort St. John with key hub partners and experts. In the case of research or insights that are consistent province-wide, this report includes the same information as our Lower Mainland report.

The development of a hydrogen hub in Northeast BC by 2035 represents an opportunity for the region to fill the emissions reduction gaps that cannot be addressed by direct electrification, thereby accelerating the transition to net zero.

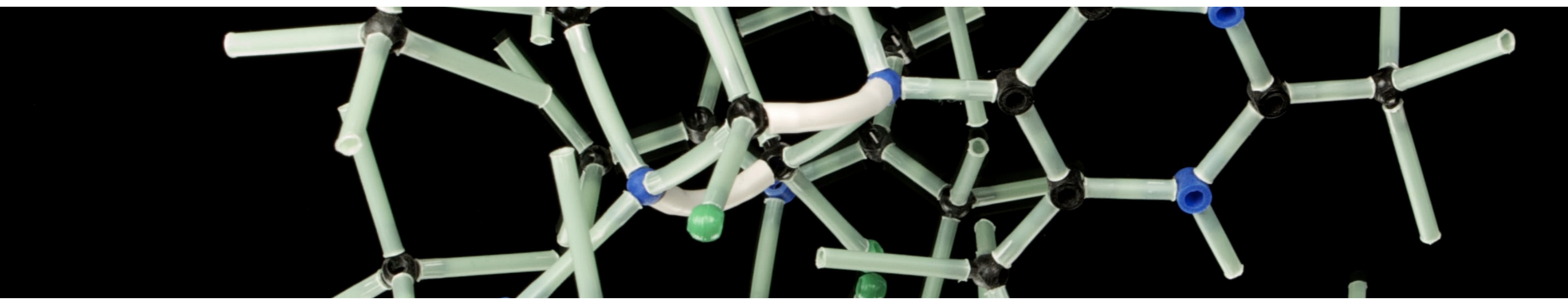
Mapping a 2035 Hydrogen Ecosystem

To provide future decision-makers and project proponents with a visualization of a hydrogen ecosystem in the region, Foresight developed a map marking areas of future supply, demand, and research and development (R&D), as well as key infrastructure.



Supply-Side

Bloomberg New Energy Finance (BNEF) modelling estimates that global clean hydrogen supply will grow thirtyfold by the end of the decade, with the majority of supply coming from non-fossil fuel sources. [4] While this estimate is subject to several uncertainties, these trends indicate that global markets will continue to grow and supply-side technologies will mature further in the next decade. In the Northeast, hydrogen production is emerging and many projects are still in the conceptual stage. Key supply-side considerations for the development of a regional hydrogen hub include production methods, locations, and transportation and storage. This section will explore each of these considerations further.



Feedstocks & Production Methods for Low Carbon Hydrogen

Blue Hydrogen

Northeast BC lies along the Western Canada Sedimentary Basin, which extends south through Alberta and Saskatchewan through to Manitoba and holds some of the largest reserves of oil and gas in the world. Given the regional availability of oil and gas and its incumbent industries, the Northeast has long appeared well-equipped to produce hydrogen derived from natural gas.

The production of “blue” hydrogen involves extracting hydrogen from methane (CH_4) molecules and capturing the resulting CO_2 for either sequestration or utilization. There are two prominent technology pathways used to produce hydrogen: Steam Methane Reforming (SMR) and Auto Thermal Reforming (ATR). SMR is commercially proven and is the primary process through which hydrogen is produced globally; it involves a chemical reaction that uses high temperature steam and methane to yield hydrogen and carbon dioxide (CO_2). ATR is a variation of SMR that has a greater thermal efficiency and involves a simpler production stream where CO_2 is more concentrated in the process gas, making capture easier. When equipped with carbon capture technology, hydrogen produced via either one of these processes is called “blue”. While variations using both technologies offer the potential to reach high levels of carbon capture (above 90 per cent) and are therefore considered “low-carbon”, they are still at the prototype stage (TRL 5) according to the International Energy Agency. [5]

What separates the Northeast from other regions of BC is the suitability of geological formations for carbon capture and storage (CCS). [6] This is the primary reason why blue hydrogen is expected to be the primary source of supply in the region within the next decade. There are two types of permanent geological storage to note that have been identified in the region:

1. **Saline Aquifers:** Deep underground rock formations that contain salty water and have significant potential for CO_2 storage.

2. **Depleted Oil and Gas Reservoirs:** Formations that have already been exploited for hydrocarbon production and now offer opportunities for CO_2 storage.

The "Northeast BC Geological Carbon Capture and Storage Atlas" project, completed by Canadian Discovery Ltd. (CDL) in collaboration with Geoscience BC, the Province, and the Centre for Innovation and Clean Energy, assessed over 130,000 square kilometers in the region and found a combined storage potential of 4.2 gigatonnes (Gt). [7] In addition to storage potential, the Atlas highlighted several important factors that should be considered for any future blue hydrogen development, including:

- **Proximity to Storage Sites:** Blue hydrogen production facilities should be strategically located near suitable geological storage sites to minimize transportation costs and infrastructure requirements.

- **Infrastructure Development:** Adequate transportation infrastructure is essential to connect hydrogen production facilities with storage sites and centers of demand.

- **Environmental Impact:** Careful consideration must be given to the potential environmental impacts of CO_2 storage, including the risk of leakage and induced seismicity, and robust monitoring and verification systems will be needed to ensure the long-term effectiveness and safety.

- **Economic Viability:** The economic feasibility of blue hydrogen in the Northeast will depend primarily on the cost of natural gas, CCS technology, and storage infrastructure.

For readers without expertise in CCS, the Atlas can help with understanding the geological makeup of the region and its potential for CO_2 storage. The report includes accessible elements such as graphs, maps, and storage potential calculations that make it easier to focus on the region's most promising areas. The maps included visualize the geographical distribution of potential storage sites, while the accompanying data on depleted gas pools and aquifers can provide a sense of the scale of storage possibilities. [7]

Lastly, it is important to note that captured carbon could also be utilized in various ways, rather than stored, and contribute to additional economic activity. For example, captured CO_2 can be used in the production of chemicals and fuels through processes such as methanation. Captured carbon could also be utilized in the production of building materials, such as concrete, where CO_2 is mineralized to enhance strength and durability while reducing the carbon footprint of construction. Plastics and fertilizer production are examples of other industries that could use captured CO_2 as a feedstock. However, many utilization pathways are not commercial yet and require further testing and research.

Other Production Methods

Another method of producing hydrogen using natural gas as a primary feedstock is pyrolysis, known as "turquoise" hydrogen. Pyrolysis technologies, which use high temperatures to break the chemical bonds in methane into hydrogen and solid carbon, and have the potential to produce hydrogen with a relatively low carbon intensity. The solid carbon byproduct can then be used as a commodity. There are various natural gas pyrolysis technologies available and variants of solid carbon can be used in different industries (e.g., rubber, construction materials, pigment for inks). [8]

Hydrogen can also be produced through a process known as electrolysis, which utilizes electricity to split highly purified water into its constituent elements: hydrogen and oxygen. Hydrogen produced in this manner is known colloquially as "green" hydrogen when renewable sources of electricity are used as the feedstock (e.g., wind, solar, or hydro). As identified in Table 1, on a provincial scale, electrolysis is projected to produce some of the least carbon-intensive hydrogen thanks to BC's predominately hydroelectric grid. However, there are two challenges in the Northeast that make it difficult to commercialize. First, as this report discusses further below, not all of the Northeast is connected to BC Hydro's grid and much of the aging infrastructure is vulnerable to natural disaster damage. Second, use of water for industrial purposes is contentious in the Northeast.

An existing source of supply is "waste" or "byproduct" hydrogen: hydrogen that is already being commercially produced as a byproduct of chemical processes. Byproduct hydrogen is typically released during industrial activities, such as chlor-alkali production and petrochemical refining, where it is not the primary product. This hydrogen can be captured and utilized, reducing waste and providing a recovered energy resource. Byproduct hydrogen is already playing a role as an early-stage source of supply in the province, and will continue to in the short term. [9] However, based on current public projections, it is not anticipated to be a large source of supply in any region of the province over the long term due to its limited ability to scale. [10]

Biomass gasification is an additional method that we do not examine further in this report. This process converts organic materials, such as agricultural residues, wood waste, or other plant-based materials, into syngas. The syngas can then be processed to separate hydrogen gas from carbon and other components. While some models view this process as having favourable prospects, it has yet to reach commercialization. Biomass-waste gasification with CCUS and biomass pyrolysis are at TRL 5 and 6, respectively, globally.

In Table 1, we list the production technologies most likely to scale as part of a Northeast hydrogen hub. The table includes each technology's approximate TRL, which measures the maturity of a given technology, from conception to proven commercial stability. It also includes carbon intensity, a measure of the GHG emissions per unit of energy produced, based on analysis from the B.C. Centre for Innovation and Clean Energy (CICE). [6] All the pyrolysis and electrolysis technologies listed in the table have projected carbon intensities below the low carbon threshold of 36.4 gCO2e/MJ adopted in the BC Hydrogen Strategy; the threshold is meant to be a starting point to define low carbon production, and represents a 60 per cent reduction "below the intensity of hydrogen produced from natural gas." [11]

Table 1. Emerging low carbon hydrogen production pathways for Northeast BC (carbon intensities including upstream emissions). [A]

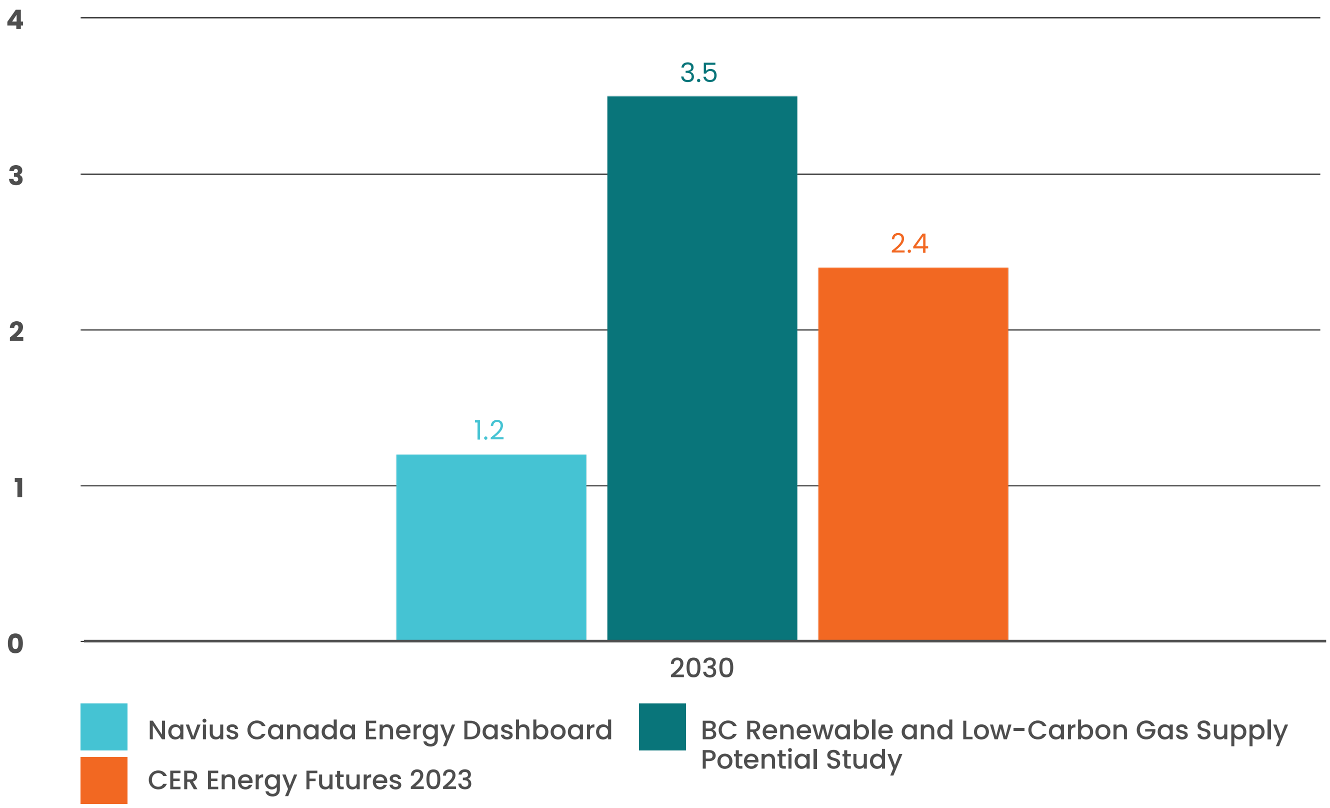
Feedstock	Technology	TRL (1-11)[5]	2030 Carbon Intensity (gCO2e/MJ) in BC [6]
Natural Gas	Electrified Steam Methane Reforming (ESMR)	4	12.2
	Steam Methane Reforming (SMR)	5-9	37.4
	Auto Thermal Reforming (ATR)	5	15
Electricty (On-Grid)	Alkaline electrolyser	9	16.2
	Polymer electrolyte membrane (PEM) electrolyser	9	15.3
	Solid oxide electrolyser	8	11.9
Natural Gas	Pyrolysis, Thermal	3-4	19.6
	Pyrolysis, Plasma	8	18.2
	Pyrolysis, Catalytic	6	19.5

[1] Note that while the carbon intensity figures in this table are among the best publicly-available projections, project proponents cannot rely on them exclusively. Projects intending to secure the federal Clean Hydrogen Investment Tax Credit must use the Government of Canada's Fuel Life Cycle Assessment Model, which has different assumptions from the CICE referenced in Table 1. Further information is available here.

Modelling Supply

There are differing projections of how much hydrogen will be produced in BC within the next decade and by what means. Using Navius Research's net zero modelling in its Canada Energy Dashboard, we observe a projection of 1.2 PJ of BC hydrogen production supply in 2030 and 2.9 PJ in 2035. [12] Navius's model projects all of this supply to come from electrolysis technologies. The BC Renewable and Low-Carbon Gas Supply Potential Study differs slightly, with approximately 3.5 PJ projected in 2030 (0.8 PJ from electrolysis, 1.5 PJ from pyrolysis, 0.9 PJ of waste hydrogen, and 0.3 PJ of biomass gasification). [10] In contrast, the Canada Energy Regulator's (CER) net zero modelling projects approximately 2.4 PJ of hydrogen production in 2030 and approximately 12 PJ in 2035; but 100 per cent of this supply is from biomass gasification in 2030, and in 2035 electrolysis technologies account for 20 per cent of provincial supply (~2.4 PJ).

Figure 1. Projected BC hydrogen production in 2030.



Electricity Supply

BC Hydro's 2021 Integrated Resource Plan (IRP), which projects the province's electricity needs over a 20-year planning horizon, has an "accelerated electrification" contingency plan that assumes the province meets its CleanBC emissions targets. [13] The plan lists future gaps between projected supply and demand, and notes that additional resources will need to be procured to meet the needs of the low-carbon transition, including new sources of electricity demand such as hydrogen production. BC Hydro is currently developing its 2025 IRP, which should discuss these opportunities and challenges further. [14]

Given the uncertainty of these future constraints and where new sources of generation will come from, it appears reasonable to question whether on-grid hydrogen production will be competing with other grid users (electric vehicles, heat pumps, industrial electrification) in the future. Time will tell as new sources of electricity supply are secured; however, given the requirements of both electrification and hydrogen production technologies, the Province will have to carefully consider how new hydrogen projects will impact the wider goals of economy-wide emissions reductions across all sectors. Nonetheless, BC's Clean Energy Strategy, released in 2024, asserts that hydrogen will be a pillar of the clean fuels mix and affirms support for the use of BC's low-carbon electricity in hydrogen production.[15]

As part of the Clean Energy Strategy, the province set a new commitment to conduct competitive calls for power every two years. [15] In April 2024, BC Hydro launched a call for 3,000 gigawatt-hours (GWh) of new power, yielding 21 proposals from independent power producers across the province (totaling over 9,000 GWh in potential generation), including two from the Peace Region. [16,17] While this volume is promising, it is important to note that in the context of a Northeast hub, current transmission infrastructure limits access to this power to only the southern part of the Northeast. BC Hydro's high-voltage (500 kV) transmission lines only reach as far north as Fort St. John, with lower-voltage lines extending only a short distance to surrounding areas and communities. [18]

It should also be noted that like the rest of the province, the Northeast is facing climate-related constraints that can affect the reliability of future electricity supply for all uses, including hydrogen production. For example:

- **Hydrological Changes:** Climate change will alter precipitation patterns, increase temperatures, and change the timing and volume of spring runoff. These changes can impact hydroelectric power generation, which relies on consistent water flows.

- **Drought Conditions:** Extended periods of dry and warm weather, as experienced in recent years, have led to record-low water levels in some reservoirs. This affects the ability to generate hydroelectric power consistently. BC has experienced some of its driest and hottest extended periods on record, impacting water availability for power generation.

- **Extreme weather events:** Wildfires, flooding and droughts can disrupt electricity supply and damage infrastructure.

Fort Nelson Region Long-Term Resource Plan

BC Hydro also developed a Long-Term Resource Plan (LTRP) specifically for the Fort Nelson region in 2024, which outlines the strategy for meeting local electricity needs over the same 20-year planning horizon while balancing reliability, affordability, and the needs of a low-carbon transition. [19]

The Fort Nelson region has unique considerations compared to the southern section of the Northeast surrounding Fort St. John; for example:

- **The region is unique**, being isolated from BC Hydro's integrated system but connected to Alberta's grid via a 144 kV transmission line.
- The region currently has **two main sources of electricity supply** (each of which are capable of meeting local demand on their own): the gas-fired Fort Nelson Generating Station, and the transmission service from Alberta.
- **Wildfires in 2023 and 2024 damaged transmission lines** and required repairs that caused interruptions in service. In its consultation with First Nations, stakeholders, and customers, the LTRP identified the urgency of improved reliability.

The LTRP's forecast indicates sufficient supply throughout the planning horizon with existing resources. However, BC Hydro notes that, currently, the Fort Nelson Generating Station is not equipped to meet the emissions standards of the proposed federal Clean Electricity Regulations and consequently would not be able to be used as a primary source of electricity. In response, two primary technology pathways are being explored:

1. **A geothermal pilot project** to confirm development potential
2. **Carbon capture technologies** for the Fort Nelson Generating Station

Alternative technologies and pathways also being monitored by BC Hydro include:

- **Local production of renewable fuels** (hydrogen, biomethane)
- **Wood-based biomass electricity**
- **New connection to BC Hydro's integrated system**
- **Wind and solar** (with battery storage)
- **Reconfiguration to smaller gas turbine units**

Indigenous-Led Projects

There are also Indigenous-led projects in the region seeking to expand the supply of clean electricity. A prominent example is the Tu-Deh-Kah geothermal project, a Fort Nelson First Nation-owned project with a target to generate between 7 and 15 MW. The project would be the first of its kind in BC and play an important role in decarbonizing local electricity supply, including any future green hydrogen or renewable fuel projects. Operations are planned to begin in 2027. [20,21]

Transportation & Storage

After production, hydrogen can be transported by truck, rail, or pipeline. Hydrogen requires specialized storage and transportation methods, such as compression, liquefaction, or conversion to alternative carriers like ammonia, methanol or liquid organic hydrogen carriers (LOHCs). Each method has its own technical and economic trade-offs, and the choice depends on factors like distance, volume, and end-use requirements. [22]

Growing hydrogen supply may require a “bulk hydrogen transportation corridor to accommodate large-scale adoption.” [23] In response, FortisBC is exploring the repurposing of its gas pipeline infrastructure to enable a “blended hydrogen stream.” [23] However, generalizing blending limits is considered “problematic because hydrogen compatibility depends on existing infrastructure component factors.” [24] FortisBC and Enbridge have commissioned a comprehensive blending feasibility study, with support from the Province, for their distribution networks. [25,26]

Transportation is an important part of the life cycle emissions associated with hydrogen. According to CICE, transporting hydrogen by truck locally would add an average of 2.8 g CO_2eq per MJ of hydrogen (in this case measured over an 80 km distance). [6] In contrast, the use of existing pipeline infrastructure for distribution would minimize transportation emissions.

Transporting hydrogen does pose significant costs. According to the Transition Accelerator report “The Techno-Economics of Hydrogen Pipelines” transporting hydrogen can account for up to 70 per cent of its total cost. The report highlights that pipelines are the most cost-effective method for transporting large volumes of hydrogen over long distances, but the initial capital costs for new pipeline infrastructure are substantial. [27]

In the Northeast, Enbridge’s BC pipeline transports natural gas from Fort Nelson to markets in the south of BC and the US. The TransCanada Foothills Pipeline also passes through the Northeast region and the Coastal GasLink Pipeline and Prince Rupert Gas Transmission pipeline would further increase the region’s pipeline infrastructure.

For more information on the risks, opportunities and infrastructure needs associated with transporting hydrogen in BC, including the use of carriers such as Methanol, Ammonia and LOHCs, readers are encouraged to review Foresight’s detailed report: “Hydrogen Transportation And Infrastructure Analysis” [28]

What We Heard: Expert Feedback on Supply

In our workshop, participants were gathered and asked: "What are the key challenges and opportunities related to increasing the production, distribution, and transportation of hydrogen in the region?" The following themes represent the summarized feedback collected by facilitators.

Feedstock Availability

- There is **plentiful gas feedstock** in the region for hydrogen production, such as "Dry gas" available in the Horn River basin and Fort Nelson regions. Dry gas has a high methane content and requires minimal processing before use.

- **Water scarcity and drought** conditions pose challenges for electrolysis-based production.

- **Regional geology** is appropriate for CCS.

Transportation Infrastructure

- An advantage for the Northeast is that it has **extensive existing pipeline infrastructure** and deep engineering expertise.

- On the other hand, **costly shipping and transportation is currently a barrier** for the region. Distance from potential customers in southern regions of the province makes the economics of supply difficult.

- There is also **limited rail capacity** in the region, and the railways that currently exist require major upgrades. Limited access and aging infrastructure leads to reduced capacity.

- Other major projects in the region have seen **companies pay for key infrastructure** upgrades, such as rail line upgrades for coal mining near Tumbler Ridge. This should be a key part of private and/or provincial support for future hydrogen projects in the region.

Regulation and Permitting

- There is a need for **streamlined processes and clarity** for project proponents, who report challenging regulatory processes at provincial and federal levels.

- **Uncertainty in permitting timelines and approvals** were suggested as an example of the barriers faced by project proponents.

Supply-Side Recommendations for Hub Partners

- **Focus on carbon capture technology development and literacy.** Based on expert feedback and existing literature, the Northeast is the best suited region in BC for blue hydrogen production, thanks to its promising geological formations that allow for carbon sequestration. Because this is an evolving sector that can experience rapid changes in technology readiness, governments, utilities and industry groups will need to closely monitor the costs and availability of carbon capture technologies. Being responsive to new data and research will be critical to limit the risk of stranded assets and it will be important for local governments and regulators to have a strong understanding of the prospective technologies and their differences. The sector is currently in an exploratory phase, meaning, as new data on carbon intensities, energy consumption and costs of carbon capture technologies becomes available in the coming decade, project proponents should be prepared to scale whichever option is most feasible. Northeast stakeholders and rights holders could work with the province to share resources and knowledge on technology development over the next decade. **[Recommendation Lead: All Partners]**

- **Provide further public clarity on electricity infrastructure adaptation and growth.** There is concern from many potential hub partners and project proponents about the future availability of clean electricity and the reliability of infrastructure amidst damaging natural disasters. The Province should work with BC Hydro to disseminate key information and better communicate the challenges ahead to local stakeholders and rights holders. There is a need to clarify BC Hydro's approach to its modelling and transparently share how it is planning for increased demand, as well as build resiliency in the system. Further clarity will help build the confidence of hydrogen project developers, investors and local governments. The 2025 IRP is a good opportunity to strengthen communication on these challenges. **[Recommendation Lead: Province, Utilities]**

- **Continue support for market-based policies that increase competition between hydrogen and carbon-intensive fuels.** Experts cited economic viability as a key area of concern. For regional hydrogen production to compete with well-established fuels, continued pollution pricing and market-based regulations will play an essential role and allow the least carbon-intensive technology to succeed in the market. However, special considerations will also need to be paid to the unique energy needs and costs in the north. Project proponents may need greater per-unit subsidies for projects to succeed than counterparts in the Southern regions of the province. **[Recommendation Lead: Province]**

Demand-Side

BNEF's net zero modelling expects global clean hydrogen demand to quadruple the current level of fossil fuel-based hydrogen demand by 2050, to 390 million tons per year, with most going towards transportation, steel and methanol decarbonization. They note that this is mainly fulfilled by electrolysis production. [29] Hydrogen appears likely to play a niche, but important, role in fulfilling global low carbon energy demand in the path to net zero.

In the local context, the CER's net zero modelling projects approximately 5-6 PJ of economy-wide hydrogen demand in BC in 2030, and 17-20 PJ by 2035. However, virtually all of this demand (over 90 per cent) is projected to come from the transportation sector, with a small portion from industry. [30] BC's climate accountability reporting corroborates this sectoral distribution, through its own modelling conducted by Navius Research. The modelling scenario (only available to 2030), where the province meets its CleanBC climate targets, projects hydrogen demand in 2030 will be slightly higher, at 8 PJ (approximately 66,667 tonnes of H2), and come almost entirely from heavy-duty trucks and rail, along with a small portion from heavy industry. [31] There is no publicly available modelling for the Northeast region alone, therefore, assumptions must be made to a certain degree based on provincial-wide forecasts.

Potential End-Users in 2035

In BC, experts have outlined a variety of potential end uses for hydrogen, which are listed in the following table. While publicly available modelling does not indicate that all these sources of demand will appear in the next decade, some may be generated in the long term and are worth noting in this assessment.

Legend	
Hydrogen Suitability Indicator Colour	**Suitability (2024 - 2035)**
H–H (green)	Well Suited for the Region
H–H (yellow)	In Development/Further Evidence Needed
H–H (red)	Not Suitable for the Region

Table 3. Potential end uses of hydrogen in the Northeast.

End-Use	Description
Transportation Fuel	Modelling by the CER found that in the long run in Canada, "hydrogen primarily fuels long-haul transportation in heavy trucks, marine shipping, and hydrogen-based fuels are used to help decarbonize aviation." [32] Navius Research's Canada Energy Dashboard supports the conclusion that hydrogen's main use in BC will be as a transportation fuel. [12] **Heavy-Duty Vehicles** Fuel cells use hydrogen as a fuel to create electricity, water, and heat. Fuel Cell Electric Vehicles (FCEVs) are being explored as an internal combustion engine replacement for on and off-road transportation applications that have limited cost-effective decarbonization options. In most cases, Battery Electric Vehicles (BEVs) are projected to be the most energy-efficient and cost-effective method of decarbonizing on-road transportation over time. [29] This is particularly true, in the case of light-duty vehicles—23 per cent of light-duty vehicles sold in BC in 2023 were BEVs. [33] This is also true of most medium-duty vehicles, including buses, drayage, short-haul, and urban freight vehicles. [34] However, battery technology does not currently have near-term prospects to meet the demands of most of the heaviest vehicles. There is a large and growing opportunity to build the provincial hydrogen sector around the heavy-duty market. According to most experts, FCEVs are the most promising solution to replace heavy diesel class 8 vehicles that need to travel long, mountainous distances and carry large cargo loads. A cost analysis from NREL projected FCEVs to be cost-competitive in the US for these types of long-haul trucks by 2035. [35] In Northern BC, BC company Hydra Energy deploys dual-fuel co-combustion technology for heavy-duty vehicles, allowing long-haul trucks to lower their GHGs by using a mix of low-carbon hydrogen with diesel. Hydra is building a production and refuelling facility in Prince George that will launch in late 2026 and play a large role in facilitating the operation of trucking routes between Northeast, Central, and Northwestern BC. [36] In the Northwest, a pilot project led by the Port of Prince Rupert is testing four new zero and low-emission heavy-duty trucks, two of which are FCEVs and another of which is a hydrogen-diesel co-combustion vehicle. [37,38] **Rail** Similar to on-road vehicles, rail operators are piloting hydrogen fuel cell technologies as an alternative to fossil fuel-powered locomotives. Rail transportation plays an important role in the distribution of commodities across Northern BC, so in the absence of new electrified alternatives, fuel cells engines could help decarbonize northern transportation routes, including the transportation of hydrogen itself. CP Rail, which has hydrogen production locations in Edmonton and Calgary, is piloting hydrogen fuel cell locomotives in Alberta that could be used for cross-border travel to BC. 39 If the technology is successfully commercialized within the next decade, it could play a valuable role in the Northeast hub. However, first and foremost, as other sectoral reports have identified, the lack of rail capacity and aging infrastructure needs to be addressed. [40]

Industrial Decarbonization

In industries where direct electrification technologies do not exist or are not technically and/or financially feasible, hydrogen holds potential as a decarbonization solution. While the public modelling detailed above suggests that hydrogen is not expected to be a major source of emission reductions in the next decade, the Northeast has a few potential sources of demand.

Hydrogen for Heat

In many industrial processes, fossil fuels are used as energy sources and combusted to produce high temperature heat. Low carbon hydrogen can be combusted directly in boilers, furnaces, and turbines to generate heat without producing CO_2 emissions. In any industry with a demand for high-temperature heat, fossil fuels could be replaced by hydrogen or other renewable fuels. There are no current demonstration projects using hydrogen for heat in the region; however, the technology is being commercialized in other regions. While the sector is facing difficulties and increased closures, pulp and paper companies in BC have demonstrated interest in testing hydrogen for high-temperature applications, such as replacing natural gas for the drying of wood chips or other forms of biomass drying in sawmills.

Hydrogen as a Chemical Feedback

Hydrogen serves as a crucial feedstock in various chemicals, such as ammonia (one of the largest global consumers of hydrogen, driven by the fertilizer industry) and methanol. The Northeast doesn't currently have any low-carbon ammonia or methanol projects under development, nor any petroleum refineries. However, in Alberta there are a few proposed ammonia and methanol projects. [41] If demand for low-carbon ammonia and methanol expands and carbon capture technology becomes commercialized, the Northeast may be well suited to follow Alberta's lead and be a BC centre for low-carbon methanol production, and therefore hydrogen demand. For example, one assessment report modelling low-carbon fuel uptake at the Port of Vancouver projected that vessels could demand approximately 22 thousand tonnes of methanol annually by 2030, and nearly 10 times that amount by 2040.[42] An expanded demand of this kind in the shipping industry would require a significant expansion of provincial production—albeit with the challenge of keeping the carbon intensity of transportation low.

Energy Storage

Hydrogen fuel cells can convert hydrogen into electricity with zero point-source emissions. In industrial sites, there is a possibility that hydrogen fuel cells could provide on-site power generation for facilities, complementing grid electricity.

After production, hydrogen can be stored until needed and used as a source of power generation during peak demand or when intermittent resources are unavailable, either through a fuel cell or combustion. Using hydrogen for energy storage could complement renewable electricity deployment in remote communities that are not grid-connected and could help communities transition away from a reliance on diesel power generation. This approach would only be sensible if the cost and carbon intensity of the hydrogen used was lower than diesel, and if it was deployed in climates where battery storage is proved to be prohibitively ineffective. The relative efficiency (energy conversion loss) of hydrogen compared to electrification is low, and community use would require new infrastructure for storage and distribution.

The latest research from CICE suggests that in BC, the likeliest use case for hydrogen as a form of long-term energy storage is on industrial sites that will have already invested in hydrogen infrastructure and co-located supply and demand; it could be used as a backup to smooth out power demand or provide competitive combined power and heat. [43] Otherwise, its levelized cost is uncompetitive. [43]

In the non grid-connected regions of Northeast BC, such as the Fort Nelson region, future industrial projects could benefit from hydrogen storage. In the more densely populated Fort St. John region, clean on-grid electricity and battery storage may be better suited.

Built Environment Heating

Some companies are exploring using hydrogen to reduce the carbon intensity of gas supply by blending it with natural gas and injecting it into the pipeline network, for commercial and residential building customers.

There would be logistical and safety challenges with this approach, as blending beyond a roughly 20 per cent volume would require that existing pipelines be retrofitted or new pipelines be constructed to accommodate hydrogen gas requirements. As mentioned in the supply section, FortisBC and Enbridge have commissioned a comprehensive blending feasibility study, to examine these questions further.

Furthermore, a recent analysis by CICE found that "blending hydrogen at approximately 20 per cent by volume" into the provincial gas grid could yield emissions reductions of only 1.7 per cent to four per cent, and should be considered a low-priority use of hydrogen. [6] Research by the Canadian Climate Institute corroborates this; a new report found that building heat will not be a cost-effective use of hydrogen in the long term (buildings account for only a small portion of low carbon gas use in a cost-optimized net zero modelling nationwide). [44]

Blending could serve as an initial offtake for blue hydrogen while regional demand grows, to stabilize the market; however, the latest evidence suggests that it should not be considered a high-priority use of hydrogen in the medium or long-term. Other approaches to decarbonizing the built environment in the northeast, such as deep retrofits, demand-side management, dual-fuel heat pumps, and renewable natural gas are likely better suited.

Cost Trends

The cost of hydrogen can fluctuate significantly as it is contingent upon the specific technology pathway employed. These costs are influenced by many factors, including the prices of feedstocks (such as natural gas or electricity), the capital investments required, ongoing operational expenditures, and transportation costs. Costs are generally projected to decline as economies of scale are achieved. For example, the CER assumed in its 2023 Energy Futures report that electrolyser capital costs will decline by 80 per cent by 2030. [32] Additional factors that will vary over time include taxes and possible offsetting revenue streams for the producer (e.g., solid carbon).

HTEC's current retail price for hydrogen at its fuelling stations in the Lower Mainland is $14.70 per kg. [45] There are no stations currently operating or planned in the Northeast. However, HTEC is planning to build refueling stations in Prince George. [46] The BC Hydrogen Strategy estimated that a competitive production cost would need to be no higher than $3 per kg by 2030 (approximately $25 per GJ based on an assumed hydrogen energy content of 120 MJ per kg). [1]

Table 4. Projected 2030 production cost at a national level.

Source	2030 Hydrogen Production Cost Projection	Production Method
Canada Hydrogen Strategy[11]	$1.38 - $4/kg	SMR + CCS
Transition Accelerator[47]	$1.38/kg	SMR + CCS
	$3.17/kg	Electrolysis
Canada Energy Regulator[32]	$1.50 - $10.50/kg	All technologies
ESMIA[48]	$1.71 - $2.03/kg	All technologies

Three BC studies over the last five years completed analyses to project cost curves for each major hydrogen production method. The results are available in the following table.

Table 5. Projected 2030 production cost in BC.

Production Method	Projected 2030 Production Cost in BC		
	The Potential for Methane Pyrolysis in BC (2024)[8]	B.C. Renewable and Low-Carbon Gas Supply Potential Study (2022)[10]	BC Hydrogen Study (2019)[49]
Electrolysis	\$6.07 - \$9.87/kg	~\$35 - ~\$41/ GJ (\$4.2 - \$4.92/kg)	\$5.13 - \$7.38/kg
Pyrolysis	\$2.71 - \$6.71/kg	~\$18/GJ (\$2.16/kg)	\$1.68 - \$2.28/kg
ATR + CCS	\$2.71/kg	-	-
SMR + CCS	-	~\$18/GJ (\$2.16/kg)	\$2.14/kg

Unlike the other literature, the CICE report "The Potential for Methane Pyrolysis in BC" went a step further and undertook valuable analysis to present cost projections for delivered hydrogen for each technology. The study found that "hydrogen compression, loading, and transport can add significant costs to the total LCOH, between \$0.2/kg to \$6/kg depending on the transport distances, volumes, and transportation method." The federal Hydrogen Strategy presented a target cost for delivered hydrogen (which includes all production and transportation-related costs) of \$1.5-\$3.5/kg, after 2030. [11]

While the best available public estimates indicate that hydrogen production costs will be near the BC Hydrogen Strategy's target for global competitiveness of \$3/kg, new research signals that, particularly at smaller production quantities, processing and transportation costs are expected to add significantly to the final price. This is particularly important to consider in the context of a co-located hydrogen hub where demand is not expected to reach large quantities in the next decade.

What We Heard: Expert Feedback on Demand

In our workshop, participants were gathered and asked: “What are the key challenges related to the end-use of hydrogen in the region?” The following themes represent the summarized feedback collected by facilitators.

Regional Readiness

- While the region’s strong agricultural base and industrial potential offer avenues for hydrogen adoption, **issues related to infrastructure, economic viability, and workforce readiness need to be addressed.**

- **Key infrastructure such as roads, bridges, railways and transmission lines are either degrading, aging, or vulnerable** to natural disasters such as wildfires. Public infrastructure investment must be a priority to ensure demand-side actors have the means to adopt new technologies.

- **The high cost of hydrogen technology and infrastructure is a major barrier** to adoption and there is a limited availability of hydrogen-powered vehicles and core technologies.

Stimulating Demand

- To ensure a balanced market, **both supply and demand for hydrogen** must be developed concurrently.

- Initial steps to build the market could involve **blending hydrogen** to transport it to gas heating customers as an initial source of demand; although, this is considered a low-priority use in the long term.

- **Heavy-duty vehicles,** including long-haul class 8 trucks and off-road vehicles used for the agriculture and construction industries should be high-priority areas.

- **Hydrogen could serve as a backup electricity generation system** during power outages. For remote or off-grid communities in the northeast, this could help reduce reliance on diesel.

- **Identifying anchor tenants** (e.g., trucks, blending, rail) can help secure demand in production zones and catalyze investment in the hub.

Public and Industry Perception

- **Demonstration projects** can help build social license and industry understanding of new technologies.
- There is **uncertainty and a lack of information regarding the cost-effectiveness** of hydrogen adoption. In addition to market certainty and stable government policies, potential regional investors need more information on the learnings of early adopters to encourage investment.
- Public and private rights holders and stakeholders need **further educational** opportunities regarding the benefits and potential of hydrogen for decarbonization, and its contrast to other decarbonization pathways.

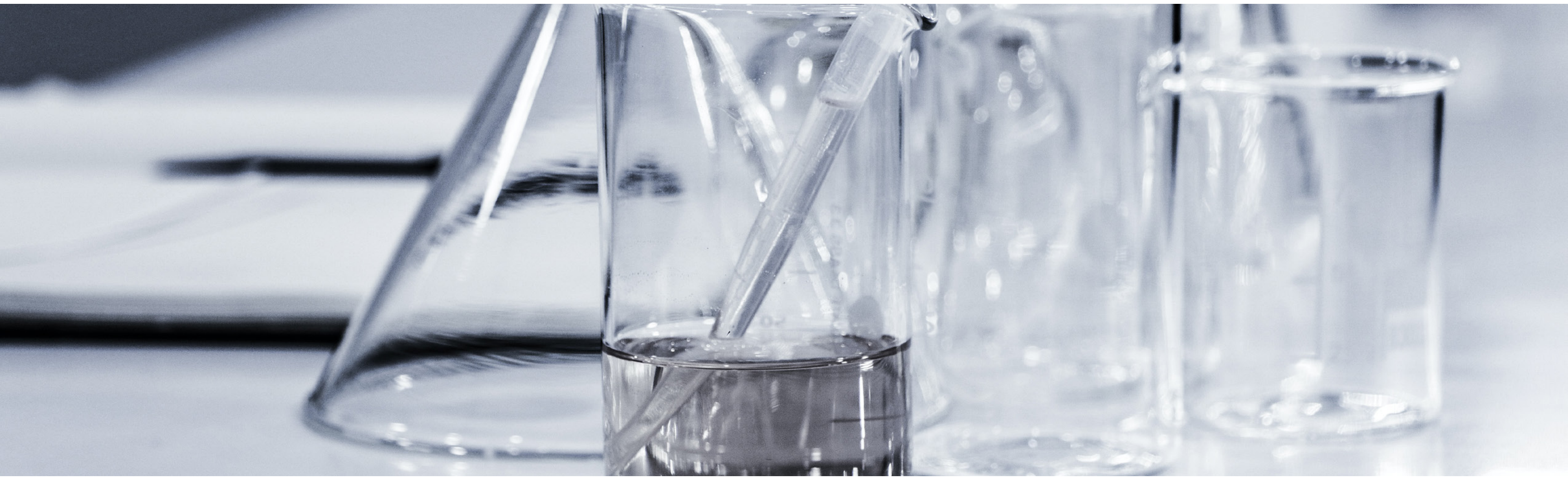
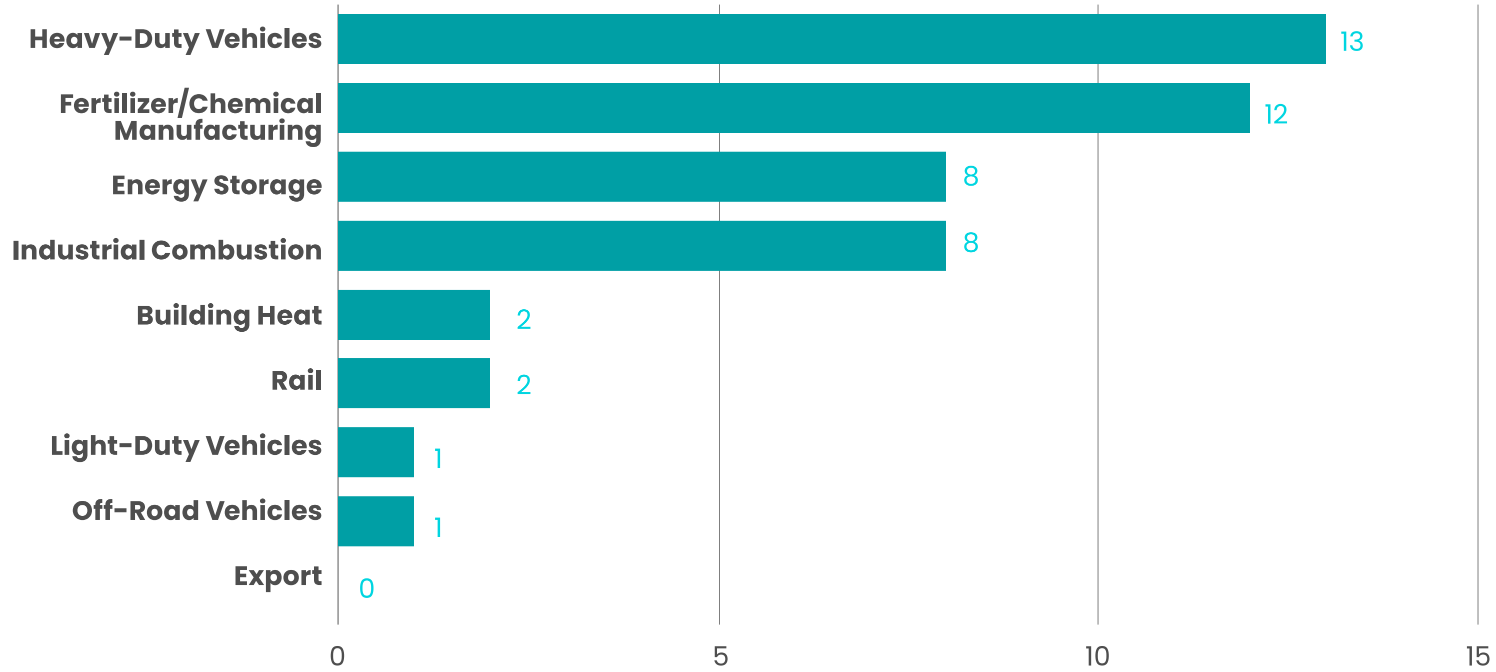


Figure 2. Workshop polling results: Likeliest sources of regional demand in 2035.



Demand-Side Recommendations for Hub Partners

1. **Focus the Northeast hub's development around heavy transportation.** The latest evidence and expert consensus suggest that these will be the primary sources of hydrogen demand in the province. In the next decade, on-road class 8 vehicles will be a target with supportive infrastructure (e.g., refuelling stations) already being built. Policy-makers should work with utilities to plan infrastructure development and incentives accordingly, and closely monitor how the costs of hydrogen end-use technologies compare to electrification counterparts over time. Rapid cost declines are not off the table for new and evolving technologies (e.g., BEVs, FCEVs) and could change the consensus. **[Recommendation Lead: All Partners]**

2. **Limit consideration of blended hydrogen for heat as a pathway to reduce emissions.** Consider blended hydrogen for heat as a short-term anchor tenant if supply outpaces the demand side of technology adoption. Beyond that, government should not consider additional support for an end use that evidence suggests will not make a meaningful difference in meeting our emission reduction goals. **[Recommendation Lead: Province, Utilities]**

3. **Continue government funding for demonstration projects and communicate outcomes.** Canada has an adoption problem across all cleantech sectors. Continued government support for pilot and demonstration projects is critical to build confidence in potentially key end-use technologies and pave the way for commercialization (e.g., ICE Fund). Existing BC support for new projects is helping lay the foundation for sectoral growth. Furthermore, it is essential for project proponents and government funders to disseminate the findings and outcomes of early adopters, including information such as technical feasibility and limitations, return on investment, and carbon intensity, to build greater understanding of technology development in the market. **[Recommendation Lead: Province, Industry]**

Regional Considerations

Northeast BC holds a strategic position, with access to robust infrastructure and established oil and gas operations. This section will discuss the opportunities for the region to stand out and leverage synergies with neighbours.

Competitive Advantages

The Northeast holds several competitive advantages for hydrogen development. Its rich natural resources and existing oil and gas infrastructure are valuable foundational elements of a future hydrogen hub. The region boasts rich natural gas reserves, which can serve as a feedstock for production, and existing regional gas infrastructure, including extraction facilities, processing plants, and pipeline networks, can be adapted for hydrogen development and distribution. Most importantly, the region holds immense geological carbon storage capacity, in the form of depleted gas reservoirs and saline aquifers, which is crucial for producing low-carbon hydrogen from natural gas. [7] This combination of feedstock and carbon storage potential positions the region as the ideal location for blue hydrogen production in the province.

The region is well-connected through existing transportation networks, including railways and pipelines, which could facilitate the movement of hydrogen to key industrial centers for use and, in the case of surplus production, exported to Northwestern BC ports or across the Alberta border.

The incumbent oil and gas industry and infrastructure presents a cost-effective pathway for large-scale hydrogen deployment in the region. Moreover, the proximity to commercial oil and gas activity within and across the province also improves the likelihood of successful CCS technology deployment. Local expertise in energy production, engineering, innovation, and safety, all lend themselves well to the needs of an emerging hub.

Government commitment to reducing emissions and promoting clean technologies also creates a favourable environment in the Province as a whole. Incentives, grants, and supportive regulations encourage investment and innovation in the sector. At the provincial level, CleanBC programs and policies including the Low Carbon Fuel Standard, Zero Emission Vehicle Act, Go Electric program, and others advance adoption of hydrogen technologies and its competitiveness with other energy sources.

Opportunities for Collaboration

The development of a Northeast BC hydrogen hub presents significant opportunities for collaboration both within British Columbia and with neighboring Alberta, creating a synergistic network that could accelerate the growth of the hydrogen economy across Western Canada:

Intra-BC Collaboration

Northeast BC's hydrogen hub could form strategic partnerships with other emerging hydrogen hubs in the province, such as those in the Lower Mainland, Interior BC (Kootenays and Okanagan), and Vancouver Island. These collaborations could focus on knowledge sharing, technology transfer, and the development of integrated supply chains. For instance, the Northeast hub, with its abundant natural gas resources and carbon storage capacity, could supply excess blue hydrogen to other regions in BC that may have limited production capabilities but growing demand. The hub could also benefit from the expertise of the Lower Mainland's established hydrogen and fuel cell industry, where most of Canada's hydrogen and fuel-cell companies are located.

Collaboration with Alberta

Alberta is a leader in the hydrogen industry due to its extensive energy infrastructure and expertise in oil and gas. Alberta's expertise in hydrogen production and use, with its existing sources of supply and demand, is complemented by significant investments in CCUS technologies, making it a competitive region for development. The majority of this activity is centered around Grande Prairie, the Alberta Industrial Heartland and the Edmonton Hydrogen Hub. The strong local industrial base, investments in hydrogen production, and storage position the region as a competitor and collaborator with the northeast. Major emerging hydrogen projects in Alberta include the $2 billion Linde Blue Hydrogen Project, Air Products' Edmonton-based "Canada Net-Zero Hydrogen Energy Complex," and "Ekona Plant One" located at ARC's Gold Creek Natural Gas Plant in Grande Prairie. [3,50,51]

Given Northeast BC's proximity to Albertan oil and gas operations, there are substantial opportunities for cross-provincial collaboration. Both regions have significant natural gas resources and are exploring blue hydrogen production. A collaborative approach could lead to the development of a larger, more robust hydrogen corridor along major transportation routes connecting the two provinces. This could facilitate the creation of a comprehensive hydrogen infrastructure network, potentially extending from Northwestern BC ports across Northeast and Central BC, to major Alberta cities like Edmonton, Calgary, and Grand Prairie. Such collaboration could also involve joint research initiatives, shared infrastructure projects such as pipelines and storage facilities, and coordinated policy approaches to create a more attractive investment environment for future large-scale hydrogen production projects.

Collaboration with Alberta across all of BC's future hydrogen hubs will be essential to enhance the hydrogen supply chain in Western Canada. Inter-provincial partnerships can facilitate knowledge sharing, technology transfer, and help establish a cohesive regional market to improve market stability.

Potential Barriers to Overcome

Regulatory and Policy Needs

Aligning regulations related to hydrogen production, storage, and distribution will be important for development in Western Canada. Standardized safety protocols and environmental regulations can mitigate these challenges. CSA Group is working to address these barriers to promote safety and harmonize requirements across North America.

The transition from oil and gas regulations to a comprehensive framework for hydrogen, ammonia, and methanol projects may create short-term challenges. Coordination between various regulatory bodies, including the BC Energy Regulator (BCER), Technical Safety BC, and local municipalities, will be crucial to streamline the permitting process.

Infrastructure and Transportation

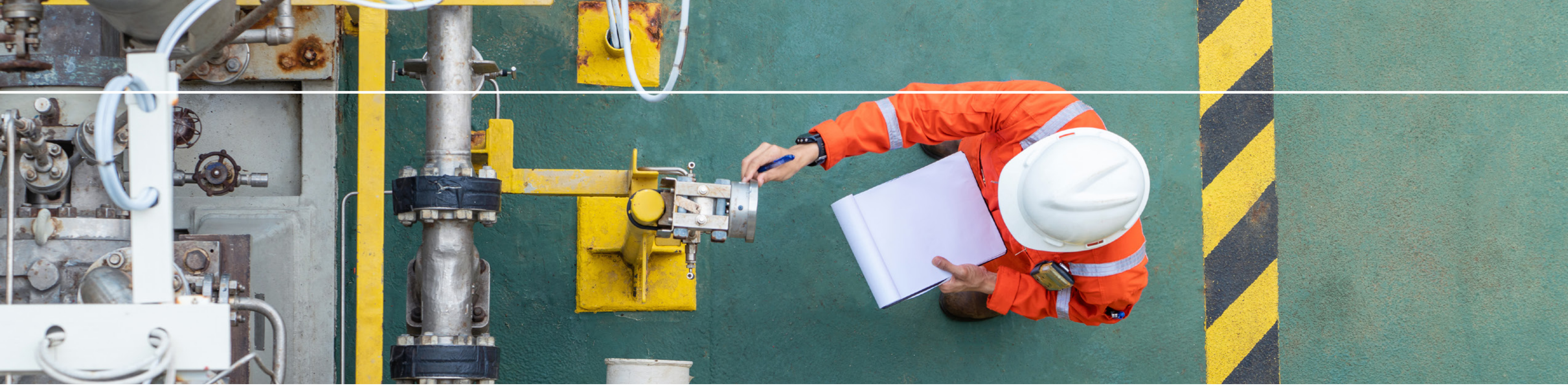
While Northeast BC has extensive natural gas infrastructure, adapting it for hydrogen production and distribution poses significant challenges. The region's vast geography and relatively sparse population centers create logistical hurdles. Developing a robust hydrogen pipeline network or establishing efficient transportation routes (e.g., trucking or rail) would be crucial but costly. [28] Additionally, the harsh winter conditions in the region may present operational challenges for aging, repurposed infrastructure. Alignment between regional partners will also be critical; building the necessary infrastructure requires coordination between regions (both intra-BC and interprovincial) and differences in readiness could create bottlenecks.

Power Availability

While blue hydrogen is expected to be the primary source of supply in the region, low-carbon blue hydrogen production methods still have substantial electricity needs. The region will need to balance its power needs with other industrial and residential demands, potentially requiring large investments in new power generation and transmission infrastructure. The momentum for new grid-connected generation is building, with the operationalization of Site C bringing approximately 5,100 GWh online and BC Hydro's 2024 call for power announcing nine new wind projects worth over 5,000 GWh. [52]

Market Development and Demand

Fostering local demand for hydrogen in Northeast BC could be challenging due to its relatively small population and industrial base compared to more densely populated areas of the province. Developing end-use applications for hydrogen and fostering partnerships with potential large-scale consumers across the north (e.g., industrial decarbonization, long-haul transportation) may be key to the hub's future success, and it would be critical for northern regions to work together to foster a collaborative market. Joint efforts to stimulate demand, such as joint public-private partnerships and incentives for hydrogen adoption in various sectors, can play a role to enhance market attractiveness. [38,53,46]



Workforce Development Needs

The development of a hydrogen hub in the northeast has the potential to create numerous multi-sectoral opportunities, necessitating a highly skilled workforce. This transition presents both challenges (e.g., retraining) and opportunities (e.g., job creation, economic diversification). Northeast BC's incumbent advantage is its existing skilled trades workforce with experience in the oil and gas industry. Several professions have direct overlap with the oil and gas industry given the similar technologies and processes associated with blue hydrogen production. Broadly, the hydrogen industry will require diverse talent in a wide range of professions in order to grow, including:

- **Engineers:** Professionals skilled in chemical, mechanical, electrical and process engineering.
- **Renewable Energy Experts:** Expertise in integrating hydrogen production with renewable energy sources, such as wind, solar, and hydroelectric power.
- **Safety and Compliance Officers:** Specialized training in safety protocols, hazardous materials handling, and compressed gas to ensure safe operations and adherence to industry standards.
- **Technician and Operators:** Skilled technicians and plant operators to manage the day-to-day operations of hydrogen production plants, storage facilities, and distribution networks.
- **Digital Experts:** Professionals with digital skills and expertise in generative AI, design, data analytics, and automation.
- **Automotive Specialists:** Skilled trades and technicians to maintain and service FCEVs and refueling stations.
- **Business and Policy Professionals:** Professionals with project management, sales and commercial skills to support the growth of the hydrogen economy, and experts who understand the regulatory and compliance requirements specific to the hydrogen industry.
- **Innovators and Researchers:** Experts who can innovate and improve hydrogen production methods, storage solutions, and application technologies.

To meet these needs, specialized training and education programs must be developed. At the early stages of a sector's growth, there is often a disconnect between what industry needs and what post-secondary institutions are offering. At a high level, this means a hydrogen hub would require:

- **Vocational Training:** Programs focused on specific technical skills related to hydrogen production, safety, and maintenance, as well as end-use technologies such as refueling stations, vehicle and fuel cell maintenance.

- **Higher education programs:** Universities and colleges offering courses and degrees in hydrogen technology, renewable energy systems, and engineering.

- **Continuing education and upskilling opportunties:** Opportunities to train existing workforces through workshops, certifications, and on-the-job training. BCIT's Hydrogen Symposium identified three elements for an upskilling package:
"1) certification for working with materials at extreme high pressure,
2) training in cryogenics for extreme low-temperature materials, and
3) hydrogen safety training." [54]

While not specifically in the northeast, efforts are already underway in BC's broader northern region to launch specialized training and education programs. For example, Prince George's College of New Caledonia is working in collaboration with local trucking company Velocity Truck Centres to develop a new hydrogen and compressed natural gas (CNG) curriculum for technicians. [55]

What We Heard: Expert Feedback on Regional Considerations

In our workshop, participants were gathered and asked: "What are the competitive advantages associated with hydrogen hub development in the region (compared to other prominent hubs in development) and what are the opportunities to collaborate with neighbouring jurisdictions?" The following themes represent the summarized feedback collected by facilitators.

Regional Advantages

- **Skilled workforce** with transferable skills from the oil and gas industry
- **Flexible and adaptable programs** at local post-secondary institutions, and a readiness to adjust programming based on new needs in the local economy (e.g., hydrogen, electrification)
- **Positive local attitude** towards industrial development and growth
- **Plentiful stock of industrial lands** available for development
- **Streamlined and efficient municipal and regional development processes**, and local governments that are responsive to industry needs
- **New pipeline infrastructure is welcomed** by local municipalities and industry

Regional Challenges

- **Limited public understanding of hydrogen's risks, uses, and benefits,** including hydrogen's role compared to existing energy sources
- **Agricultural Land Reserve (ALR) restrictions** on potential industrial land and permitting challenges
- **Negative public perception of new energy infrastructure investment** when basic needs (e.g., power, water) are unmet
- **Limited capacity** of current rail networks and aging infrastructure
- **Difficulities attracting new workers**, without major projects (e.g., Site C)
- **Electrification challenges** in rural areas, including infrastructure and reliability

Regional Opportunities

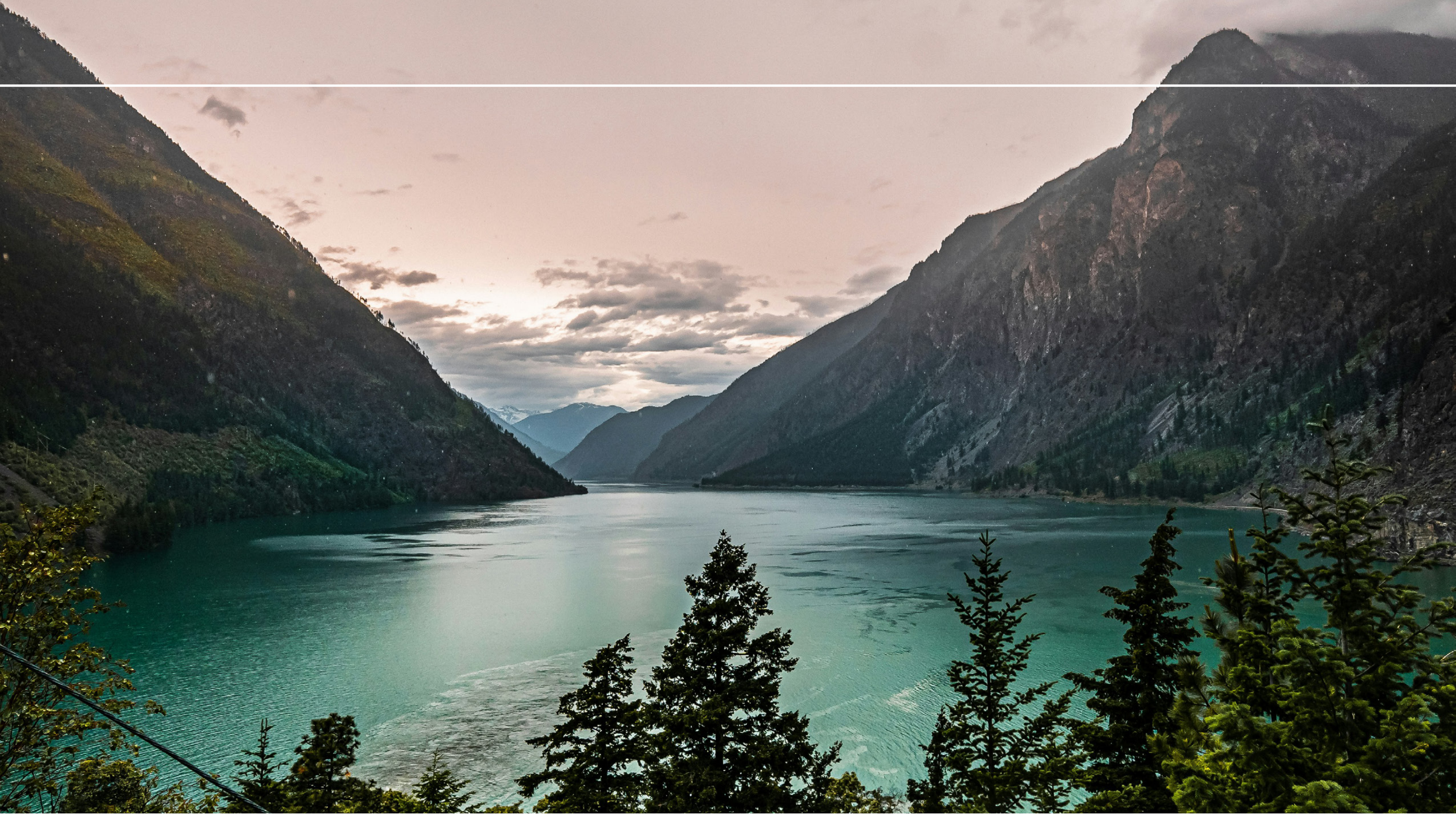
- There are several **First Nations taking the lead** to develop new energy projects and infrastructure for the region
- **Interest in developing working groups** that include the Agricultural Land Commission, CN Rail, and BCER, among others, to discuss future industrial development in the region
- **Continuing partnerships with the Alberta grid** for electricity exchange in the Fort Nelson region
- **Leveraging the positive existing local government and industry relations** to explore and remove the barriers to development
- **Addressing public concerns** through further educational materials and events

Regional Recommendations for Hub Partners

- **Explore new ways to enhance knowledge transfer between the region and nearby hubs.** The Northeast hub, if successful, would need to operate in close collaboration with Central and Northwestern partners. Knowledge transfer between the north and south, where the majority of hydrogen technology companies are headquartered, will also be critical. **[Recommendation Lead: All Partners]**
- **Explore the creation of a regulatory task force.** There is a need to streamline regulatory and permitting barriers to project development for hydrogen all across the province. There may be a role for CEMPO to play in facilitating regular collaboration between industry, utilities, First Nations, and municipalities, to identify the barriers facing project developers and overcome them promptly. This recommendation aligns closely with the policy action in the BC Hydrogen Strategy to "Establish a working group made up of representatives from the hydrogen industry, regulatory agencies, and government to implement B.C. Hydrogen Strategy actions". **[Recommendation Lead: Province, Utilities, BCER]**
- **Create a hydrogen workforce development strategy.** Part of the collaborative approach to develop and retain talent should include setting measurable, actionable targets to develop the hub's labour force. BC does not currently have a dedicated labour strategy for the clean economy. A dedicated hydrogen workforce strategy should build on the existing consultations to avoid duplication, and rely on partnerships with post-secondary institutions and municipalities. There is a need for ongoing collaboration between academia and industry to ensure that the skills needed by industry are being taught and that they are marketed as a tangible career path for workers of all ages looking to join the low-carbon workforce. The Province partnered with Fraser Basin Council and Creative Links to complete a gap analysis to identify resources for hydrogen labour and skills development in BC; this could lay the groundwork for the strategy. [56] **[Recommendation Lead: Province, Industry, Post-Secondary Institutions]**

- **Continue support for public education and awareness activities.** There still appears to be a limited public understanding of hydrogen province-wide. Further efforts are needed to disseminate the latest evidence surrounding hydrogen's role in the local economy, from carbon intensity to safety to best end uses and more. Accessible, summarized resources and "101" content can help dispel myths and increase public awareness of the role hydrogen can play in the decarbonization of local communities, thereby building buy-in. The Province partnered with Fraser Basin Council and the Canadian Hydrogen Association to develop new hydrogen education materials to inform the public. This is a good first step and should be a building block for ongoing public-private-nonprofit sector collaborations to advance awareness and education. **[Recommendation Lead: Province, Local Governments]**

- **Establish a formal collaborative framework for Northern BC hydrogen hubs:** Create a structured platform, such as a joint working group or committee, where representatives from the Central, Northwest and Northeast regions can regularly meet. This collaboration should enable the exchange of best practices and technical expertise, and build off of the foundational work by the City of Prince George to establish a northern hydrogen hub. It is important for regional leaders to have a forum where they can develop joint projects, such as shared infrastructure, joint research and development, or coordinated marketing and outreach campaigns. Furthermore, collaboration on regulatory and policy frameworks, such as harmonizing regulations and policies related to hydrogen production and transportation, can help streamline processes and reduce barriers to project development in all regions. By implementing these strategies, the Northeast can build strong partnerships with its Central and Northwestern counterparts, fostering a collaborative and mutually beneficial approach to hydrogen development in BC. **[Recommendation Lead: Local Governments]**



Conclusion

The feasibility of a Northeast BC hydrogen hub by 2035 is intertwined with a complex interplay of factors. The region's abundant natural gas reserves, coupled with existing infrastructure and proximity to geological formations suitable for carbon storage position it as a prime location for blue hydrogen production. However, to fully realize this potential, supply-side challenges must be addressed. These include the need for further advancements and cost reductions in carbon capture technologies, as well as careful consideration of potential constraints in electricity supply and infrastructure, particularly in light of the region's vulnerability to climate change impacts. The need for new public-private investments in key transportation infrastructure such as railways, roads and bridges is also of the utmost importance.

On the demand side, the pathway to success likely lies in prioritizing heavy-duty transportation, particularly long-haul trucking, rail, and off-road heavy-duty vehicles as the primary drivers for hydrogen adoption in the region. While other potential end uses, such as industrial applications and energy storage hold promise, their current costs limit prospects within the next decade. The current high cost of hydrogen production and transportation also remains a significant hurdle, underscoring the importance of ongoing research, development, and economies of scale to achieve cost competitiveness with traditional fuels.

Collaboration is likely to be paramount to the hub's success. Collaboration opportunities with neighboring Northern BC regions and Alberta offer the potential for knowledge sharing, technology transfer, and shared market development, ultimately strengthening the hydrogen supply chain in Western Canada. However, this is contingent on overcoming regulatory and policy differences, infrastructure gaps, and securing affordable and reliable power, all of which are essential for fostering a conducive environment for investment and innovation. Furthermore, developing a skilled workforce through targeted training and education programs will be critical to support the growth and sustainability of the hydrogen industry in the region.

In conclusion, the development of a hydrogen hub in Northeast BC presents a compelling opportunity for economic growth and decarbonization. However, its realization demands a concerted effort from all partners. Addressing supply-side challenges, fostering demand in priority sectors, promoting regional collaboration, and investing in workforce development are all crucial steps towards establishing a thriving hydrogen ecosystem in the region by 2035. This will require ongoing commitment, innovation, and strategic investments. By embracing the unique roles of hydrogen in a regional clean economy, Northeast BC could potentially position itself at the forefront of the next wave of clean economic growth in BC.

All Recommendations for Hub Partners

Category	Recommendation	Lead Partner(s)	Timeline
Supply-Side	**1.** Focus on carbon capture technology development and literacy	All Partners	2025-2030
	2. Provide further public clarity on electricity infrastructure adaptation and growth	Province, Utilities	2025-2030
	3. Continue support for market-based policies that increase competition between hydrogen and carbon-intensive fuels	Province	Ongoing
Demand-Side	**1.** Focus the Northeast hub's development around heavy transportation	All Partners	2025-2030
	2. Limit consideration of blended hydrogen for heat as a pathway to reduce emissions	Province, Utilities	2025-2030
	3. Continue government funding for demonstration projects and communicate outcomes	Province	2025-2030
Regional Considerations	**1.** Explore new ways to enhance knowledge transfer between the region and nearby hubs	All Partners	2025-2030
	2. Explore the creation of a regulatory task force	Province, Utilities, BCER	<1 year
	3. Create a hydrogen workforce development strategy	Province, Industry, Post-Secondary Institutions	2025-2030
	4. Continue support for public education and awareness activities	Province, Industry	Ongoing
	5. Establish a formal collaborative framework for Northern BC hydrogen hubs	Province, Local Governments	2025-2030

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